



JUNOS[™]e Software for E-series[™] Routing Platforms

Physical Layer Configuration Guide

Release 10.1.x

Juniper Networks, Inc.

1194 North Mathilda Avenue
Sunnyvale, California 94089
USA

408-745-2000

www.juniper.net

Part Number: 162-02050-00, Revision A00

Juniper Networks, the Juniper Networks logo, JUNOS, NetScreen, ScreenOS, and Steel-Belted Radius are registered trademarks of Juniper Networks, Inc. in the United States and other countries. JUNOSe is a trademark of Juniper Networks, Inc. All other trademarks, service marks, registered trademarks, or registered service marks are the property of their respective owners.

Juniper Networks assumes no responsibility for any inaccuracies in this document. Juniper Networks reserves the right to change, modify, transfer, or otherwise revise this publication without notice.

Products made or sold by Juniper Networks or components thereof might be covered by one or more of the following patents that are owned by or licensed to Juniper Networks: U.S. Patent Nos. 5,473,599, 5,905,725, 5,909,440, 6,192,051, 6,333,650, 6,359,479, 6,406,312, 6,429,706, 6,459,579, 6,493,347, 6,538,518, 6,538,899, 6,552,918, 6,567,902, 6,578,186, and 6,590,785.

JUNOSe™ Software for E-series™ Routing Platforms Physical Layer Configuration Guide

Release 10.1.x

Copyright © 2009, Juniper Networks, Inc.

All rights reserved. Printed in USA.

Writing: Krupa Chandrashekar, Subash Babu Asokan, Mark Barnard, Bruce Gillham, Sarah Lesway-Ball, Helen Shaw, Brian Wesley Simmons, Fran Singer, Michael Taillon

Editing: Benjamin Mann

Illustration: Nathaniel Woodward

Cover Design: Edmonds Design

Revision History

30 April 2009— Revision 1

The information in this document is current as of the date listed in the revision history.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. The JUNOS software has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

END USER LICENSE AGREEMENT

READ THIS END USER LICENSE AGREEMENT ("AGREEMENT") BEFORE DOWNLOADING, INSTALLING, OR USING THE SOFTWARE. BY DOWNLOADING, INSTALLING, OR USING THE SOFTWARE OR OTHERWISE EXPRESSING YOUR AGREEMENT TO THE TERMS CONTAINED HEREIN, YOU (AS CUSTOMER OR IF YOU ARE NOT THE CUSTOMER, AS A REPRESENTATIVE/AGENT AUTHORIZED TO BIND THE CUSTOMER) CONSENT TO BE BOUND BY THIS AGREEMENT. IF YOU DO NOT OR CANNOT AGREE TO THE TERMS CONTAINED HEREIN, THEN (A) DO NOT DOWNLOAD, INSTALL, OR USE THE SOFTWARE, AND (B) YOU MAY CONTACT JUNIPER NETWORKS REGARDING LICENSE TERMS.

1. **The Parties.** The parties to this Agreement are (i) Juniper Networks, Inc. (if the Customer's principal office is located in the Americas) or Juniper Networks (Cayman) Limited (if the Customer's principal office is located outside the Americas) (such applicable entity being referred to herein as "Juniper"), and (ii) the person or organization that originally purchased from Juniper or an authorized Juniper reseller the applicable license(s) for use of the Software ("Customer") (collectively, the "Parties").

2. **The Software.** In this Agreement, "Software" means the program modules and features of the Juniper or Juniper-supplied software, for which Customer has paid the applicable license or support fees to Juniper or an authorized Juniper reseller, or which was embedded by Juniper in equipment which Customer purchased from Juniper or an authorized Juniper reseller. "Software" also includes updates, upgrades and new releases of such software. "Embedded Software" means Software which Juniper has embedded in or loaded onto the Juniper equipment and any updates, upgrades, additions or replacements which are subsequently embedded in or loaded onto the equipment.

3. **License Grant.** Subject to payment of the applicable fees and the limitations and restrictions set forth herein, Juniper grants to Customer a non-exclusive and non-transferable license, without right to sublicense, to use the Software, in executable form only, subject to the following use restrictions:

a. Customer shall use Embedded Software solely as embedded in, and for execution on, Juniper equipment originally purchased by Customer from Juniper or an authorized Juniper reseller.

b. Customer shall use the Software on a single hardware chassis having a single processing unit, or as many chassis or processing units for which Customer has paid the applicable license fees; provided, however, with respect to the Steel-Belted Radius or Odyssey Access Client software only, Customer shall use such Software on a single computer containing a single physical random access memory space and containing any number of processors. Use of the Steel-Belted Radius or IMS AAA software on multiple computers or virtual machines (e.g., Solaris zones) requires multiple licenses, regardless of whether such computers or virtualizations are physically contained on a single chassis.

c. Product purchase documents, paper or electronic user documentation, and/or the particular licenses purchased by Customer may specify limits to Customer's use of the Software. Such limits may restrict use to a maximum number of seats, registered endpoints, concurrent users, sessions, calls, connections, subscribers, clusters, nodes, realms, devices, links, ports or transactions, or require the purchase of separate licenses to use particular features, functionalities, services, applications, operations, or capabilities, or provide throughput, performance, configuration, bandwidth, interface, processing, temporal, or geographical limits. In addition, such limits may restrict the use of the Software to managing certain kinds of networks or require the Software to be used only in conjunction with other specific Software. Customer's use of the Software shall be subject to all such limitations and purchase of all applicable licenses.

d. For any trial copy of the Software, Customer's right to use the Software expires 30 days after download, installation or use of the Software. Customer may operate the Software after the 30-day trial period only if Customer pays for a license to do so. Customer may not extend or create an additional trial period by re-installing the Software after the 30-day trial period.

e. The Global Enterprise Edition of the Steel-Belted Radius software may be used by Customer only to manage access to Customer's enterprise network. Specifically, service provider customers are expressly prohibited from using the Global Enterprise Edition of the Steel-Belted Radius software to support any commercial network access services.

The foregoing license is not transferable or assignable by Customer. No license is granted herein to any user who did not originally purchase the applicable license(s) for the Software from Juniper or an authorized Juniper reseller.

4. **Use Prohibitions.** Notwithstanding the foregoing, the license provided herein does not permit the Customer to, and Customer agrees not to and shall not: (a) modify, unbundle, reverse engineer, or create derivative works based on the Software; (b) make unauthorized copies of the Software (except as necessary for backup purposes); (c) rent, sell, transfer, or grant any rights in and to any copy of the Software, in any form, to any third party; (d) remove any proprietary notices, labels, or marks on or in any copy of the Software or any product in which the Software is embedded; (e) distribute any copy of the Software to any third party, including as may be embedded in Juniper equipment sold in the secondhand market; (f) use any 'locked' or key-restricted feature, function, service, application, operation, or capability without first purchasing the applicable license(s) and obtaining a valid key from Juniper, even if such feature, function, service, application, operation, or capability is enabled without a key; (g) distribute any key for the Software provided by Juniper to any third party; (h) use the Software in any manner that extends or is broader than the uses purchased by Customer from Juniper or an authorized Juniper reseller; (i) use Embedded Software on non-Juniper equipment; (j) use Embedded Software (or make it available for use) on Juniper equipment that the Customer did not originally purchase from Juniper or an authorized Juniper reseller; (k) disclose the results of testing or benchmarking of the Software to any third party without the prior written consent of Juniper; or (l) use the Software in any manner other than as expressly provided herein.

5. **Audit.** Customer shall maintain accurate records as necessary to verify compliance with this Agreement. Upon request by Juniper, Customer shall furnish such records to Juniper and certify its compliance with this Agreement.

6. **Confidentiality.** The Parties agree that aspects of the Software and associated documentation are the confidential property of Juniper. As such, Customer shall exercise all reasonable commercial efforts to maintain the Software and associated documentation in confidence, which at a minimum includes restricting access to the Software to Customer employees and contractors having a need to use the Software for Customer's internal business purposes.

7. **Ownership.** Juniper and Juniper's licensors, respectively, retain ownership of all right, title, and interest (including copyright) in and to the Software, associated documentation, and all copies of the Software. Nothing in this Agreement constitutes a transfer or conveyance of any right, title, or interest in the Software or associated documentation, or a sale of the Software, associated documentation, or copies of the Software.

8. **Warranty, Limitation of Liability, Disclaimer of Warranty.** The warranty applicable to the Software shall be as set forth in the warranty statement that accompanies the Software (the "Warranty Statement"). Nothing in this Agreement shall give rise to any obligation to support the Software. Support services may be purchased separately. Any such support shall be governed by a separate, written support services agreement. TO THE MAXIMUM EXTENT PERMITTED BY LAW, JUNIPER SHALL NOT BE LIABLE FOR ANY LOST PROFITS, LOSS OF DATA, OR COSTS OR PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, OR FOR ANY SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THIS AGREEMENT, THE SOFTWARE, OR ANY JUNIPER OR JUNIPER-SUPPLIED SOFTWARE. IN NO EVENT SHALL JUNIPER BE LIABLE FOR DAMAGES ARISING FROM UNAUTHORIZED OR IMPROPER USE OF ANY JUNIPER OR JUNIPER-SUPPLIED SOFTWARE. EXCEPT AS EXPRESSLY PROVIDED IN THE WARRANTY STATEMENT TO THE EXTENT PERMITTED BY LAW, JUNIPER DISCLAIMS ANY AND ALL WARRANTIES IN AND TO THE SOFTWARE (WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE), INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT DOES JUNIPER WARRANT THAT THE SOFTWARE, OR ANY EQUIPMENT OR NETWORK RUNNING THE SOFTWARE, WILL OPERATE WITHOUT ERROR OR INTERRUPTION, OR WILL BE FREE OF VULNERABILITY TO INTRUSION OR ATTACK. In no event shall Juniper's or its suppliers' or licensors' liability to Customer, whether in contract, tort (including negligence), breach of warranty, or otherwise, exceed the price paid by Customer for the Software that gave rise to the claim, or if the Software is embedded in another Juniper product, the price paid by Customer for such other product. Customer acknowledges and agrees that Juniper has set its prices and entered into this Agreement in reliance upon the disclaimers of warranty and the limitations of liability set forth herein, that the same reflect an allocation of risk between the Parties (including the risk that a contract remedy may fail of its essential purpose and cause consequential loss), and that the same form an essential basis of the bargain between the Parties.

9. **Termination.** Any breach of this Agreement or failure by Customer to pay any applicable fees due shall result in automatic termination of the license granted herein. Upon such termination, Customer shall destroy or return to Juniper all copies of the Software and related documentation in Customer's possession or control.

10. **Taxes.** All license fees payable under this agreement are exclusive of tax. Customer shall be responsible for paying Taxes arising from the purchase of the license, or importation or use of the Software. If applicable, valid exemption documentation for each taxing jurisdiction shall be provided to Juniper prior to invoicing, and Customer shall promptly notify Juniper if their exemption is revoked or modified. All payments made by Customer shall be net of any applicable withholding tax. Customer will provide reasonable assistance to Juniper in connection with such withholding taxes by promptly: providing Juniper with valid tax receipts and other required documentation showing Customer's payment of any withholding taxes; completing appropriate applications that would reduce the amount of withholding tax to be paid; and notifying and assisting Juniper in any audit or tax proceeding related to transactions hereunder. Customer shall comply with all applicable tax laws and regulations, and Customer will promptly pay or reimburse Juniper for all costs and damages related to any liability incurred by Juniper as a result of Customer's non-compliance or delay with its responsibilities herein. Customer's obligations under this Section shall survive termination or expiration of this Agreement.

11. **Export.** Customer agrees to comply with all applicable export laws and restrictions and regulations of any United States and any applicable foreign agency or authority, and not to export or re-export the Software or any direct product thereof in violation of any such restrictions, laws or regulations, or without all necessary approvals. Customer shall be liable for any such violations. The version of the Software supplied to Customer may contain encryption or other capabilities restricting Customer's ability to export the Software without an export license.

12. **Commercial Computer Software.** The Software is "commercial computer software" and is provided with restricted rights. Use, duplication, or disclosure by the United States government is subject to restrictions set forth in this Agreement and as provided in DFARS 227.7201 through 227.7202-4, FAR 12.212, FAR 27.405(b)(2), FAR 52.227-19, or FAR 52.227-14(ALT III) as applicable.

13. **Interface Information.** To the extent required by applicable law, and at Customer's written request, Juniper shall provide Customer with the interface information needed to achieve interoperability between the Software and another independently created program, on payment of applicable fee, if any. Customer shall observe strict obligations of confidentiality with respect to such information and shall use such information in compliance with any applicable terms and conditions upon which Juniper makes such information available.

14. **Third Party Software.** Any licensor of Juniper whose software is embedded in the Software and any supplier of Juniper whose products or technology are embedded in (or services are accessed by) the Software shall be a third party beneficiary with respect to this Agreement, and such licensor or vendor shall have the right to enforce this Agreement in its own name as if it were Juniper. In addition, certain third party software may be provided with the Software and is subject to the accompanying license(s), if any, of its respective owner(s). To the extent portions of the Software are distributed under and subject to open source licenses obligating Juniper to make the source code for such portions publicly available (such as the GNU General Public License ("GPL") or the GNU Library General Public License ("LGPL")), Juniper will make such source code portions (including Juniper modifications, as appropriate) available upon request for a period of up to three years from the date of distribution. Such request can be made in writing to Juniper Networks, Inc., 1194 N. Mathilda Ave., Sunnyvale, CA 94089, ATTN: General Counsel. You may obtain a copy of the GPL at <http://www.gnu.org/licenses/gpl.html>, and a copy of the LGPL at <http://www.gnu.org/licenses/lgpl.html>.

15. **Miscellaneous.** This Agreement shall be governed by the laws of the State of California without reference to its conflicts of laws principles. The provisions of the U.N. Convention for the International Sale of Goods shall not apply to this Agreement. For any disputes arising under this Agreement, the Parties hereby consent to the personal and exclusive jurisdiction of, and venue in, the state and federal courts within Santa Clara County, California. This Agreement constitutes the entire and sole agreement between Juniper and the Customer with respect to the Software, and supersedes all prior and contemporaneous

agreements relating to the Software, whether oral or written (including any inconsistent terms contained in a purchase order), except that the terms of a separate written agreement executed by an authorized Juniper representative and Customer shall govern to the extent such terms are inconsistent or conflict with terms contained herein. No modification to this Agreement nor any waiver of any rights hereunder shall be effective unless expressly assented to in writing by the party to be charged. If any portion of this Agreement is held invalid, the Parties agree that such invalidity shall not affect the validity of the remainder of this Agreement. This Agreement and associated documentation has been written in the English language, and the Parties agree that the English version will govern. (For Canada: Les parties aux présentes confirment leur volonté que cette convention de même que tous les documents y compris tout avis qui s'y rattache, soient rédigés en langue anglaise. (Translation: The parties confirm that this Agreement and all related documentation is and will be in the English language)).

Abbreviated Table of Contents

About the Documentation	xix
-------------------------	-----

Part 1

Chapters

Chapter 1	Configuring Channelized T3 Interfaces	3
Chapter 2	Configuring T3 and E3 Interfaces	45
Chapter 3	Configuring Unchannelized OCx/STMx Interfaces	73
Chapter 4	Configuring Channelized OCx/STMx Interfaces	109
Chapter 5	Configuring Ethernet Interfaces	175
Chapter 6	Managing Tunnel-Service and IPSec-Service Interfaces	215

Part 2

Index

Index	233
-------	-----

Table of Contents

About the Documentation xix

E-series and JUNOS ^e Documentation and Release Notes	xix
Audience	xix
E-series and JUNOS ^e Text and Syntax Conventions	xix
Obtaining Documentation	xxi
Documentation Feedback	xxi
Requesting Technical Support	xxi
Self-Help Online Tools and Resources	xxii
Opening a Case with JTAC	xxii

Part 1

Chapters

Chapter 1

Configuring Channelized T3 Interfaces 3

Overview	3
MDL/FDL Support	3
MDL Standards	4
FDL Standards	4
Timeout of Received MDL and FDL Messages	4
Frequency of FDL Path Messages	5
Higher-Level Protocols	5
Platform Considerations	5
CT3/T3-F0 Line Modules and CT3/T3 12 I/O Modules	6
Exchanging Modules	6
Interface Stack	7
Numbering Scheme	7
T3 Controllers	7
T1 Channels	8
Fractional T1	8
HDLC Channels	9
References	9
Before You Configure an Interface	9

Configuration Tasks	10
Configuring a T3 Controller	10
Configuring MDL Messages	11
Other Optional Tasks	12
Configuring T1 Channels	14
Optional Tasks	14
Configuring FDL Messages	17
Configuring an HDLC Channel	20
Optional Tasks	20
Configuration Example	23
Testing Interfaces	23
Testing at the T3 Layer	23
Testing at the T1 Layer	26
Monitoring Interfaces	29
Setting a Baseline	29
Displaying Counters and Time Intervals	29
Output Filtering	30

Chapter 2 Configuring T3 and E3 Interfaces 45

Overview	45
MDL Support	45
MDL Standards	46
Timeout of Received MDL Messages	46
Higher-Level Protocols	47
Platform Considerations	47
COCX-F3 Line Modules and Associated I/O Modules	47
OCx/STMx/DS3-ATM Line Modules and 4xDs3 ATM I/O Modules	48
CT3/T3-F0 Line Modules and CT3/T3 12 I/O Modules	48
Interface Stack	49
Numbering Scheme	49
References	50
Before You Configure an Interface	50
Configuration Tasks	51
Configuring a T3 or an E3 Controller	51
Configuring MDL Messages	52
Optional Tasks	54
Configuring Fractional T3	56
Configuring an HDLC Channel	57
Optional Tasks	57
Configuration Examples	60
Testing Interfaces	61
Sending BERT Patterns	61
Enabling Local, Network, and Payload Loopback	62
Enabling Remote Loopback	62
Monitoring Interfaces	64
Setting a Baseline	64
Displaying Counters and Time Intervals	64
Output Filtering	65

Chapter 3	Configuring Unchannelized OCx/STMx Interfaces	73
	Overview	73
	APS and MSP	73
	Automatic Switchover	74
	Manual Switchover	74
	Switching Mechanisms	74
	Reversion After Switchover	75
	Communication Methods	75
	Higher-Level Protocols	77
	Platform Considerations	77
	OCx/STMx/DS3-ATM Line Modules	78
	OCx/STMx POS Line Modules	78
	OC48 Line Modules	79
	OC3/STM1 GE/FE Line Module	79
	ES2 4G Line Module	80
	E120 Router Configuration	80
	E320 Router Configuration	80
	OCx/STMx ATM IOAs	81
	OCx/STMx POS IOAs	81
	Numbering Scheme	81
	ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router	82
	E120 Router and E320 Router	83
	Interface Specifier	83
	Exchanging Modules	84
	References	84
	Configuration Tasks	84
	Configuring the SONET/SDH Layers	85
	Configuring APS/MSP	89
	Configuring the Working Interface	90
	Configuring the Protect Interface	91
	Configuring SONET/SDH Alarms	93
	Configuration Example	94
	Configuring APS Event Collection	94
	Manual Switching to a Redundant Port	95
	Testing Interfaces	96
	Loopback Testing	96
	Testing Connectivity	97
	Monitoring SONET/SDH Interfaces	98
	Monitoring Interface Statistics	98
	Monitoring APS/MSP	106
Chapter 4	Configuring Channelized OCx/STMx Interfaces	109
	Overview	109
	SONET APS and SDH MSP	109
	MDL/FDL Support	109
	MDL Standards	110
	FDL Standards	110

Timeout of Received MDL and FDL Messages	110
Frequency of FDL Path Messages	111
Higher-Level Protocols	111
Platform Considerations	111
cOCx/STMx FO Line Module	112
Interface Stack	112
SONET/SDH VT Controllers	113
T3 Controllers	116
HDLC	116
Numbering Scheme	117
References	117
Before You Configure an Interface	118
Configuration Tasks	119
SONET/SDH Configuration Tasks	119
Configuring Higher Layers	124
T1/E1 Configuration Tasks	124
Configuring an Unframed E1 Line	125
Configuring T1 and E1 Lines	125
Configuring T1 Interfaces to Send FDL Messages	128
Disabling Interfaces and Channel Groups	130
Configuring Higher Layers	130
T3 Configuration Tasks	130
Configuring T3 Line Parameters	131
Configuring T3 Interfaces to Send MDL Messages	133
Configuring T1 Channels on T3 Interfaces	134
Configuring T1 Channels to Send FDL Messages	137
Configuring Higher Layers	139
HDLC Channel Configuration Tasks	139
Optional Tasks	139
Configuration Examples	142
Example 1: Configuring Interfaces in SONET Mode	142
Example 2: Configuring Interfaces in SDH Mode	143
Example 3: Configuring Frame Relay	144
Example 4: Configuring PPP	145
Testing Interfaces	145
Sending BERT Patterns	145
Receiving BERT Patterns	147
Enabling Local or Network Loopback	147
Enabling Remote Loopback Testing	149
Testing Connectivity	152
Monitoring Interfaces	153
Setting a Baseline	154
Output Filtering	154
Monitoring APS/MSP	173

Chapter 5**Configuring Ethernet Interfaces****175**

Ethernet Overview	175
Features	176
Ethernet Interface Platform Considerations	176
Numbering Scheme	177
ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router	177
E120 Router and E320 Router	177
Interface Specifier	178
Fast Ethernet I/O Modules	178
FE-8 I/O Module	178
FE-8 SFP I/O Module	179
Gigabit Ethernet I/O Modules and IOAs	179
GE I/O Module	179
GE-2 SFP I/O Module	180
Ports on GE-2 SFP I/O Module	180
Bandwidth and Line Rate Considerations	180
GE-8 I/O Module	180
Bandwidth and Line Rate Considerations	181
Managing High-Density Ethernet	182
OC3-2 GE APS I/O Module	182
ES2-S1 GE-4 IOA	182
ES2-S1 GE-8 IOA	183
ES2 4G LM Combination	183
ES2 10G LM Combination	186
ES2 10G ADV LM Combination	187
ES2-S3 GE-20 IOA	189
ES2 10G LM Combination	189
Bandwidth and Line Rate Considerations	189
Managing High-Density Ethernet	190
ES2 10G ADV LM Combination	190
Bandwidth and Line Rate Considerations	190
Managing High-Density Ethernet	191
10-Gigabit Ethernet IOAs	191
ES2-S1 10GE IOA	191
Managing High-Density Ethernet	191
ES2-S2 10GE PR IOA	192
ES2 10G Uplink LM Combination	192
ES2 10G LM Combination	193
ES2 10G ADV LM Combination	194
Ethernet References	195
High-Density Ethernet	196
Managing Port Redundancy on Gigabit Ethernet I/O Modules	196
Configuration Tasks for Ethernet	198
Configuring the Physical Interface	198
Disabling Ethernet Interfaces	204
Monitoring Ethernet Interfaces	205
Setting Statistics Baselines	205
Using Ethernet show Commands	205

Chapter 6 **Managing Tunnel-Service and IPSec-Service Interfaces** **215**

Tunnel-Service and IPSec-Service Overview	215
Types of Tunnel-Server Ports	216
Dedicated Tunnel-Server Ports	216
Shared Tunnel-Server Ports	216
Types of Tunnel-Service Interfaces	216
Tunnel-Service Interface Platform Considerations	217
Supported Modules for Dedicated Tunnel-Server Ports	217
ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router	218
E120 Router and E320 Router	218
Supported Modules for Shared Tunnel-Server Ports	218
ERX-14xx Models and the ERX-310 Router	218
E120 Router and E320 Router	218
Numbering Scheme	219
ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router	219
E120 Router and E320 Router	219
Interface Specifier	220
Supported Applications for Dedicated and Shared Tunnel-Server Ports	220
Redundancy and Interface Distribution of Tunnel-Service Interfaces	221
SMs, ES2-S1 Service IOA, and Shared Tunnel-Server Modules	221
Static IP Tunnel-Service Interfaces	221
Dynamic Tunnel-Service Interfaces	222
Interface Allocation for Shared Tunnel-Server Modules	222
ISMs	222
Tunnel-Service Interface Considerations	223
Provisioning Tunnel-Service Interfaces	223
Bandwidth Limitations of Shared Tunnel-Server Ports	224
Exchanging Tunnel-Server Modules	224
Unprovisioned Tunnel-Service Interfaces	224
Configuring Tunnel-Server Ports and Tunnel-Service Interfaces	225
Identifying the Physical Location of the Tunnel-Server Port	225
Provisioning the Maximum Number of Interfaces on a Tunnel-Server Port	225
Verifying the Tunnel-Server Interface Configuration	226
Unprovisioning Tunnel-Service Interfaces	226
Monitoring Tunnel-Service Interfaces	228

Part 2 **Index**

Index	233
-------------	-----

List of Figures

Part 1

Chapters

Chapter 1	Configuring Channelized T3 Interfaces	3
	Figure 1: Stack for Channelized T3 Interface	7
	Figure 2: T1 Channels and DS0 Timeslots on a T3 Line	8
Chapter 2	Configuring T3 and E3 Interfaces	45
	Figure 3: Stack for T3 ATM Interfaces	49
	Figure 4: Stack for T3 Frame and E3 Frame Interfaces	49
Chapter 3	Configuring Unchannelized OCx/STMx Interfaces	73
	Figure 5: Interface Stack for OCx/STMx/DS3-ATM Interfaces	78
	Figure 6: Interface Stack for OCx/STMx POS and OC48/STM16 Interfaces	79
	Figure 7: Interface Stack for OCx/STMx POS Interfaces	81
Chapter 4	Configuring Channelized OCx/STMx Interfaces	109
	Figure 8: Stack for cOCx/STMx Interfaces	113
	Figure 9: SONET Multiplexing	114
	Figure 10: SDH Multiplexing	115
	Figure 11: Configuring Fractional T1 in SONET Mode	142
	Figure 12: Configuring Fractional E1 and Unframed E1 in SDH Mode	143
Chapter 6	Managing Tunnel-Service and IPSec-Service Interfaces	215
	Figure 13: Interface Stacking for Tunnel-Service Interfaces	215

List of Tables

About the Documentation	xix
Table 1: Notice Icons	xx
Table 2: Text and Syntax Conventions	xx

Part 1

Chapters

Chapter 1	Configuring Channelized T3 Interfaces	3
	Table 3: MDL and FDL Message Strings and Message Types	4
	Table 4: Sample T1 Subchannel/Timeslot Assignments	8
Chapter 2	Configuring T3 and E3 Interfaces	45
	Table 5: MDL Message Strings and Message Types	46
Chapter 3	Configuring Unchannelized OCx/STMx Interfaces	73
	Table 6: Sample Pairings for Valid APS/MSP Groups	74
	Table 7: Explanation of K1 Byte	76
	Table 8: Explanation of K2 Byte	76
Chapter 4	Configuring Channelized OCx/STMx Interfaces	109
	Table 9: MDL and FDL Message Strings and Message Types	111
	Table 10: Tributary Standards That cOCx/STMx Interfaces Support	114
	Table 11: Identifiers for SONET/SDH VT Controllers	115
	Table 12: Definitions for Identifiers for SONET/SDH VT Controllers	115
	Table 13: Identifiers for T3 Controllers	116
Chapter 5	Configuring Ethernet Interfaces	175
	Table 14: Average Data Rate for ERX-310 Router or in Slots 2 or 4 of an ERX-1440 Router	181
	Table 15: Average Data Rate When Installed in All Other Slots on an ERX-1440 Router	182
	Table 16: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 4G LM	184
	Table 17: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 4G LM	184
	Table 18: Average Data Rate for ES2-S1 GE-8 IOA Combined with Other IOA Types in Same Slot	185
	Table 19: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 10G LM	186
	Table 20: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 10G LM	187
	Table 21: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 10G ADV LM	188
	Table 22: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 10G ADV LM	188

	Table 23: Average Data Rate for One ES2-S3 GE-20 IOA Installed with an ES2 10G LM	189
	Table 24: Average Data Rate for One ES2-S3 GE-20 IOA Installed with an ES2 10G ADV LM	190
Chapter 6	Managing Tunnel-Service and IPSec-Service Interfaces	215
	Table 25: Sample Capacity, Configuration, and Utilization Values for Tunnel-Service Interfaces	224

About the Documentation

- E-series and JUNOS^e Documentation and Release Notes on page xix
- Audience on page xix
- E-series and JUNOS^e Text and Syntax Conventions on page xix
- Obtaining Documentation on page xxi
- Documentation Feedback on page xxi
- Requesting Technical Support on page xxi

E-series and JUNOS^e Documentation and Release Notes

For a list of related JUNOS^e documentation, see
<http://www.juniper.net/techpubs/software/index.html>.

If the information in the latest *JUNOS^e Release Notes* differs from the information in the documentation, follow the *JUNOS^e Release Notes*.

To obtain the most current version of all Juniper Networks technical documentation, see the product documentation page on the Juniper Networks Web site at <http://www.juniper.net/>.

Audience

This guide is intended for experienced system and network specialists working with E-series routers in an Internet access environment.

E-series and JUNOS^e Text and Syntax Conventions

Table 1 on page xx defines notice icons used in this documentation.

Table 1: Notice Icons





Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.

Table 2 on page xx defines text and syntax conventions that we use throughout the E-series and JUNOS documentation.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents commands and keywords in text.	<ul style="list-style-type: none"> ■ Issue the clock source command. ■ Specify the keyword exp-msg.
Bold text like this	Represents text that the user must type.	host1(config)# traffic class low-loss1
Fixed-width text like this	Represents information as displayed on your terminal's screen.	host1# show ip ospf 2 Routing Process OSPF 2 with Router ID 5.5.0.250 Router is an Area Border Router (ABR)
<i>Italic text like this</i>	<ul style="list-style-type: none"> ■ Emphasizes words. ■ Identifies variables. ■ Identifies chapter, appendix, and book names. 	<ul style="list-style-type: none"> ■ There are two levels of access: <i>user</i> and <i>privileged</i>. ■ <i>clusterId</i>, <i>ipAddress</i>. ■ <i>Appendix A, System Specifications</i>
Plus sign (+) linking key names	Indicates that you must press two or more keys simultaneously.	Press Ctrl + b.
Syntax Conventions in the Command Reference Guide		
Plain text like this	Represents keywords.	terminal length
<i>Italic text like this</i>	Represents variables.	<i>mask</i> , <i>accessListName</i>
(pipe symbol)	Represents a choice to select one keyword or variable to the left or to the right of this symbol. (The keyword or variable can be either optional or required.)	diagnostic line

Table 2: Text and Syntax Conventions (*continued*)

Convention	Description	Examples
[] (brackets)	Represent optional keywords or variables.	[internal external]
[]* (brackets and asterisk)	Represent optional keywords or variables that can be entered more than once.	[level1 level2 l1]*
{ } (braces)	Represent required keywords or variables.	{ permit deny } { in out } { <i>clusterId</i> <i>ipAddress</i> }

Obtaining Documentation

To obtain the most current version of all Juniper Networks technical documentation, see the products documentation page on the Juniper Networks Web site at <http://www.juniper.net/>.

To download complete sets of technical documentation to create your own documentation CD-ROMs or DVD-ROMs, see the CD-ROM and DVD-ROM Documentation page at

<http://www.juniper.net/techpubs/resources/cdrom.html>

Copies of the Management Information Bases (MIBs) available in a software release are included on the software CDs and at <http://www.juniper.net/>.

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation to better meet your needs. Send your comments to techpubs-comments@juniper.net, or fill out the documentation feedback form at <https://www.juniper.net/cgi-bin/docbugreport/>. If you are using e-mail, be sure to include the following information with your comments:

- Document or topic name
- URL or page number
- Software release version

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNASC support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/customers/support/downloads/710059.pdf>.

- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC Hours of Operation —The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes: <http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications: <https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum: <http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool located at <https://tools.juniper.net/SerialNumberEntitlementSearch/>.

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at <http://www.juniper.net/cm/>.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see http://www.juniper.net/support/requesting_support.html

Part 1

Chapters

- Configuring Channelized T3 Interfaces on page 3
- Configuring T3 and E3 Interfaces on page 45
- Configuring Unchannelized OCx/STMx Interfaces on page 73
- Configuring Channelized OCx/STMx Interfaces on page 109
- Configuring Ethernet Interfaces on page 175
- Managing Tunnel-Service and IPSec-Service Interfaces on page 215

Chapter 1

Configuring Channelized T3 Interfaces

Use the procedures described in this chapter to configure channelized T3 (CT3) interfaces on E-series routers.

This chapter contains the following sections:

- Overview on page 3
- Platform Considerations on page 5
- References on page 9
- Before You Configure an Interface on page 9
- Configuration Tasks on page 10
- Configuration Example on page 23
- Testing Interfaces on page 23
- Monitoring Interfaces on page 29

Overview

Channelized T3 interfaces are supported by the modules described in this chapter. Configuration procedures for all channelized T3 physical interfaces are identical; however, the capabilities of the modules differ. Each port on a CT3 module offers a total bidirectional rate of 43.008 Mbps.

This section describes the features of channelized T3 interfaces. For information about configuring channelized T3 interfaces over SONET/SDH, see “Configuring Channelized OCx/STMx Interfaces” on page 109.

MDL/FDL Support

Channelized T3 interfaces on some line modules support maintenance data link (MDL) messages at the T3 level and facilities data link (FDL) messages at the T1 level. For a list of the line modules that support MDL and FDL, see *ERX Module Guide, Appendix A, Module Protocol Support*.

You can use MDL and FDL messages to determine the status of a link and to display statistics for the remote end of a connection. MDL and FDL messages do not interfere with other data transmitted over the link.

MDL Standards

You can configure channelized T3 interfaces to send MDL messages that comply with ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990). MDL messages identify a particular link by sharing common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

FDL Standards

Similarly, you can configure T1 channels to send FDL messages that comply with either or both of the following standards:

- ANSI T1.403-1989 Standard for Telecommunications—Network and Customer Installation Interfaces – DS1 Metallic Interface – Robbed-bit Signaling State Definitions (1989)

FDL messages that comply with the ANSI standard identify a particular link by sharing common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

- AT&T Technical Reference 54016—Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format (September 1989)

FDL messages that comply with the AT&T standard identify a particular link by sharing performance data and do not use common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

Timeout of Received MDL and FDL Messages

When a line module receives an MDL or FDL message string, it stores the strings for a period of 10 seconds after the last message was received. If the line module does not receive another message of any type containing the same string within 10 seconds, it erases the local copy of the message.

Most MDL and FDL message strings are common to all three types of messages that can be transmitted: path identifications, idle signals, and test signals. Certain message strings, however, are unique to a particular message type. Table 3 on page 4 briefly describes each MDL/FDL message string and indicates, with a checkmark (✓), the types of messages in which it can be sent.

Table 3: MDL and FDL Message Strings and Message Types

Message String	Description	Path Message	Idle Signal Message	Test Signal Message
eic	Equipment identification code	✓	✓	✓
fic	Frame identification code	✓	✓	✓
generator	Generator number	–	–	✓

Table 3: MDL and FDL Message Strings and Message Types *(continued)*

Message String	Description	Path Message	Idle Signal Message	Test Signal Message
lic	Line identification code	✓	✓	✓
pfi	Facility identification code	✓	–	–
port	Equipment port number	–	✓	–
unit	Unit identification code	✓	✓	✓

As long as another message of any type containing the same string is received within 10 seconds, the line module retains the local copy of the message string and resets the 10-second timer for that string.

For example, if a line module receives an MDL or FDL test signal message containing an eic string, and then receives an idle signal message within 10 seconds that also contains an eic string, it retains the local copy of the most recent eic string received and resets the 10-second timer for that message. However, if 10 seconds pass without the line module receiving a path identification, test signal, or idle signal message containing an eic string, the line module erases the local copy of the eic message string.

For message strings that are unique to a particular message type, the line module must receive another message of the same type containing this string in order to retain the local copy of the string and reset the timer. For example, if the line module receives a test signal message containing a generator string and does not receive another test signal message within 10 seconds, it will erase the local copy of the generator string.

Frequency of FDL Path Messages

E-series routers transmit FDL path identifier messages every second. This behavior complies with the ANSI T1.403 specification (see “References” on page 9 for more information) and is consistent with the MDL implementation for E-series routers.

Higher-Level Protocols

See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the higher-level protocols that channelized T3 interfaces support.

Platform Considerations

You can configure channelized T3 interfaces on the following E-series routers:

- ERX-1440 router
- ERX-1410 router
- ERX-710 router

- ERX-705 router
- ERX-310 router



NOTE: The E120 router and the E320 router do not support configuration of channelized T3 interfaces.

For detailed information about the modules that support channelized T3 interfaces on ERX-7xx models, ERX-14xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that channelized T3 modules support.

CT3/T3-F0 Line Modules and CT3/T3 12 I/O Modules

ERX-7xx models, ERX-14xx models, and the ERX-310 router support the CT3/T3-F0 line module and CT3/T3 12 I/O module. The CT3/T3-F0 line module and CT3/T3 12 I/O module support both channelized and unchannelized T3 operation. You can configure a mixture of channelized and unchannelized ports on these modules. For information about configuring unchannelized T3 ports, see “Configuring Channelized T3 Interfaces” on page 3.

ERX-14xx models support up to 12 CT3/T3-F0 line modules and 12 CT3/T3 12 I/O modules, ERX-7xx models support up to 5 CT3/T3-F0 line modules and 5 CT3/T3 12 I/O modules, and the ERX-310 router supports up to two CT3/T3-F0 line modules and two CT3/T3 12 I/O modules. Each CT3/T3 12 I/O module has 12 physical T3 (DS3) ports. Each port uses two SMB connectors: one for the transmit (TX) connection and one for the receive (RX) connection.

CT3/T3-F0 line modules and CT3/T3 12 I/O modules support the following in channelized mode:

- 28 asynchronous T1 (DS1) channels per T3 port
- 24 DS0 channels (64-Kbps) per T1 interface
- 166 DS0 channels per T3 port

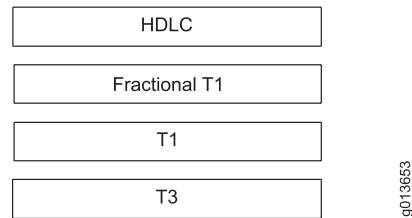
Exchanging Modules

If you replace a CT3/T3 line module and a CT3/T3 I/O module with a CT3/T3-F0 line module and a CT3/T3 12 I/O module or vice versa, you must erase the configuration of the existing modules. See the slot accept command in *Managing Modules* in the *JUNOS System Basics Configuration Guide*.

Interface Stack

Figure 1 on page 7 shows the stack for a channelized T3 interface. To configure a channelized T3 interface, configure a T3 controller, followed by a T1 channel, and then a fractional T1 channel. Finally, you must configure a High-Speed Data Link Control (HDLC) data channel on the interface.

Figure 1: Stack for Channelized T3 Interface



For more information about the layers in a channelized T3 interface, see “Numbering Scheme” on page 7.



NOTE: For a detailed description of interface types and specifiers, see Interface Types and Specifiers in *JUNOS Command Reference Guide*. For information about interfaces, see *Planning Your Network* in *JUNOS System Basics Configuration Guide*.

Numbering Scheme

This section describes how to identify each layer in a channelized T3 interface stack.

T3 Controllers

A T3 controller on a channelized T3 interface is identified using the *slot/port* format where:

- *slot*—Number of the slot in which the line module resides in the chassis.

In ERX-7xx models, line module slots are numbered 2-6; slots 0 and 1 are reserved for SRP modules. In ERX-14xx models, line module slots are numbered 0-5 and 8-13; slots 6 and 7 are reserved for SRP modules. In an ERX-310 router, line module slots are numbered 0-2; slot 0 is reserved for the SRP module.
- *port*—Number of the port on the I/O module. On a CT3/T3 12 I/O module, ports are numbered 0-11.

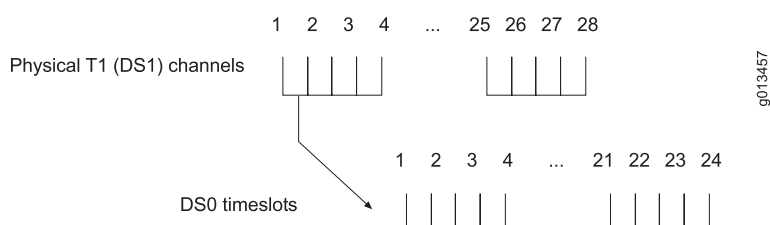
For information about installing line modules and I/O modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

T1 Channels

A T3 line consists of 28 T1 channels (or data streams). A T1 channel is identified by its number in the range 1–28.

Each T1 channel is an aggregate of 24 DS0 timeslots, as shown in Figure 2 on page 8. To configure an entire T1 line, assign 24 timeslots to each channel.

Figure 2: T1 Channels and DS0 Timeslots on a T3 Line



Fractional T1

Fractional T1 is a portion of a T1 line. To configure fractional T1 on a channelized T3 interface, you assign a range of DS0 timeslots to a T1 channel and *subchannel*. A subchannel is group of timeslots. Subchannel numbers range from 1–24 and do not necessarily correspond to DS0 timeslots. The subchannel number identifies a fractional T1 channel.

For example, you might make the assignments for subchannels 1–6 as listed in Table 4 on page 8.

Table 4: Sample T1 Subchannel/Timeslot Assignments

Subchannel	DS0 Timeslot
1	1–4, 10, 22–24
2	5–6
3	7–9
4	11
5	12–15, 20–21
6	16–19

To configure the subchannels listed in Table 4 on page 8, use the following command to specify the T3 controller in chassis slot 0, port 1.

```
host1(config)#controller t3 0/1
```

Then assign the timeslots to channel 1, subchannel 1.

```
host1(config-controll)#t1 1/1 timeslots 1-4,10,22-24
host1(config-controll)#t1 1/2 timeslots 5-6
host1(config-controll)#t1 1/3 timeslots 7-9
host1(config-controll)#t1 1/4 timeslots 11
host1(config-controll)#t1 1/5 timeslots 12-15,20-21
host1(config-controll)#t1 1/6 timeslots 16-19
```

HDLC Channels

To identify an HDLC channel or the complete channelized T3 interface, use the format *slot/port:T1 channel/subchannel*. Refer to the preceding sections for definitions of the variables.

References

For more information about channelized T3 interfaces, consult the following resources:

- RFC 1661—The Point-to-Point Protocol (PPP) (July 1994)
- RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999)
- RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999)
- ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990)
- ANSI T1.403-1989 Standard for Telecommunications—Network and Customer Installation Interfaces – DS1 Metallic Interface – Robbed-bit Signaling State Definitions (1989)
- AT&T Technical Reference 54016—Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format (September 1989)

For more information about bit error rate test (BERT) patterns, see:

- ITU O.151—Error performance measuring equipment operating at the primary rate and above (October 1992)
- ITU O.153—Basic parameters for the measurement of error performance at bit rates below the primary rate (October 1992)
- T1M1.3 Working Group—A Technical Report on Test Patterns for DS1 Circuits (November 1993)
- ANSI T1.404-1994 Standard for Telecommunications—Network-to-Customer – DS3 Metallic Interface Specification (1994)

Before You Configure an Interface

Before you configure a channelized T3 interface, verify the following:

- You have installed the line module and the I/O module correctly.
- Each configured line module is able to transmit data to and receive data from your switch connections.

For more information about installing line modules and I/O modules, see the *ERX Hardware Guide*.

You should also have the following information available:

- Framing type, clock source, cable length, and the loopback method for each T3 controller
- Framing type and clock source for each T1 channel
- Timeslot mapping and line speed for each fractional T1 channel
- HDLC channel information, such as data inversion information, cyclic redundancy check (CRC) type, idle character, maximum transmission unit (MTU), and maximum receive unit (MRU)

Configuration Tasks

To configure a channelized T3 interface:

1. Configure a T3 controller.
2. (Optional) Configure MDL settings.
3. (Optional) Configure other settings for the interface.
4. Configure T1 channels and subchannels.
5. Configure HDLC channels.

Configuring a T3 Controller

To configure a T3 controller:

1. Access Controller Configuration mode by specifying the T3 controller.

```
host1(config)#controller t3 0/1
```

2. Enable the T3 controller.

T3 controllers are disabled by default.

```
host1(config-control)#no shutdown
```

controller t3

- Use to specify a T3 controller in *slot/port* format.
 - *slot*—Number of the slot in which the line module resides in the chassis

- *port*—Number of the port on the I/O module

- Example

```
host1(config)#controller t3 0/1
```

- There is no **no** version.
- See controller t3.

shutdown

- Use to disable a T3 controller.
- The T3 interface is disabled by default.
- Example

```
host1(config-control)#no shutdown
```

- Use the **no** version to restart a disabled interface.
- See shutdown.

Configuring MDL Messages

You can configure a channelized T3 interface to send MDL messages. MDL messages are supported only when T3 framing uses C-bit parity, the default setting.

To configure a channelized T3 interface to send MDL messages:

1. Specify a T3 interface.

```
host1(config)#controller t3 8/0
```

2. (Optional) Configure the interface to operate in an MDL carrier environment.

```
host1(config-control)#mdl carrier
```

3. Specify the MDL messages.

```
host1(config-control)#mdl string eic "ERX-1410"  
host1(config-control)#mdl string fic "FG786"  
host1(config-control)#mdl string lic "Bldg 10"  
host1(config-control)#mdl string pfi "Site 25"  
host1(config-control)#mdl string port 0800  
host1(config-control)#mdl string unit 080001
```

4. Enable transmission of MDL messages.

```
host1(config-control)#mdl transmit path-id  
host1(config-control)#mdl transmit idle-signal  
host1(config-control)#mdl transmit test-signal
```

mdl carrier

- Use to specify that an interface is used in the carrier environment.
- Example

```
host1(config-control)#mdl carrier
```

- Use the **no** version to restore the default situation, in which the interface does not operate in the carrier environment.
- See mdl carrier.

mdl string

- Use to specify an MDL message.
- Example

```
host1(config-control)#mdl string port 0800
```

- Use the no version to restore the default value to the specified MDL message or to all MDL messages.
- See mdl string.

mdl transmit

- Use to enable transmission of MDL messages.
- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.
- Specify the keyword **test-signal** to transmit test signals every second.
- Example

```
host1(config-control)#mdl transmit test-signal
```

- Use the no version to disable transmission of the specified MDL message or all MDL messages.
- See mdl transmit.

Other Optional Tasks

The following configuration tasks are optional when you configure a T3 controller:

- Specify a cable length.
- Change the clock source.
- Change the framing format.
- Enable or disable SNMP link status processing.
- Assign a text description or an alias to the interface.

cablelength

- Use to adjust the transmit power appropriate to the length of the T3 cable.
- Specify a cable length in the range 1–450 feet.
- The router supports two transmit powers, one for a cable length 1–225 feet and another for a cable length 226–450 feet. Therefore, it is not necessary for you to know the exact length of your cable. You only need to know if the cable length is greater than 225 feet. For example, if your cable size exceeds 225 feet, specify any number greater than 225 (and less than 451).
- Example

```
host1(config-controll)#cablelength 300
```

- Use the **no** version to restore the default value, 0 feet.
- See cablelength.

clock source

- Use to configure the transmit clock source for a T3 controller.
- Configure one end of the line as **internal** and the other end as **line**.
- Specify the keyword **line** to use a transmit clock recovered from the line's receive data stream.
- Specify the keywords **internal module** to use the line module's internal clock as the transmit clock.
- Specify the keywords **internal chassis** to use the router's clock as the transmit clock.
- Example

```
host1(config-controll)#clock source internal module
```

- Use the **no** version to revert to the default, **line**.
- See clock source.

description

- Use to assign a text description or an alias to a channelized T3 interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show controllers t3” on page 30 to display the text description.
- Example

```
host1(config-controll)#description toronto ct3 interface
```

- Use the **no** version to remove the text description or alias.
- See description.

framing

- Use to configure the framing format for a T3 controller.
- Specify either **m23** or **c-bit** framing.
- Choose the framing format that is compatible with the framing format of the Telco network device at the other end of the line.
- Select c-bit framing if you intend to configure MDL messages.
- Example

```
host1(config-controll)#framing c-bit
```

- Use the **no** version to restore the default value, **c-bit**.
- See framing.

snmp trap ip link-status

- Use to enable SNMP link status processing on a T3 controller.
- Example

```
host1(config-controll)#snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See snmp trap ip link-status.

Configuring T1 Channels

To configure T1 channels and subchannels:

1. From Global Configuration mode, specify the T3 controller in slot 0, port 1.

```
host1(config)#controller t3 0/1
```

2. Assign a range of timeslots to a channel and subchannel.

For example, assign the following range of timeslots: 1, 3–8, and 10 to channel 2, subchannel 1. Timeslots 2, 9, and 11–24 are available for other subchannels.

```
host1(config-controll)#t1 2/1 timeslots 1,3-8,10
```

Optional Tasks

The T1 channel configuration commands enable you to specify options for a single channel, multiple individual channels, ranges of channels, or any combination of the three types of specifications. For example:

```
host1(config-controll)#t1 2,4,6-15,20-25 clock source line
```

The following configuration tasks are optional when you configure T1 channels:

- Disable T1 channels.
- Change the clock source.
- Assign a text description or an alias to the interface.
- Change the framing format.
- Enable or disable SNMP link status processing.
- Configure FDL messages.

controller t3

- Use to specify a T3 controller in *slot/port* format.
 - *slot*—Number of the slot in which the line module resides in the chassis
 - *port*—Number of the port on the I/O module

- Example

```
host1(config)#controller t3 0/1
```

- There is no **no** version.
- See controller t3.

t1 clock source

- Use to configure the transmit clock source for T1 channels.
- The router supports **internal** and **line clocking**.
 - If you specify internal clocking, the interface transmits data using the line module or the chassis as the internal clock. You must specify one of the following for internal clocking:
 - **module**—Specifies internal clock is from the line module itself
 - **chassis**—Specifies internal clock is from the configured router clock
 - If you specify line clocking, the interface transmits data with a clock recovered from the line's receive data stream.

- Example

```
host1(config-controll)#t1 2,4-10 clock source line
```

- Use the no version to restore the default value, **line**.
- See t1 clock source.

t1 description

- Use to assign a text description or an alias to T1 or fractional T1 channels on a CT3 module.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.

- Use “show controllers t3” on page 30 to display the text description.
- Examples

```
host1(config-controll)#t1 2 description london t1 interface
host1(config-controll)#t1 2/1 description london first ft1 interface
```

- Use the **no** version to remove the text description or alias.
- See t1 description.

t1 framing

- Use to configure the framing format for T1 channels.
- You must specify either **esf** (extended superframe) or **sf** (superframe) framing.
- The framing format you choose must be compatible with the framing format at the other end of the line.
- Example

```
host1(config-controll)#t1 2 framing sf
```

- Use the **no** version to restore the default value, **esf**.
- See t1 framing.

t1 shutdown

- Use to disable T1 channels or a subchannel.
- To disable channels or a subchannel, specify one or more T1 channels or a subchannel in *channel* or *channel/subchannel* format.
 - *channel*—One or more T1 channels, or a range of channels in the range 1–28
 - *subchannel*—Subchannel from 1–24
- The T1 interface is enabled by default.
- Example

```
host1(config-controll)#t1 4-15,18,21,25-27 shutdown
```

- Use the **no** version to restart a disabled interface.
- See t1 shutdown.

t1 snmp trap link-status

- Use to enable SNMP link status processing on T1 channels.
- To enable or disable SNMP on an interface, specify T1 channels or subchannel in *channel* or *channel/subchannel* format.
 - *channel*—One or more T1 channels, or a range of channels in the range 1–28
 - *subchannel*—Subchannel from 1–24
- Example

```
host1(config-controll)#t1 2 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See `t1 snmp trap link-status`.

t1 timeslots

- Use to assign a range of DS0 timeslots to a subchannel as a single data stream.
- To configure a subchannel, specify a T1 channel in *channel/subchannel* format and a range of timeslots.
 - *channel*—T1 channel in the range 1–28
 - *subchannel*—Number from 1–24
 - *dash*—Represents a range of timeslots; a comma separates timeslots. For example, 1-10, 15-18 assigns timeslots 1–10 and 15–18.
- Example

```
host1(config-controll)#t1 2/1 timeslots 1,3-8,10
```

- You can specify a line speed that applies to all DS0 timeslots assigned to a subchannel. The default line speed is 64 Kbps.
- Use the **no** version to delete the fractional T1 circuit.
- See `t1 timeslots`.

Configuring FDL Messages

To configure T1 channels to send FDL messages:

1. Specify a T3 interface.

```
host1(config)#controller t3 8/0
```

2. Specify the standard for transmission of FDL messages on both ends of the T1 connection.

```
host1(config-controll)#t1 1 fdl ansi
```

3. (Optional) Configure one or more T1 channels to operate in an FDL carrier environment.

```
host1(config-controll)#t1 1 fdl carrier
```

4. (ANSI signals) Specify the FDL messages.

```
host1(config-controll)#t1 1 fdl string eic "ERX-1410"  
host1(config-controll)#t1 1 fdl string fic "HY0019"  
host1(config-controll)#t1 1 fdl string lic "Bldg 10"  
host1(config-controll)#t1 1 fdl string unit 080001  
host1(config-controll)#t1 1 fdl string pfi "Site 25"
```

```
host1(config-control)#t1 1 fdl string port 0800
host1(config-control)#t1 1 fdl string generator "Test generator"
```

5. Enable transmission of FDL messages.

```
host1(config-control)#t1 1 fdl transmit path-id
```

6. (Optional) Specify that the router should generate yellow alarms for the T1 channels.

```
host1(config-control)#t1 1 yellow generate
```

7. (Optional) Specify that the router should detect yellow alarms for the T1 channels.

```
host1(config-control)#t1 1 yellow detect
```

t1 fdl

- Use to specify the FDL standard for the channel.
- Specify one or more T1 channels or a range of channels in the range 1–28.
- Specify the keyword **ansi** to support the ANSI FDL standard (see “References” on page 9).
- Specify the keyword **att** to support the AT&T FDL standard (see “References” on page 9).
- Specify the keyword **all** to support both the ANSI and AT&T standards
- Specify the keyword **none** to remove the current FDL mode settings
- You can configure a different standard on each T1 channel.
- Example

```
host1(config-control)#t1 14-20,24 fdl att
```

- Use the **no** version to restore the default, none.
- See t1 fdl.

t1 fdl carrier

- Use to specify that T1 channels are used in the carrier environment.
- Example

```
host1(config-control)#t1 6 fdl carrier
```

- Use the **no** version to restore the default situation, in which the T1 channels do not operate in the carrier environment.
- See t1 fdl carrier.

t1 fdl string

- Use to specify an FDL message as defined in the ANSI T1.403 specification.



NOTE: The router sends these FDL messages only if you have issued the `t1 fdl` command with the **ansi** or **all** keyword and then issued the `t1 fdl transmit` command.

- Example

```
host1(config-controll)#t1 6 fdl string eic "ERX-1440"
```

- Use the **no** version to restore the default value to the specified FDL message or to all FDL messages.
- See `t1 fdl string`.

t1 fdl transmit

- Use to configure the router to send the specified type of FDL message.
- By default, the router sends only FDL performance data messages.



NOTE: The router sends FDL messages specified with “`t1 fdl string`” on page 19 only if you have issued the `t1 fdl` command with the **ansi** or **all** keyword. If you specified the **att** keyword with the `t1 fdl` command, the router sends only performance data.

- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.
- Specify the keyword **test-signal** to transmit test signals every second.
- Example

```
host1(config-controll)#t1 28 fdl transmit path-id
```

- Use the **no** version to disable transmission of the specified FDL message or all FDL messages.
- See `t1 fdl transmit`.

t1 yellow detect

- Use to detect yellow alarm for T1 channels.
- By default, T1 channels detect alarms.
- Example

```
host1(config-controll)#t1 6,10-14,19 yellow detect
```

- Use the **no** version to disable detection of yellow alarms.
- See `t1 yellow`.

t1 yellow generate

- Use to generate a yellow alarm when a loss of frame or loss of signal condition is detected on T1 channels.
- By default, T1 channels generate alarms.
- Example


```
host1(config-controll)#t1 6,10-14,19 yellow generate
```
- Use the **no** version to disable generation of yellow alarms.
- See t1 yellow.

Configuring an HDLC Channel

You must configure an HDLC channel for each group of fractional T1 lines and each full T1 line.

To configure an HDLC channel, specify a serial interface (for example, HDLC channel in slot 0, port 1, channel 1, subchannel 5).

```
host1(config)#interface serial 0/1:1/5
```

Optional Tasks

The following configuration tasks are optional when you configure an HDLC channel on a channelized T3 interface:

- Configure the CRC.
- Specify the HDLC idle character.
- Enable data inversion on the interface.
- Set the time interval for monitoring bit and packet rates.
- Set the MRU.
- Set the MTU.
- Assign a text description or an alias to the serial interface.

crc

- Use to configure the size of the CRC.
- The CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data.
- 16 and 32 indicate the number of bits per frame that are used to calculate the frame check sequence (FCS). Both the sender and receiver must use the same setting.
- Use a 32-bit CRC when transmitting long streams at fast rates and to provide better ongoing error detection.
- Example

```
host1(config-if)#crc 32
```

- Use the **no** version to restore the default value, 16.
- See `crc`.

idle-character

- Use to configure the HDLC idle character.
- The idle character is sent between HDLC packets.
- Specify one of the following idle characters:
 - **flags**—Sets the idle character to 0x7E
 - **marks**—Sets the idle character to 0xFF
- Example

```
host1(config-if)#idle-character marks
```

- Use the **no** version to restore the default value, 0x7E (flags).
- See `idle-character`.

interface serial

- Use to configure a serial interface in the *slot/port:channel/subchannel* format.
 - *slot*—Number of the slot in which the line module resides in the chassis
 - *port*—Number of the port on the I/O module
 - *channel*—T1 channel
 - *subchannel*—Subchannel in the range 1–24
- Example

```
host1(config)#interface serial 0/1:1/5
```

- Use the **no** version to disable the interface.
- See `interface serial`.

invert data

- Use to enable data stream inversion for the interface.
- Enable data stream inversion only if it is turned on at the other end of the line.
- Example

```
host1(config-if)#invert data
```

- Use the **no** version to disable data inversion.
- See `invert data`.

load-interval

- Use to set the time interval at which the router calculates bit and packet rate counters.
- You can choose a multiple of 30 seconds, in the range 30–300 seconds.
- Example

```
host1(config-if)#load-interval 90
```

- Use the **no** version to restore the default value, 300 seconds.
- See load-interval.

mru

- Use to configure the MRU size for the interface.
- Specify a value in the range 4–9996 bytes.
- You should coordinate this value with the network administrator on the other end of the line.
- If you configure a different MRU value in higher-level protocols, such as IP, the router uses the lower value. This can produce unexpected behavior in your network.
- Example

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

- Use the **no** version to restore the default, 1600 bytes.
- See mru.

mtu

- Use to configure the MTU size for the interface.
- Specify a value in the range 4–9996 bytes.
- You should coordinate this value with the network administrator on the other end of the line.
- If you configure a different MTU value in higher-level protocols, such as IP, the router uses the lower value. This can produce unexpected behavior in your network.
- Example

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

- Use the **no** version to restore the default, 1600 bytes.
- See mtu.

serial description

- Use to assign a text description or an alias to a serial HDLC interface.
- You can use this command to help you identify the interface and keep track of interface connections.

- The description or alias can be a maximum of 80 characters.
- Use “show interfaces serial” on page 43 to display the text description.
- Example

```
host1(config-if)#serial description ottawa012 hdlc channel
```

- Use the **no** version to remove the text description or alias.
- See serial description.

Configuration Example

The following example illustrates how to configure the layers on a channelized T3 interface:

```
host1(config)#controller t3 0/1
host1(config-controll)#no shutdown
host1(config-controll)#framing c-bit
host1(config-controll)#clock source internal module
host1(config-controll)#cablelength 220
host1(config-controll)#t1 2 framing esf
lihost1(config-controll)#t1 2 clock source internal
host1(config-controll)#t1 2 loopback local
host1(config-controll)#t1 2/1 timeslots 1,3-8,10
host1(config-controll)#exit
host1(config)#interface serial 0/1:2/1
host1(config-if)#invert data
host1(config-controll)#exit
```

Testing Interfaces

If you want to run loopback tests or bit error rate tests on channelized T3 interfaces, you must enable testing at the T3 or T1 layer. See “Interface Stack” on page 7 for a description of the layers.

For a list of the modules that support bit error rate tests (BERTs) and remote loopback, see *ERX Module Guide, Appendix A, Module Protocol Support*.



NOTE: BERTs are supported on frame-based channelized T3 interfaces, with the exception of the CT3/T3 line module used with the 3-port CT3/T3 I/O module.

Testing at the T3 Layer

To enable testing at the T3 layer:

1. Change the clock source to internal.

```
host1(config-controll)#clock source internal module
```

2. Configure one of the following tests:

- Set the loopback to **local** to test the line without connecting to the network.

```
host1(config-control)#loopback local
```

- Set the loopback to **network** to test the line connected to the network.

```
host1(config-control)#loopback network line
```

3. (Optional) Configure one of the following tests for remote loopback:

- Set the loopback to **remote** to request that a remote device connected on a T3 interface enter into a loopback.

```
host1(config-control)#loopback remote
```

- Configure the T3 interface to enable or disable the ability to enter into a loopback initiated by a remote device, as follows:

- Issue the **equipment customer loopback** command to enable the router to enter into loopback when it receives an appropriate signal from the remote device.

```
host1(config-control)#equipment customer loopback
```

- Issue the **equipment network loopback** command to disable the ability to enter into loopback initiated by a remote device.

```
host1(config-control)#equipment network loopback
```

4. Configure the line to run bit error rate tests.

```
host1(config-control)#bert pattern 2^15 time 20
```

bert

- Use to enable bit error rate tests using the specified pattern on a channelized T3 interface.
- Unlike other configuration commands, **bert** is not stored in NVRAM.
- Specify one of the following test patterns:
 - **0s**—Repetitive test pattern of all zeros, 00000...
 - **1s**—Repetitive test pattern of all ones, 11111...
 - **2^9**—Pseudorandom test pattern, 511 bits in length
 - **2^11**—Pseudorandom test pattern, 2047 bits in length
 - **2^15**—Pseudorandom test pattern, 32,767 bits in length
 - **2^20**—Pseudorandom test pattern, 1,048,575 bits in length
 - **2^20-QRSS**—Pseudorandom QRSS test pattern, 1,048,575 bits in length

- **2^23**—Pseudorandom test pattern, 8,388,607 bits in length
- **alt-0-1**—Repetitive alternating test pattern of zeros and ones, 01010101...
- Specify the duration of the test in the range 1–1440 minutes.
- Example


```
host1(config-controll)#bert pattern 2^15 interval 20
```
- Use the **no** version to stop the test that is running.
- See bert.

equipment loopback

- Use to enable or disable the router's ability to enter into a loopback initiated by a remote device connected on a channelized T3 interface.



NOTE: Remote loopback is available only on channelized T3 interfaces configured to use C-bit framing.

- Specify one of the following loopback options:
 - **customer**—Enables the router to enter into loopback when it receives an appropriate signal from the remote interface
 - **network**—Disables the router's ability to enter into loopback when it receives an appropriate signal from the remote interface
- Examples


```
host1(config-controll)#equipment customer loopback
host1(config-controll)#equipment network loopback
```
- Use the **no** version to disable the router's ability to be placed in loopback by the remote device.
- See equipment loopback.

loopback

- Use to configure a loopback.
- Specify one of the following loopback options.
 - **local**—Loops the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network
 - **network**—Loops the data toward the network before the framer processes the data

- **payload**—Loops the data toward the network after the framer processes the data
- **remote**—Sends a far end alarm code in the C-bit framing, as defined in ANSI T1.404, to notify the remote end to activate or (when you use the **no** version) deactivate the line loopback



NOTE: Remote loopback is available only on channelized T3 interfaces configured to use C-bit framing.

- Example

```
host1(config-control)#loopback local
```

- Use the **no** version to restore the default configuration, no loopback.
- See loopback.

Testing at the T1 Layer

The T1 channel testing commands enable you to specify testing parameters for a single channel, multiple individual channels, ranges of channels, or any combination of the three types of specifications. For example:

```
host1(config-control)#t1 3,6-15,22,25-27 loopback local
```

To enable testing at the T1 layer:

1. Configure one of the following loopback tests.
 - Set the loopback to **local** to test the line without connecting to the network.


```
host1(config-control)#t1 2 loopback local
```
 - Set the loopback to **network** to test the line connected to the network.


```
host1(config-control)#t1 2 loopback network line
```
 - Set the loopback to **remote-loopback** to enable acceptance of loopback commands issued from a remote router.


```
host1(config-control)#t1 2 remote-loopback
```

2. Configure the line to run bit error rate tests.

```
host1(config-control)#t1 2 bert pattern 2^11 time 10 unframed
```

t1 bert

- Use to enable bit error rate tests using the specified pattern on a T1 interface.
- Unlike other configuration commands, **bert** is not stored in NVRAM.

- Specify one of the following test patterns:



NOTE: The CT3/T3-F0 line module supports only the **2^11**, **2^15**, and **2^20-O153** options.

- **0s**—Repetitive test pattern of all zeros, 00000...
- **1s**—Repetitive test pattern of all ones, 11111...
- **2^11**—Pseudorandom test pattern, 2047 bits in length
- **2^15**—Pseudorandom test pattern, 32,767 bits in length
- **2^20-O153**—Pseudorandom test pattern, 1,048,575 bits in length
- **2^20-QRSS**—Pseudorandom QRSS test pattern, 1,048,575 bits in length
- **2^23**—Pseudorandom test pattern, 8,388,607 bits in length
- **alt-0-1**—Repetitive alternating test pattern of zeros and ones, 01010101...



NOTE: The BERT patterns supported when testing the T1 layer vary depending on the line module and I/O module assembly you are using.

- Specify the duration of the test in the range 1–1440 minutes.
- Optionally, specify the unframed keyword to overwrite the framing bits.
- Example

```
host1(config-controll)#t1 2 bert pattern 2^11 interval 10 unframed
```

- Use the **no** version to stop the test that is running.
- See t1 bert.

t1 loopback

- Use to configure a loopback.
- Specify one of the following options:



NOTE: The CT3/T3-F0 line module does not support the **remote line inband** option.

- **local**—Loops the router output data back toward the router at the T1 framer; on supported line modules, also sends an alarm indication signal (AIS) out toward the network
- **network { line | payload }**—Specify the **line** keyword to loop the data back toward the network before the T1 framer and automatically set a local loopback at the HDLC controllers. Specify the **payload** keyword to loop the

payload data back toward the network at the T1 framer and automatically set a local loopback at the HDLC controllers.

- **remote line fdl ansi**—Sends a repeating 16-bit ESF data link code word (00001110 11111111) to the remote end requesting that it enter into a network line loopback. Specify the **ansi** keyword to enable the remote line facilities data link (FDL) ANSI bit loopback on the T1 channel, according to the ANSI T1.403 Specification.
- **remote line fdl bellcore**—Sends a repeating 16-bit ESF data link code word (00010010 11111111) to the remote end requesting that it enter into a network line loopback. Specify the **bellcore** keyword to enable the remote line facilities data link (FDL) Bellcore bit loopback on the T1 channel, per the Bellcore TR-TSY-000312 Specification.
- **remote line inband**—Sends a repeating 5-bit inband pattern (00001) to the remote end requesting that it enter into a network line loopback
- **remote payload [fdl] [ansi]**—Sends a repeating, 16-bit, ESF data link code word (00010100 11111111) to the remote end requesting that it enter into a network payload loopback. Enables the remote payload facilities data link (FDL) ANSI bit loopback on the T1 channel. You can optionally specify **fdl** and **ansi**.
- If you do not specify an option, the router will set a local loopback for the channel.
- Example

```
host1(config-controll)#t1 2 loopback local
```

- Use the **no** version to deactivate loopback. If you specify the **remote** keyword, the **no** version sends the 16-bit ESF data link code word or inband pattern to deactivate the loopback at the remote end based on the last activate request sent to the remote end. If you do not specify the **remote** keyword, the **no** version clears the local loopback configuration.
- See t1 loopback.

t1 remote-loopback

- Use to enable the acceptance of loopback commands issued from a remote router.
- Example

```
host1(config-controll)#t1 2 remote-loopback
```

- Use the **no** version to restore the factory default, which is to reject loopback commands issued from a remote router.
- See t1 remote-loopback.

Monitoring Interfaces

From User Exec mode, use the following **show** commands to monitor and display the T3 interface, T1 interface, and HDLC serial data channel information:

- Monitor channelized T3 interfaces on a slot and port.

```
host1#show controllers t3 0/1
```

- Monitor a T1 interface.

```
host1#show controllers t3 0/1:1
```

- Monitor fractional T1 subchannels.

```
host1#show controllers t3 ft1
```

- Monitor the state of the serial interface or a slot/port.

```
host1#show controllers t3 serial 0/1
```

Setting a Baseline

You can set a statistics baseline for serial interfaces, subinterfaces, and/or circuits using the **baseline interface serial** command. Use the **delta** keyword with the **show** commands to display statistics with the baseline subtracted.

Displaying Counters and Time Intervals

Counters and time intervals are MIB statistics, which are defined in the following specifications:

- RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999)
- RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999)

The **show controllers t3 slot/port all** command displays the following information:

- T3 current interval counters—Counters for the current interval
- T3 last interval counters—Counters for the previous interval
- T3 24-hour total counters—Cumulative counters for the last 24 hours or since the interface was started
- The last 24 hours of 15-minute reporting intervals (96 intervals)

The **show controllers t3 slot/port: channel all** command displays the following information:

- T1 current interval counters—Counters for the current interval
- T1 last interval counters—Counters for the previous interval
- T1 24-hour total counters—Cumulative counters for the last 24 hours or since the interface was started
- The last 24 hours of 15-minute reporting intervals (96 intervals)

Output Filtering

You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See *Command Line Interface* in *JUNOS System Basics Configuration Guide*, for details.

baseline interface serial

- Use to set a statistics baseline for serial interfaces.
- The router implements the baseline by reading and storing the statistics at the time the baseline is set and subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the optional delta keyword with the **show interfaces serial** commands to view the baseline statistics.
- Example

```
host1#baseline interface serial 2/0:1/1
```

- There is no **no** version.
- See baseline interface.

show controllers t1

show controllers t3

- Use to display data and MIB statistics for a T3 interface or a T1 channel.
- Use the **brief** keyword to display the administrative and operational status of all configured T3 interfaces, or to display abbreviated information for the specified T3 interface.
- For definitions of the MIB statistics for a T3 interface, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).
- For definitions of the MIB statistics for a T1 channel, see RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999).
- Field descriptions for T3 interface (T1 channel not specified)
 - Description—Text description or alias if configured for the interface
 - ifAdminStatus—One of the following administrative states of the interface:
 - ifAdminUp—Interface is administratively enabled
 - ifAdminDown—Interface is administratively disabled
 - ifAdminTesting—Interface is administratively configured in a testing state

- snmp trap link-status—Status of SNMP trapping (enabled or disabled)
- alarms detected—One of the following T3 alarms:
 - No alarm present—No alarms present on the line
 - Rcv RAI Failure—Remote device is sending a far end alarm failure
 - Xmt RAI Failure—Local device is sending a far end alarm failure
 - Rcv AIS—Remote device is sending an alarm indication signal (AIS)
 - Xmt AIS—Local device is sending an AIS
 - Rcv LOF—Loss of one or more frames from the remote end
 - Rcv LOS—Loss of signal at the local end
 - Undefined line status—Indicates that the line is in an undefined state



NOTE: The alarms detected field does not appear for interfaces that you disabled in the software.

- framing—Type of framing format
- line code—Type of line code format
- clock source—Type of clock source
- cable length—Cable length, in feet
- Loopback—State of loopback for the controller: enabled or disabled. If loopback is enabled, one of the following states is displayed:
 - Diagnostic—Loops the data back toward the router and sends an AIS toward the network
 - Payload—Loops the data toward the network after the framer has processed the data
 - Line—Loops the data toward the network before the data reaches the framer
- MDL Transmit Path—Status of path transmission: active or not active
- MDL Transmit Test-Signal—Status of test signal: active or not active
- MDL Transmit Idle-Signal—Status of idle signal: active or not active
- Equipment Identification Code—eic string for MDL
- Line Identification Code—lic string for MDL
- Frame Identification Code—fic string for MDL
- Unit Identification Code—unit string for MDL

- Facility Identification Code—pfi string for MDL
- Port Code—port string for MDL
- Generator Number—generator string for MDL
- BERT test—Number of current test and total number of tests
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
- Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
- Time elapse in current interval—Reported in 15-second intervals
- P-bit errored seconds—Number of errored seconds encountered by a T3 in the current interval
- P-bit severely errored seconds—Number of severely errored seconds encountered by a T3 in the current interval
- Severely errored frame seconds—Number of severely errored framing seconds encountered by a T3 in the current interval
- Unavailable seconds—Number of unavailable seconds encountered by a T3 in the current interval
- Line code violations—Number of line code violations encountered by a T3 in the current interval
- P-bit coding violations—Number of coding violations encountered by a T3 in the current interval
- Line errored seconds—Number of line errored seconds encountered by a T3 in the current interval
- C-bit coding violations—Number of C-bit coding violations encountered by a T3 in the current interval
- C-bit errored seconds—Number of C-bit errored seconds encountered by a T3 in the current interval
- C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3 in the current interval
- Example 1—In this example, a T3 interface is specified.

```
host1#show controllers t3 2/0
```

```
DS3 2/0
Description: toronto ct3 interface
ifAdminStatus = ifAdminDown
snmp trap link-status = enabled
No alarms detected
Framing is C-BIT, Line Code is B3ZS, Clock Source is Line
Cable Length is 0 ft
Loopback Disabled
MDL Transmit Path is not active
MDL Transmit Test-Signal is active
MDL Transmit Idle-Signal is not active
Equipment Identification Code is ERX-1400
Line Identification Code is Bldg 10
Frame Identification Code is null string
Unit Identification Code is 080001
Facility Identification Code is Site 25
Port Code is Port 0800
Generator Number is null string
Number of valid interval - 96
Time elapse in current interval - 861
Ds3 Current Interval Counters
P-bit errored seconds           = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds            = 0
Line code violations            = 0
P-bit coding violations         = 0
Line errored seconds           = 0
C-bit coding violations         = 0
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
Ds3 Last Interval Counters
P-bit errored seconds           = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds            = 0
Line code violations            = 0
P-bit coding violations         = 0
Line errored seconds           = 0
C-bit coding violations         = 0
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
Ds3 24 Hour Total Counters
P-bit errored seconds           = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds            = 0
Line code violations            = 0
P-bit coding violations         = 0
Line errored seconds           = 0
C-bit coding violations         = 0
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
```

- Example 2—In this example, the **brief** keyword is specified.

```
host1#show controllers t3 brief
```

Interfaces	ifAdminStatus	OperationalStatus
5/0(channelized)	up	up
5/1(channelized)	up	up
5/2(channelized)	up	down
5/3(channelized)	down	down
5/4(channelized)	down	down
5/5(channelized)	down	down
5/6(channelized)	down	down
5/7(channelized)	down	down
5/8(channelized)	down	down
5/9(channelized)	down	down
5/10(channelized)	down	down
5/11(channelized)	down	down
3/0(channelized)	down	down
3/1(channelized)	down	down
3/2(channelized)	down	down
4/0:1/1(unchannelized)	up	down
4/2:1/1(channelized)	up	LowerLayerDown

- Field descriptions for a T1 channel
 - Description—Text description or alias if configured for the interface
 - ifOperStatus—Physical state of the interface:
 - ifOperDown—Interface is not functioning
 - ifOperLowerLayerDown—Lower layer in the interface stack is not functioning
 - ifOperNotPresent—Module has been removed from the chassis
 - ifOperTesting—Interface is being tested
 - ifOperUp—Interface is functioning
 - Yellow Alarm detection—Status of yellow alarm detection: active or not active
 - Yellow Alarm generation—Status of yellow alarm generation: active or not active
 - snmp trap link-status—Status of SNMP trapping (enabled or disabled)
 - Framing—Type of framing format
 - Clock source—Type of clock source
 - Loopback state—Type of loopback (if enabled) and status: enabled or disabled
 - Last remote loopback request sent—None or deactivate
 - FDL—Status of FDL: standard configured or not configured
 - FDL Transmit Path—Status of path transmission: active or not active
 - FDL Transmit Idle-Signal—Status of idle signal: active or not active

- FDL Transmit Test-Signal—Status of test signal: active or not active
- Equipment Identification Code—eic string for FDL
- Line Identification Code—lic string for FDL
- Frame Identification Code—fic string for FDL
- Unit Identification Code—unit string for FDL
- Facility Identification Code—pfi string for FDL
- Port Code—port string for FDL
- Generator Number—generator string for FDL
- BERT test—Number of current test and total number of tests
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
- Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
- Time elapse in current interval—Statistics are reported in 15-minute intervals
- Errored seconds—Number of errored seconds encountered by a T1 in the current interval
- Severely errored seconds—Number of severely errored seconds encountered by a T1 in the current interval
- Severely errored frame seconds—Number of severely errored framing seconds encountered by a T1 in the current interval
- Unavailable seconds—Number of unavailable seconds encountered by a T1 in the current interval
- Clock slip seconds—Number of clock slips encountered by a T1 in the current interval
- Path code violations—Number of coding violations encountered by a T1 in the current interval
- Line errored seconds—Number of line errored seconds encountered by a T1 in the current interval
- Bursty errored seconds—Number of bursty errored seconds encountered by a T1 in the current interval

- Degraded minutes—Number of minutes that a T1 line is degraded
- Line code violations—Number of line code violations encountered by a T1 in the current interval
- Example 1—In this example, a T1 channel and the **brief** keyword are specified.

```
host1#show controllers t1 2/0:1 brief
```

```
DS3 2/0:1
ifOperStatus = ifOperUp
Yellow Alarm detection is active
Yellow Alarm generation is active
snmp trap link-status = disabled
Framing is D4, Line Code is Ami, Clock Source is Internal - Module
Allocated Ds0 time slot map = 0x0
Loopback Enabled - Diagnostic
Last Remote Loopback Request Sent - Deactivate
FDL is not configured
FDL Transmit Path-Id is not active
FDL Transmit Test-Signal is not active
FDL Transmit Idle-Signal is not active
Equipment Identification Code is the null string
Line Identification Code is the null string
Frame Identification Code is the null string
Unit Identification Code is the null string
Facility Identification Code is the null string
Port Code is the null string
Generator Number is the null string
BERT test - 2 in 23
Test Interval 1 minute(s), Complete
Sync count = 1
Received bit count = 92148912
Error bit count = 17
Number of valid interval - 90
Time elapse in current interval - 580
```

- Example 2—In this example, the **brief** keyword is specified for all T1 channels.

```
host1#show controllers t1 brief
```

Interfaces	ifAdminStatus	OperationalStatus
5/0:1(framed)	up	lowerLayerDown
5/0:2(framed)	up	lowerLayerDown
5/0:3(framed)	up	lowerLayerDown
5/0:4(framed)	up	lowerLayerDown
5/0:5(framed)	up	lowerLayerDown
5/0:6(framed)	up	lowerLayerDown
...		
5/2:26(framed)	up	lowerLayerDown
5/2:27(framed)	up	lowerLayerDown
5/2:28(framed)	up	lowerLayerDown

- Example 3—In this example, a T1 channel is specified.

```
host1#show controllers t1 1/0:1
```

```
DS1 1/0:1
Description: toronto t1 channel
ifOperStatus = ifOperUp
Yellow Alarm detection is active
Yellow Alarm generation is active
snmp trap link-status = disabled
Framing is D4, Line Code is Ami, Clock Source is Internal - Module
Allocated Ds0 time slot map = 0x0
Last Remote Loopback Request Sent - Deactivate
FDL is not configured
FDL Transmit Path-Id is not active
FDL Transmit Test-Signal is not active
FDL Transmit Idle-Signal is not active
Equipment Identification Code is the null string
Line Identification Code is the null string
Frame Identification Code is the null string
Unit Identification Code is the null string
Facility Identification Code is the null string
Port Code is the null string
Generator Number is the null string
BERT test - 2 in 23
Test Interval 1 minute(s), Complete
Sync count = 1
Received bit count = 92148912
Error bit count = 17
Number of valid interval - 90
Time elapse in current interval - 580
```

```
Ds1 Current Interval Counters
Errored seconds = 0
Severely errored second = 0
Severely errored frame seconds = 0
Unavailable seconds = 0
Clock slip seconds = 0
Path code violations = 0
Line errored seconds = 0
Bursty errored seconds = 0
Degraded minutes = 0
Line code violations = 0
```

```
Ds1 Last Interval Counters
Errored seconds = 0
Severely errored second = 0
Severely errored frame seconds = 0
Unavailable seconds = 0
Clock slip seconds = 0
Path code violations = 0
Line errored seconds = 0
Bursty errored seconds = 0
Degraded minutes = 0
Line code violations = 0
```

```
Ds1 24 Hour Total Counters
Errored seconds = 25
Severely errored second = 7
Severely errored frame seconds = 25
Unavailable seconds = 0
Clock slip seconds = 6
```

```

Path code violations = 18
Line errored seconds = 0
Bursty errored seconds = 0
Degraded minutes = 0
Line code violations = 0

```

- See `show controllers t1`.
- See `show controllers t3`.

`show controllers t3 ft1`

- Use to display information about the state of a fractional T1 subchannel.
- Field descriptions
 - Description—Text description or alias if configured for the interface
 - ifOperStatus—Physical status of the interface
 - ifOperUp—Interface is functioning
 - ifOperTesting—Interface is being tested
 - ifOperNotPresent—Module has been removed from the chassis
 - ifOperDown—Interface is not functioning
 - snmp trap link-status of SNMP trapping (enabled or disabled)
 - Ds0 time slot map—Fractional T1 subchannel
 - Ds0 mode—Base data rate: either Nx56 or Nx64
- The `ft1` option displays the state of the serial interface.
- The optional slot and port parameters display information about a specific slot and port.
- Example

```

host1#show controllers t3 ft1

Ft1 Interface at 2/0:1/1
Description: toronto ft1 interface
ifOperStatus = ifOperLowerLayerDown
snmp trap link-status = disabled
Ds0 time slot map = 0x1
Ds0 mode = Nx64

```

- See `show controllers t3`.

`show controllers t3 remote`

- Use to display MIB statistics for the remote end of a channelized T3 interface configured for MDL or for the remote end of a T1 channel configured for FDL.
- Specify the `all` option to display detailed information for all 15-minute intervals.
- For definitions of the MIB statistics for a T3 interface, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).

- For definitions of the MIB statistics for a T1 channel, see RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999).
- Field descriptions for a T3 interface
 - Far End MDL Carrier bit—Status of MDL configuration on remote device connected to T3 interface
 - set—MDL is configured for carrier mode
 - not set—MDL is not configured for carrier mode
 - Far End Equipment Identification Code—eic string sent by remote device for MDL
 - Far End Line Identification Code—lic string sent by remote device for MDL
 - Far End Frame Identification Code—fic string sent by remote device for MDL
 - Far End Unit Identification Code—unit string sent by remote device for MDL
 - Far End Facility Identification Code—pfi string sent by remote device for MDL
 - Far End Generator Number—generator string sent by remote device for MDL
 - Far End Port Number—port string sent by remote device for MDL
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapse in current interval—Number of seconds that have passed in the 15-minute (900-second) interval
 - C-bit errored seconds—Number of C-bit errored seconds encountered by a T3 in the current interval
 - C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3 in the current interval
 - C-bit coding violations—Number of C-bit coding violations encountered by a T3 in the current interval
 - Unavailable seconds—Number of unavailable seconds encountered by a T3 in the current interval
 - Invalid seconds—Number of seconds when statistics were not collected
- Example—In this example, a T3 interface is specified.

```
host1#show controllers t3 5/0 remote
```

```
Far End MDL Carrier bit is not set
Far End Equipment Identification Code is the null string
Far End Line Identification Code is the null string
Far End Frame Identification Code is the null string
Far End Unit Identification Code is the null string
Far End Facility Identification Code is the null string
```

Far End Generator Number is the null string
 Far End Port Number is the null string

Number of valid interval - 3
 Time elapse in current interval - 756

Ds3 Current Interval Counters
 C-bit errored seconds = 0
 C-bit severely errored seconds = 0
 C-bit coding violations = 0
 Unavailable seconds = 0
 Invalid seconds = 0

Ds3 Last Interval Counters
 C-bit errored seconds = 0
 C-bit severely errored seconds = 0
 C-bit coding violations = 0
 Unavailable seconds = 0
 Invalid seconds = 0

Ds3 24 Hour Total Counters
 C-bit errored seconds = 1
 C-bit severely errored seconds = 1
 C-bit coding violations = 330
 Unavailable seconds = 0
 Invalid seconds = 0

- Field descriptions for a T1 channel
 - DS1—Identifier of T1 channel
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapse in current interval—Number of seconds that have passed in the 15-minute (900-second) interval
 - Far End FDL Carrier bit—Status of FDL configuration on remote device connected to T1 channel
 - set—FDL is configured for carrier mode
 - not set—FDL is not configured for carrier mode
 - Far End Equipment Identification Code—eic string sent by remote device for FDL
 - Far End Line Identification Code—lic string sent by remote device for FDL
 - Far End Frame Identification Code—fic string sent by remote device for FDL
 - Far End Unit Identification Code—unit string sent by remote device for FDL
 - Far End Facility Identification Code—pfi string sent by remote device for FDL
 - Far End Generator Number—generator string sent by remote device for FDL
 - Far End Port Number—port string sent by remote device for FDL

- Errored seconds—Number of errored seconds encountered by a T1 in the current interval
- Severely errored seconds—Number of severely errored seconds encountered by a T1 in the current interval
- Severely errored frame seconds—Number of severely errored framing seconds encountered by a T1 in the current interval
- Unavailable seconds—Number of unavailable seconds encountered by a T1 in the current interval
- Clock slip seconds—Number of clock slips encountered by a T1 in the current interval
- Path code violations—Number of coding violations encountered by a T1 in the current interval
- Line errored seconds—Number of line errored seconds encountered by a T1 in the current interval
- Bursty errored seconds—Number of bursty errored seconds encountered by a T1 in the current interval
- Degraded minutes—Number of minutes that a T1 line is degraded
- Example—In this example, a T1 channel is specified.

```
host1#show controllers t1 10/1:1 remote
```

```
DS1 10/1:1
```

```
Number of valid interval - 0
```

```
Time elapse in current interval - 0
```

```
Far End FDL Carrier bit is not set
```

```
Far End Equipment Identification Code is the null string
```

```
Far End Line Identification Code is the null string
```

```
Far End Frame Identification Code is the null string
```

```
Far End Unit Identification Code is the null string
```

```
Far End Facility Identification Code is the null string
```

```
Far End Port Number is the null string
```

```
Far End Generator Number is the null string
```

```
DS1 Current Interval Counters
```

```
Errored seconds = 0
```

```
Severely errored second = 0
```

```
Severely errored frame seconds = 0
```

```
Unavailable seconds = 0
```

```
Clock slip seconds = 0
```

```
Path code violations = 0
```

```
Line errored seconds = 0
```

```
Bursty errored seconds = 0
```

```
Degraded minutes = 0
```

```
DS1 24 Hour Total Counters
```

```
Errored seconds = 0
```

```
Severely errored second = 0
```

```
Severely errored frame seconds = 0
```

```
Unavailable seconds = 0
```

```

Clock slip seconds          = 0
Path code violations        = 0
Line errored seconds       = 0
Bursty errored seconds     = 0
Degraded minutes           = 0

```

- See `show controllers t3 remote`.

show controllers t3 serial

- Use to display the state of the serial interface.
- Field descriptions
 - Description—Text description or alias if configured for the interface
 - ifOperStatus—Physical status of the interface
 - ifOperUp—Interface is functioning
 - ifOperTesting—Interface is being tested
 - ifOperNotPresent—Module has been removed from the chassis
 - ifOperDown—Interface is not functioning
 - snmp trap link-status of SNMP trapping (enabled or disabled)
 - Crc type checking—Size of the cyclic redundancy check (CRC)
 - Hdlc mru—Current size of the maximum receive unit (MRU)
 - Hdlc mtu—Current size of the maximum transmission unit (MTU)
 - Hdlc interface speed—Current line speed of the interface
 - Ds0 time slot map—T1 subchannel
 - Invert data disabled—Status of the data inversion feature
- The optional *slot* and *port* parameters display information about a specific slot and port.
- Use the *slot/port/channel/subchannel* option to display information about a specific interface.
- Example

```
host1#show controllers t3 serial
```

```

Serial Interface at 2/0:1/1
ifOperStatus = ifOperLowerLayerDown
snmp trap link-status = disabled
Crc type checking - CRC16
Hdlc mru = 9996
Hdlc mtu = 9996
Hdlc interface speed = 64000
Ds0 time slot map = 0x1
Invert data disabled, Ds0 mode = Nx64

```

```

Serial Interface at 2/1:1/1
ifOperStatus = ifOperLowerLayerDown
snmp trap link-status = disabled
Crc type checking - CRC16
Hdlc mru = 9996
Hdlc mtu = 9996
Hdlc interface speed = 64000
Ds0 time slot map = 0x1
Invert data disabled, Ds0 mode = Nx64

```

Found 2 Serial Interfaces

- See show controllers t3.

show interfaces serial

- Use to display information about the serial interfaces you specify.
- Field descriptions
 - Fractional Interface—Location of a channelized T1 or E1 interface
 - Description—Text description or alias if configured for the interface
 - ifOperStatus—Administrative status of the interface
 - ifOperUp—Interface is functioning
 - ifOperTesting—Interface is being tested
 - ifOperNotPresent—Module has been removed from the chassis
 - ifOperDown—Interface is not functioning
 - ifOperLowerDown—Lower layer in the interface stack is not functioning
 - snmp trap link-status—Enabled or disabled
 - Encapsulation—Layer 2 encapsulation display; options include: ppp, frame-relay ietf, mlppp, mlframe-relay ietf, hdlc
 - Crc type checking—Size of the CRC
 - Hdlc mru—Current size of the MRU
 - Hdlc mtu—Current size of the MTU
 - Hdlc interface speed—Current line speed of the interface
 - Hdlc idle-character—Current idle character
 - Invert data disabled—Status of the data inversion feature
 - Ds0 time slot map—Channelized T1 or E1 channel group
 - Ds0 mode—Nx56 or Nx64
 - 5 minute input rate—Data rates based on the traffic received in the last five minutes

- 5 minute output rate—Data rates based on the traffic sent in the last five minutes
- Interface statistics
 - Packets received—Number of packets received on the interface
 - Bytes received—Number of bytes received on the interface
 - Errored packets received—Number of packets with errors received on the interface
 - Packets sent—Number of packets sent on the interface
 - Bytes sent—Number of bytes sent on the interface
- Errored packets sent—Number of packets with errors sent from the interface
- Example

```
host1#show interfaces serial 0/1:2 brief
```

```
Serial Interface at 0/1:2
Description: ottawa012 hdlc channel
ifOperStatus = ifOperUp
snmp trap link-status = disabled
Encapsulation hdlc
Crc type checking - CRC16
Hdlc mru = 1600
Hdlc mtu = 1600
Hdlc interface speed = 768000
Hdlc idle-character marks
Invert data disabled
Ds0 time slot map = 0xfff
Ds0 mode = Nx64
```

```
Serial Interface at 13/0:2
Description: ottawa013 hdlc channel
ifOperStatus = ifOperUp
snmp trap link-status = disabled
Crc type checking - CRC16
Hdlc mru = 1600
Hdlc mtu = 1600
Hdlc interface speed = 768000
Invert data disabled
Ds0 time slot map = 0xfff000
Ds0 mode = Nx64
```

```
Found 2 Serial Interfaces
```

- See show interfaces.

Chapter 2

Configuring T3 and E3 Interfaces

Use the procedures described in this chapter to configure T3 and E3 interfaces on E-series routers.

This chapter contains the following sections:

- Overview on page 45
- Platform Considerations on page 47
- References on page 50
- Before You Configure an Interface on page 50
- Configuration Tasks on page 51
- Configuration Examples on page 60
- Testing Interfaces on page 61
- Monitoring Interfaces on page 64

Overview

Unchannelized T3 (DS3) and E3 interfaces are supported by the modules described in this chapter.

Throughout this chapter, interfaces on modules that provide ATM support are called T3/E3 ATM interfaces. Similarly, interfaces on modules that provide frame (HDLC) support are called T3/E3 frame interfaces.

This section describes the features of unchannelized T3/E3 interfaces. For information about configuring unchannelized T3 (DS3) interfaces over SONET/SDH, see “Configuring Channelized OCx/STMx Interfaces” on page 109.

MDL Support

T3 interfaces on some line modules support maintenance data link (MDL) messages. For a list of the line modules that support MDL, see *ERX Module Guide, Appendix A, Module Protocol Support*.

You can use MDL messages to determine the status of a link and to display statistics for the remote end of a connection. MDL messages do not interfere with other data transmitted over the link.

MDL Standards

You can configure T3 interfaces to send MDL messages that comply with ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990). MDL messages identify a particular link by sharing common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

Timeout of Received MDL Messages

When a line module receives an MDL message string, it stores the strings for a period of 10 seconds after the last message was received. If the line module does not receive another message of any type containing the same string within 10 seconds, it erases the local copy of the message.

Most MDL message strings are common to all three types of messages that can be transmitted: path identifications, idle signals, and test signals. Certain message strings, however, are unique to a particular message type. Table 5 on page 46 briefly describes each MDL message string and indicates, with a checkmark (✓), the types of messages in which it can be sent.

Table 5: MDL Message Strings and Message Types

Message String	Description	Path Message	Idle Signal Message	Test Signal Message
eic	Equipment identification code	✓	✓	✓
fic	Frame identification code	✓	✓	✓
generator	Generator number	–	–	✓
lic	Line identification code	✓	✓	✓
pfi	Facility identification code	✓	–	–
port	Equipment port number	–	✓	–
unit	Unit identification code	✓	✓	✓

As long as another message of any type containing the same string is received within 10 seconds, the line module retains the local copy of the message string and resets the 10-second timer for that string.

For example, if a line module receives an MDL test signal message containing an eic string, and then receives a idle signal message within 10 seconds that also contains an eic string, it retains the local copy of the most recent eic string received and resets the 10-second timer for that message. However, if 10 seconds pass without the line module receiving a path identification, test signal, or idle signal message containing an eic string, the line module erases the local copy of the eic message string.

For message strings that are unique to a particular message type, the line module must receive another message of the same type containing this string in order to retain the local copy of the string and reset the timer. For example, if the line module receives a test signal message containing a generator string and does not receive another test signal message within 10 seconds, it will erase the local copy of the generator string.

Higher-Level Protocols

See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the higher-level protocols that T3 and E3 interfaces support.

Platform Considerations

You can configure unchannelized T3 and unchannelized E3 interfaces on the following E-series routers:

- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router



NOTE: The E120 router and the E320 router do not support configuration of unchannelized T3/E3 interfaces.

For detailed information about the modules that support unchannelized T3/E3 interfaces on ERX-7xx models, ERX-14xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that unchannelized T3/E3 modules support.

COCX-F3 Line Modules and Associated I/O Modules

ERX-7xx models, ERX-14xx models, and the ERX-310 router support the COCX-F3 line modules and associated I/O modules.

ERX-14xx models support up to twelve COCX-F3 line modules and twelve corresponding I/O modules, ERX-7xx models support up to five of these line modules and five corresponding I/O modules, and the ERX-310 router supports up to two of these line modules and two corresponding I/O modules. There are twelve physical T3/E3 (DS3) ports per I/O module. Each port uses two SMB connectors: one for the transmit (TX) connection and one for the receive (RX) connection.

COCX-F3 line modules and associated I/O modules support the following:

- Clocking
- Redundancy
- Frame Relay logical interface support
- Unique IP interface support for each PPP or Frame Relay PVC interface
- HDLC
- Fractional T3 (T3 only)
- Line speeds of 45 Mbps (T3) and 34 Mbps (E3)

OCx/STMx/DS3-ATM Line Modules and 4xDS3 ATM I/O Modules

ERX-7xx models, ERX-14xx models, and the ERX-310 router support the OCx/STMx/DS3-ATM line modules and 4xDS3 ATM I/O modules.

ERX-14xx models support up to twelve OCx/STMx/DS3-ATM line modules and twelve 4xDS3 ATM I/O modules, the ERX-7xx models support up to five of these line modules and five corresponding I/O modules, and the ERX-310 router supports up to two of these line modules and two corresponding I/O modules. There are four physical T3 (DS3) ports per I/O module. Each port uses two BNC connectors: one for the transmit (TX) connection and one for the receive (RX) connection.

OCx/STMx/DS3-ATM line modules pair with 4xDS3 ATM I/O modules to support the following:

- Clocking
- Redundancy
- Frame Relay logical interface support
- Unique IP interface support for each PPP or Frame Relay PVC interface
- Line speeds of 45 Mbps

CT3/T3-F0 Line Modules and CT3/T3 12 I/O Modules

ERX-7xx models, ERX-14xx models, and the ERX-310 router support the CT3/T3-F0 line modules and CT3/T3 12 I/O modules.

The CT3/T3-F0 line module and CT3/T3 12 I/O module support both channelized and unchannelized T3 operation. You can configure a mixture of channelized and unchannelized ports on these modules. To configure these modules to support unchannelized T3 operation, issue **no** “channelized” on page 51 . (See “Configuration Tasks” on page 51 .) For information about configuring channelized T3 ports, see “Configuring T3 and E3 Interfaces” on page 45.

ERX-14xx models support up to twelve CT3/T3-F0 line modules and twelve CT3/T3 12 I/O modules, ERX-7xx models support up to five of these line modules and five corresponding I/O modules, and the ERX-310 router supports up to two of these line modules and two corresponding I/O modules. There are twelve physical T3 (DS3) ports per I/O module. Each port uses two SMB connectors: one for the transmit (TX) connection and one for the receive (RX) connection.

CT3/T3-F0 line modules and CT3/T3 12 I/O I/O modules to support the following:

- Clocking
- Redundancy
- Frame Relay logical interface support
- Unique IP interface support for each PPP or Frame Relay PVC interface
- Line speeds of 45 Mbps

Interface Stack

Figure 3 on page 49 shows the stack for T3 ATM interfaces. Figure 4 on page 49 shows the stack for T3 frame and E3 frame interfaces.

To configure a T3 ATM interface, first configure a T3 controller. To configure ATM parameters, see *Configuring ATM* in *JUNOS Link Layer Configuration Guide*.

To configure a T3 frame or E3 frame interface, first configure a T3 or E3 controller, and then configure a High-Speed Data Link Control (HDLC) data channel on the controller.

Figure 3: Stack for T3 ATM Interfaces

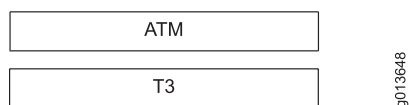
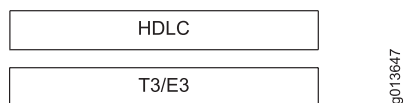


Figure 4: Stack for T3 Frame and E3 Frame Interfaces



NOTE: For a detailed description of interface types and specifiers, see Interface Types and Specifiers in *JUNOS Command Reference Guide*. For information about interfaces, see *Planning Your Network* in *JUNOS System Basics Configuration Guide*.

Numbering Scheme

This section describes how to identify T3 and E3 interfaces.

A T3/E3 controller on an ATM or frame interface is identified using the *slot/port* format, where:

- *slot*—Number of the slot in which the line module resides in the chassis. In ERX-7xx models, line module slots are numbered 2-6 (slots 0 and 1 are reserved for SRP modules). In ERX-14xx models, line module slots are numbered 0–5

and 8–13 (slots 6 and 7 are reserved for SRP modules). In the ERX-310 router, the line module slots are numbered 0–2 (slot 0 is reserved for the SRP module).

- *port*—Number of the port on the I/O module. On the CT3/T3 12 I/O and E3-12 FRAME I/O modules, ports are numbered 0–11.

For information about installing line modules and I/O modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

References

For more information about T3 and E3 interfaces, consult the following resources:

- RFC 1661—The Point-to-Point Protocol (PPP) (July 1994)
- RFC 2364—PPP over AAL5 (July 1998)
- RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999)
- RFC 2516—Method for Transmitting PPP over Ethernet (PPPoE) (February 1998)
- RFC 2684—Multiprotocol Encapsulation over ATM Adaptation Layer 5 (September 1999)
- ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990)

For more information about bit error test (BERT) patterns, see:

- ITU O.151—Error performance measuring equipment operating at the primary rate and above (October 1992)
- ITU O.153—Basic parameters for the measurement of error performance at bit rates below the primary rate (October 1992)
- ANSI T1.404-1994 Standard for Telecommunications—Network-to-Customer – DS3 Metallic Interface Specification (1994)

Before You Configure an Interface

Before you configure a T3 or an E3 interface, verify that you have installed the line modules and I/O modules correctly.

You need the following information for each T3 controller:

- Framing type
- Clock source
- Cable length

You also need HDLC channel information, such as data inversion information, for interfaces that support HDLC.

Configuration Tasks

Configure a T3 interface by entering Global Configuration mode and performing the following tasks:

1. Configure a T3 controller.
2. (Optional) Configure MDL settings.
3. (Optional) Configure other settings for the interface.
4. Configure HDLC channels for T3 frame and E3 frame controllers.
5. (Optional) Configure fractional T3 for T3 frame controllers.
6. Use the appropriate **show** commands to verify your configuration.

E3 interface configuration tasks are identical to T3 interface configuration tasks, except that the CLI commands contain **e3** instead of **t3**.

For example, you configure an E3 controller with the **controller e3** command instead of the **controller t3** command.

Configuring a T3 or an E3 Controller

To configure a T3 or an E3 controller:

1. Select the T3 or E3 controller from Global Configuration mode.

```
host1(config)#controller t3 3/2
```

2. Enable the T3 or E3 controller.

```
host1(config-controller)#no shutdown
```

3. (CT3/T3-F0 line module only) Enable unchannelized operation for this controller.

```
host1(config-controller)#no channelized
```

channelized

- Use to enable channelized T3 operation on an interface of a CT3/T3-F0 line module.

- Example

```
host1(config-controller)#channelized
```

- Use the **no** version to enable unchannelized T3 operation on an interface for a CT3/T3-F0 line module.

- See channelized.

controller e3

- Use to specify an E3 controller in *slot/port* format.

- *slot*—Number of the slot in which the line module resides in the chassis
- *port*—Number of the port on the I/O module
- Example


```
host1(config)#controller e3 3/2
```
- There is no **no** version.
- See controller e3.

controller t3

- Use to specify a T3 controller in *slot/port* format.
 - *slot*—Number of the slot in which the line module resides in the chassis
 - *port*—Number of the port on the I/O module
- Example


```
host1(config)#controller t3 0/1
```
- There is no **no** version.
- See controller t3.

shutdown

- Use to disable a T3 or an E3 controller.
- The T3 or E3 interface is disabled by default.
- Example


```
host1(config-controll)#shutdown
```
- Use the **no** version to restart a disabled interface.
- See shutdown.

Configuring MDL Messages

You can configure a T3 interface to send MDL messages. MDL messages are supported only when T3 framing uses C-bit parity, the default setting.

To configure a T3 interface to send MDL messages:

1. Specify a T3 interface.

```
host1(config)#controller t3 8/0
```

2. (Optional) Configure the interface to operate in an MDL carrier environment.

```
host1(config-controll)#mdl carrier
```

3. Specify the MDL messages.

```
host1(config-control)#mdl string eic "ERX-1410"
host1(config-control)#mdl string fic "FG786"
host1(config-control)#mdl string lic " Bldg 10"
host1(config-control)#mdl string pfi "Site 25"
host1(config-control)#mdl string port 0800
```

4. Enable transmission of MDL messages.

```
host1(config-control)#mdl transmit path-id
host1(config-control)#mdl transmit idle-signal
host1(config-control)#mdl transmit test-signal
```

mdl carrier

- Use to specify that an interface is used in the carrier environment.
- Example

```
host1(config-control)#mdl carrier
```

- Use the **no** version to restore the default situation, in which the interface does not operate in the carrier environment.
- See mdl carrier.

mdl string

- Use to specify an MDL message.
- Example

```
host1(config-control)#mdl string port 0800
```

- Use the **no** version to restore the default value to the specified MDL message or to all MDL messages.
- See mdl string.

mdl transmit

- Use to enable transmission of MDL messages.
- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.
- Specify the keyword **test-signal** to transmit test signals every second.
- Example

```
host1(config-control)#mdl transmit test-signal
```

- Use the **no** version to disable transmission of the specified MDL message or all MDL messages.
- See mdl transmit.

Optional Tasks

The following configuration tasks are optional for T3 and E3 interfaces:

- Specify the cable length (T3 only).
- Change the clock source.
- Change the framing format.
- Enable cell scrambling (ATM interfaces only).
- Assign a text description or an alias to the interface.

cablelength

- Use to adjust the transmit power appropriate to the length of a T3 cable.
- Specify a cable length in the range 1–450 feet.
- The router supports two transmit powers, one for a cable length between 1–225 feet and another for a cable length between 226–450 feet. Therefore, it is not necessary to know the exact size of your cable. You only need to know if the cable size is greater than 225 feet. For example, if your cable size exceeds 225 feet, specify any number greater than 225 and less than 451.
- Example


```
host1(config-control)#cablelength 300
```
- Use the **no** version to restore the default, 0 feet.
- See *cablelength*.

clock source

- Use to configure the transmit clock source for a T3 or E3 line.
- Use a transmit clock on the line's receive data stream, except in rare cases such as back-to-back router tests. When performing back-to-back router tests, configure one end of the line as **internal** and the other end as **line**.
- Specify the keyword **line** to use a transmit clock on the line's receive data stream.
- Specify the keywords **internal module** to use the line module's internal clock.
- Specify the keywords **internal chassis** to use the router's clock.
- Example


```
host1(config-control)#clock source internal module
```
- Use the **no** version to revert to the default, **line**.
- See *clock source*.

description

- Use to assign a text description or an alias to a T3 or E3 interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show controllers t3” on page 65 or “show controllers e3” on page 65 to display the text description.
- Example

```
host1(config-controll)#description westford t3 interface
```

- Use the **no** version to remove the text description or alias.
- See description.

ds3-scramble

- Use to enable cell scrambling in a T3 ATM interface.
- Example

```
host1(config-controll)#ds3-scramble
```

- Use the **no** version to turn off cell scrambling on the interface.
- See ds3-scramble.

e3-scramble

- Use to enable cell scrambling in an E3 ATM interface.
- Example

```
host1(config-controll)#e3-scramble
```

- Use the **no** version to turn off cell scrambling on the interface.
- See e3-scramble.

framing

- Use to configure the framing format for a T3 or E3 line.
- For a T3 line, you must specify one of the following:
 - T3 FRAME—**c-bit** or **m23** (the default is **c-bit**)
 - T3 ATM—**cbitadm**, **cbitplcp**, **m23adm**, or **M23plcp** (the default is **cbitplcp**)
- For an E3 line, you must specify one of the following:
 - E3 FRAME—**g751** or **g832** (the default is **g751**)
- Choose a framing format that is compatible with the framing format of the network device at the other end of the line.
- Example

```
host1(config-controll)#framing m23
```

- Use the **no** version to restore the default value.
- See framing.

Configuring Fractional T3

You can configure fractional T3 on T3 frame interfaces. E3 frame interfaces do not support fractional E3.

Fractional T3 is a portion of a T3 transmission service and provides a set of lines with a speed that is greater than T1 (1.544 Mbps), but less than T3 (44.736 Mbps).

To configure fractional T3:

1. Set the DSU mode for the lines.
2. Set the speed of the fractional T3 lines.
3. Enable scrambling of the payload.



CAUTION: Complete all three steps at the same time. Otherwise, the interface might drop packets unexpectedly.

dsu bandwidth

- Use to set the speed for the fractional T3 lines.
- If you issue this command, be sure to issue the **dsu mode** and **scramble** commands. Otherwise, the interface might drop packets unexpectedly.
- The router offers a set of speeds in increments that depend on the DSU mode you specify. The actual speed of the fractional T3 lines will be the value closest to the fractional bandwidth you specify.
- Example

```
host1(config-control)#dsu bandwidth 10000
```

- Use the **no** version to clear the bandwidth.
- If you issue the **no** version, be sure to issue the **no dsu mode** and **no scramble** commands. Otherwise, the interface might drop packets unexpectedly.
- See dsu bandwidth.

dsu mode

- Use to set the DSU mode for the lines.
- Specify 0 for Digital Link mode or 2 for Larscom mode.
- If you issue this command, be sure to issue the **dsu bandwidth** and **scramble** commands. Otherwise, the interface might drop packets unexpectedly.
- Example

```
host1(config-control)#dsu mode 0
```

- Use the **no** version to clear the DSU mode.
- If you issue the **no** version, be sure to issue the **no dsu bandwidth** and **no scramble** commands. Otherwise, the interface might drop packets unexpectedly.
- See dsu mode.

scramble

- Use to enable cell scrambling on a T3 frame interface.
- If you issue this command, be sure to issue the **dsu mode** and **dsu bandwidth** commands. Otherwise, the interface might drop packets unexpectedly.
- Example

```
host1(config-control)#scramble
```

- Use the no version to turn off cell scrambling on the interface.
- If you issue the **no** version, be sure to issue the **no dsu mode** and **no dsu bandwidth** commands. Otherwise, the interface might drop packets unexpectedly.
- See scramble.

Configuring an HDLC Channel

You must configure an HDLC channel for each T3 frame or E3 frame controller.

To configure an HDLC channel, configure a serial interface (for example, HDLC channel in slot 0, 1).

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

Optional Tasks

The following configuration tasks are optional when you configure an HDLC channel on a T3/E3 frame interface:

- Configure the cyclic redundancy check (CRC).
- Configure the HDLC idle character.
- Enable data inversion on the interface.
- Set the time interval for monitoring bit and packet rates.
- Set the maximum receive unit (MRU).
- Set the maximum transmit unit (MTU).
- Assign a text description or an alias to the serial interface.

crc

- Use to configure the size of the CRC.
- Specify the number of bits per frame (16 or 32) that are used to calculate the frame check sequence (FCS). Both the sender and receiver must use the same setting.
- The CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data.
- A 32-bit CRC should be used to protect longer streams at faster rates and, therefore, provide better ongoing error detection.
- Example

```
host1(config-if)#crc 32
```

- Use the **no** version to restore the default value, 16.
- See `crc`.

idle-character

- Use to configure the HDLC idle character.
- The idle character is sent between HDLC packets.
- Specify one of the following idle characters:
 - **flags**—Sets the idle character to 0x7E
 - **marks**—Sets the idle character to 0xFF
- Example

```
host1(config-if)#idle-character marks
```

- Use the **no** version to restore the default value, 0x7E (flags).
- See `idle-character`.

interface serial

- Use to configure a serial interface in the *slot/port* format.
 - *slot*—Number of the slot in which the line module resides in the chassis
 - *port*—Number of the port on the I/O module
- Example

```
host1(config)#interface serial 3/0
```

- Use the **no** version to disable the interface.
- See `interface serial`.

invert data

- Use to enable data stream inversion for the interface.
- Enable data stream inversion only if it is turned on at the other end of the line.

- Example

```
host1(config-if)#invert data
```

- Use the **no** version to disable the feature.
- See invert data.

load-interval

- Use to set the time interval at which the router calculates bit and packet rate counters.
- Choose a multiple of 30 seconds, in the range 30–300 seconds.
- Example

```
host1(config-if)#load-interval 90
```

- Use the **no** version to restore the default value, 300 seconds.
- See load-interval.

mru

- Use to configure the MRU size for the interface.
- Specify a value in the range 4–9996 bytes.
- Coordinate this value with the network administrator on the other end of the line.
- If you set this parameter to a different value for another protocol, such as IP, the router uses the lower value. This could produce unexpected behavior in your network.
- Example

```
host1(config-if)#mru 1500
```

- Use the **no** version to restore the default, 1600 bytes.
- See mru.

mtu

- Use to configure the MTU size for the interface.
- Specify a value in the range 4–9996 bytes.
- Coordinate this value with the network administrator on the other end of the line.
- If you set this parameter to a different value for another protocol, such as IP, the router uses the lower value. This could produce unexpected behavior in your network.
- Example

```
host1(config-if)#mtu 1500
```

- Use the **no** version to restore the default, 1600 bytes.
- See mtu.

serial description

- Use to assign a text description or an alias to a serial HDLC interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use the **show interfaces serial** command to display the text description.
- Example

```
host1(config-if)#serial description boston09 hdlc channel
```

- Use the **no** version to remove the text description or alias.
- See serial description.

Configuration Examples

To configure a T3 interface, start at the Global Configuration mode, and issue the following commands:

```
host1(config)#controller t3 0/1
host1(config-controll)#no shutdown
host1(config-controll)#framing c-bit
host1(config-controll)#clock source internal module
host1(config-controll)#cablelength 220
host1#exit
```

To configure an E3 interface, use the **controller e3** command in place of the **controller t3** command.

To configure HDLC channels on a T3 serial interface, issue the following commands:

```
host1(config)#controller t3 10/0
host1(config-controll)#exit
host1(config)#interface serial 10/0
host1(config-subif)#encapsulation ppp
host1(config-subif)#ip address 192.32.10.2 255.255.255.0
```

To configure fractional T3 on an interface, issue the following commands:

```
host1(config)#controller t3 10/0
host1(config-controll)#dsu mode 0
host1(config-controll)#dsu bandwidth 10000
host1(config-controll)#scramble
```

Testing Interfaces

Testing interfaces allows you to troubleshoot problems and to check the quality of links at various layers in the interface stack. The router supports the following test options:

- Transmission of BERT patterns to remote devices
- Local loopback—Loops the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network
- Network loopback—Loops the data toward the network before the data reaches the frame
- Payload loopback—Loops the data toward the network after the framer processes the data
- Remote loopback—Provides the ability to:
 - Request that remote devices enter into loopback
 - Be placed in loopback by remote devices

Sending BERT Patterns

The router can send BERT patterns from different layers in the interface stack on frame-based T3 interfaces.

For a list of the modules that support bit error rate tests, see *ERX Module Guide, Appendix A, Module Protocol Support*.

To send BERT patterns:

1. Select a controller.

```
host1(config)#controller t3 3/2
```

2. Configure a specific layer in the interface to generate BERT patterns.

```
host1(config-controll)#bert pattern 2^11 interval 10
```

For information about BERT patterns, see “References” on page 50.

bert

- Use to enable bit error rate tests using the specified pattern on a T3 interface.
- Unlike other configuration commands, **bert** is not stored in NVRAM.
- Specify one of the following test patterns:
 - **0s**—Repetitive test pattern of all zeros, 00000...
 - **1s**—Repetitive test pattern of all ones, 11111...
 - **2^9**—Pseudorandom test pattern, 511 bits in length

- **2^11**—Pseudorandom test pattern, 2047 bits in length
- **2^15**—Pseudorandom test pattern, 32,767 bits in length
- **2^20**—Pseudorandom test pattern, 1,048,575 bits in length
- **2^20-QRSS**—Pseudorandom QRSS test pattern, 1,048,575 bits in length
- **2^23**—Pseudorandom test pattern, 8,388,607 bits in length
- **alt-0-1**—Repetitive alternating test pattern of zeros and ones, 01010101...
- Specify the duration of the test in the range 1–1440 minutes.
- Example


```
host1(config-controll)#bert pattern 2^11 interval 10
```
- Use the **no** version to stop the test that is running.
- See `bert`.

Enabling Local, Network, and Payload Loopback

To enable local, network, or payload loopback testing of a T3 or E3 line, use the **clock source** and **loopback** commands from Controller Configuration mode.

1. Change the clock source to internal.

```
host1(config-controll)#clock source internal module
```

2. Specify a loopback.

```
host1(config-controll)#loopback local
```

Enabling Remote Loopback

You can enable remote loopback capability on frame-based T3 interfaces configured to use C-bit framing. Remote loopback is *not* supported on E3 ATM, E3 FRAME, and T3 ATM interfaces.

For a list of the modules that support remote loopback, see *ERX Module Guide, Appendix A, Module Protocol Support*.

To enable remote loopback:

1. Change the clock source to internal.

```
host1(config-controll)#clock source internal module
```

2. Ensure that the line is configured to use C-bit framing, which is the default for frame-based T3 interfaces.

```
host1(config-controll)#framing c-bit
```

3. Configure one of the following loopback tests:

- Set the loopback to **remote** to request that a remote device connected on a T3 interface enter into a loopback.

```
host1(config-control)#loopback remote
```

- Configure the T3 interface to enable or disable the ability to enter into a loopback initiated by a remote device, as follows:
 - Issue the **equipment customer loopback** command to enable the router to enter into loopback when it receives an appropriate signal from the remote device.

```
host1(config-control)#equipment customer loopback
```

- Issue the **equipment network loopback** command to disable the ability to enter into loopback initiated by a remote device.

```
host1(config-control)#equipment network loopback
```

equipment loopback

- Use to enable or disable the router's ability to enter into a loopback initiated by a remote device connected on a T3 interface.



NOTE: Remote loopback is available only on frame-based T3 interfaces configured to use C-bit framing.

- Specify one of the following loopback options:
 - **customer**—Enables the router to enter into loopback when it receives an appropriate signal from the remote interface
 - **network**—Disables the router's ability to enter into loopback when it receives an appropriate signal from the remote interface

- Examples

```
host1(config-control)#equipment customer loopback  
host1(config-control)#equipment network loopback
```

- Use the **no** version to disable the router's ability to be placed in loopback by the remote device.
- See equipment loopback.

loopback

- Use to configure a loopback.
- Specify one of the following loopback options:

- **local**—Loops the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network
- **network**—Loops the data toward the network before the framer processes the data
- **payload**—Loops the data toward the network after the framer processes the data
- **remote**—Sends a far end alarm code in the C-bit framing, as defined in ANSI T1.404, to notify the remote end to activate or (when you use the **no** version) deactivate the line loopback



NOTE: Remote loopback is available only on frame-based T3 interfaces configured to use C-bit framing.

- Example

```
host1(config-controll)#loopback local
```

- Use the **no** version to restore the default configuration, no loopback.
- See loopback.

Monitoring Interfaces

From User Exec mode, use the following **show** commands to monitor and display the T3 or E3 interface information:

```
host1#show controllers t3 0/1
host1#show controllers e3 3/2
```

Setting a Baseline

You can set a statistics baseline for serial interfaces using the **baseline interface serial** command. Use the **delta** keyword with the **show** commands to display statistics with the baseline subtracted.

Displaying Counters and Time Intervals

Counters and time intervals are MIB statistics, which are defined in RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).

The **show controllers t3 slot/port all** command displays the following interface information:

- Status information
- T3 current interval counters—Displays the counters for the current interval

- T3 last interval counters—Displays the counters for the previous interval
- T3 24-hour total counters—Displays the cumulative counters for the last 24-hours or since the interface was started
- The last 24-hours of 15-minute reporting intervals (96 intervals)

The **show controllers e3 slot/port all** command displays identical information for an E3 controller (except where noted).

Output Filtering

You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See *Command Line Interface* in *JUNOS System Basics Configuration Guide*.

baseline interface

- Use to set a statistics baseline for serial interfaces.
- The router implements the baseline by reading and storing the statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the optional **delta** keyword with the **show interfaces serial** commands to view the baseline statistics.
- Example

```
host1#baseline interface serial 2/0
```

- There is no **no** version.
- See baseline interface.

show controllers e3

show controllers t3

- Use to display the parameters and MIB statistics on an interface.
- Use the **brief** keyword to display the administrative and operational status of all configured T3 or E3 interfaces, or to display abbreviated information for the specified T3 or E3 interface.
- For definitions of the MIB statistics, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999)
- Field descriptions
 - Description—Text description or alias if configured for the interface
 - ifAdminStatus—One of the following administrative states of the interface:
 - ifAdminUp—Interface is administratively enabled
 - ifAdminDown—Interface is administratively disabled
 - ifAdminTesting—Interface is administratively configured in a testing state

- snmp trap link-status—Status of SNMP trapping (enabled or disabled)
- alarms detected—One of the following T3 alarms (not applicable for E3):
 - No alarm present—No alarms present on the line
 - Rcv RAI Failure—Remote device is sending a far end alarm failure
 - Xmt RAI Failure—Local device is sending a far end alarm failure
 - Rcv AIS—Remote device is sending an alarm indication signal (AIS)
 - Xmt AIS—Local device is sending an AIS
 - Rcv LOF—Loss of one or more frames from the remote end
 - Rcv LOS—Loss of signal at the local end



NOTE: The alarms detected field does not appear for interfaces that you disabled in the software.

- framing—Type of framing format
- line code—Type of line code format
- clock source—Type of clock source
- cable length—Cable length, in feet (this field is not present for E3 controllers)
- Loopback—State of loopback for the controller: enabled or disabled. If loopback is enabled, one of the following states is displayed:
 - Diagnostic—Data loops back toward the router and sends an alarm AIS toward the network
 - Payload—Data loops toward the network after the framer has processed the data
 - Line—Data loops toward the network before the data reaches the framer
- loopback state—State of loopback for the controller: enabled or disabled
- DSU mode—Mode of the fractional T3 lines: Digital Link mode or Larscom mode
- DSU bandwidth—Speed of the fractional T3 lines
- DSU scramble—Status of scrambling for fractional T3: on or off
- MDL Transmit Path—Indicates whether the transmission is active or not active (T3 only)
- MDL Transmit Test-Signal—Indicates if the transmission is active or not active (T3 only)

- MDL Transmit Idle-Signal—Indicates if the transmission is active or not active (T3 only)
- Equipment Identification Code—eic string for MDL (T3 only)
- Line Identification Code—lic string for MDL (T3 only)
- Frame Identification Code—fic string for MDL (T3 only)
- Facility Identification Code—fic string for MDL (T3 only)
- Equipment Port—port string for MDL (T3 only)
- Unit Identification Code—unit string for MDL (T3 only)
- Facility Identification Code—pfi string for MDL (T3 only)
- Port Code—port string for MDL (T3 only)
- Generator Number—generator string for MDL (T3 only)
- BERT test—Number of current test and total number of tests (T3 only)
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
- Number of valid intervals—Number of 15-minute intervals since the T3 or E3 module was last powered on or reset
- Time elapse in current interval—Number of seconds that have passed in the 15-minute (900 second) interval
- Errored seconds—Number of errored seconds encountered by an E3 (not applicable for T3) in the current interval (this field is not present for T3 controllers)
- P-bit errored seconds—Number of errored seconds encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)
- Severely errored seconds—Number of severely errored seconds encountered by an E3 (not applicable for T3) in the current interval (this field is not present for T3 controllers)
- P-bit severely errored seconds—Number of severely errored seconds encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)

- Severely errored frame seconds—Number of severely errored framing seconds encountered by a T3 or E3 in the current interval
- Unavailable seconds—Number of unavailable seconds encountered by a T3 or E3 in the current interval
- Line code violations—Number of line code violations encountered by a T3 or E3 in the current interval
- P-bit coding violations—Number of coding violations encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)
- Coding violations—Number of coding violations encountered by an E3 (not applicable for T3) in the current interval (this field is not present for T3 controllers)
- Line errored seconds—Number of line errored seconds encountered by a T3 or E3 in the current interval
- C-bit coding violations—Number of C-bit coding violations encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)
- C-bit errored seconds—Number of C-bit errored seconds encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)
- C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3 (not applicable for E3) in the current interval (this field is not present for E3 controllers)
- Example 1

```
host1#show controllers t3 2/0
```

```
DS3 2/0
Description: boston09 hdlc channel
ifAdminStatus = ifAdminDown
snmp trap link-status = enabled
No alarms detected
Framing is C-BIT, Line Code is B3ZS, Clock Source is Line
Cable Length is 0 ft
Loopback Disabled
DSU Mode is Larscom
DSU Bandwidth is 4000
DSU Scrambler is off
MDL Transmit Path is not active
MDL Transmit Test-Signal is active
MDL Transmit Idle-Signal is not active
Equipment Identification Code is ERX-1400
Line Identification Code is Bldg 10
Frame Identification Code is null string
Unit Identification Code is 080001
Facility Identification Code is Site 25
Port Code is Port 0800
Generator Number is null string
```

Number of valid interval - 96
 Time elapse in current interval - 861

Ds3 Current Interval Counters
 P-bit errored seconds = 0
 P-bit severely errored seconds = 0
 Severely errored frame seconds = 0
 Unavailable seconds = 0
 Line code violations = 0
 P-bit coding violations = 0
 Line errored seconds = 0
 C-bit coding violations = 0
 C-bit errored seconds = 0
 C-bit severely errored seconds = 0

Ds3 Last Interval Counters
 P-bit errored seconds = 0
 P-bit severely errored seconds = 0
 Severely errored frame seconds = 0
 Unavailable seconds = 0
 Line code violations = 0
 P-bit coding violations = 0
 Line errored seconds = 0
 C-bit coding violations = 0
 C-bit errored seconds = 0
 C-bit severely errored seconds = 0

Ds3 24 Hour Total Counters
 P-bit errored seconds = 0
 P-bit severely errored seconds = 0
 Severely errored frame seconds = 0
 Unavailable seconds = 0
 Line code violations = 0
 P-bit coding violations = 0
 Line errored seconds = 0
 C-bit coding violations = 0
 C-bit errored seconds = 0
 C-bit severely errored seconds = 0

- Example 2—In this example, the **brief** keyword is specified.

host1#show controllers t3 brief

Interfaces	ifAdminStatus	OperationalStatus
5/0(channelized)	up	up
5/1(channelized)	up	up
5/2(channelized)	up	down
5/3(channelized)	down	down
5/4(channelized)	down	down
5/5(channelized)	down	down
5/6(channelized)	down	down
5/7(channelized)	down	down
5/8(channelized)	down	down
5/9(channelized)	down	down
5/10(channelized)	down	down
5/11(channelized)	down	down
3/0(channelized)	down	down
3/1(channelized)	down	down
3/2(channelized)	down	down

4/0:1/1(unchannelized)	up	down
4/2:1/1(channelized)	up	lowerLayerDown

- See show controllers e3.
- See show controllers t3.

show controllers t3 remote

- Use to display MIB statistics for the remote end of a T3 interface configured for MDL.
- Specify the **all** option to display detailed information for all 15-minute intervals.
- For definitions of the MIB statistics for a T3 interface, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).
- Field descriptions
 - Far End MDL Carrier bit—Status of MDL configuration on remote device connected to T3 interface
 - set—MDL is configured for carrier mode
 - not set—MDL is not configured for carrier mode
 - Far End Equipment Identification Code—eic string sent by remote device for MDL
 - Far End Line Identification Code—lic string sent by remote device for MDL
 - Far End Frame Identification Code—fic string sent by remote device for MDL
 - Far End Unit Identification Code—unit string sent by remote device for MDL
 - Far End Facility Identification Code—pfi string sent by remote device for MDL
 - Far End Generator Number—generator string sent by remote device for MDL
 - Far End Port Number—port string sent by remote device for MDL
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapse in current interval—Number of seconds that have passed in the 15-minute (900-second) interval
 - C-bit errored seconds—Number of C-bit errored seconds encountered by a T3 in the current interval
 - C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3 in the current interval
 - C-bit coding violations—Number of C-bit coding violations encountered by a T3 in the current interval

- Unavailable seconds—Number of unavailable seconds encountered by a T3 in the current interval
- Invalid seconds—Number of seconds when statistics were not collected
- Example—This example specifies a T3 interface.

```
host1#show controllers t3 5/0 remote
```

```
Far End MDL Carrier bit is not set
Far End Equipment Identification Code is the null string
Far End Line Identification Code is the null string
Far End Frame Identification Code is the null string
Far End Unit Identification Code is the null string
Far End Facility Identification Code is the null string
Far End Generator Number is the null string
Far End Port Number is the null string
```

```
Number of valid interval - 3
Time elapse in current interval - 756
```

```
Ds3 Current Interval Counters
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
C-bit coding violations        = 0
Unavailable seconds           = 0
Invalid seconds                = 0
```

```
Ds3 Last Interval Counters
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
C-bit coding violations        = 0
Unavailable seconds           = 0
Invalid seconds                = 0
```

```
Ds3 24 Hour Total Counters
C-bit errored seconds          = 1
C-bit severely errored seconds = 1
C-bit coding violations        = 330
Unavailable seconds           = 0
Invalid seconds                = 0
```

- See show controllers t3 remote.

Chapter 3

Configuring Unchannelized OCx/STMx Interfaces

This chapter provides information you need to configure unchannelized SONET/SDH interfaces on E-series routers.

This chapter contains the following sections:

- Overview on page 73
- Platform Considerations on page 77
- References on page 84
- Configuration Tasks on page 84
- Testing Interfaces on page 96
- Monitoring SONET/SDH Interfaces on page 98

Overview

SONET/SDH interfaces are supported by the modules described in this chapter. This section describes features that are available with SONET/SDH interfaces.

APS and MSP

E-series routers support Automatic Protection Switching (APS) and Multiplex Section Protection (MSP) on selected I/O modules that provide SONET/SDH connections. This feature provides a redundant connection if a primary SONET/SDH connection fails.

For a list of I/O modules that support APS/MSP, see *ERX Module Guide, Appendix A, Module Protocol Support*.



NOTE: The E120 router and the E320 router do not support APS/MSP.

I/O modules that support APS/MSP have some ports designated for primary operation and other ports designated for redundant operation. For APS/MSP to work correctly, you must provide connections from a primary port and a corresponding redundant port to the remote device. The remote device must also support APS/MSP.

You configure a *working interface* on the primary port and a corresponding *protect interface* on the redundant port of the I/O module. The working interface provides the primary connection, and the protect interface provides the redundant connection.

The router sends and receives data through both interfaces; however, in normal operation, only the signal on the working interface is used. If the signal on the primary interface fails, the router can use the signal on the protect interface. The process by which the router switches to the protect interface is called *switchover*.

When you configure APS/MSP, you must assign a working interface and a corresponding protect interface to a unique group. This group establishes the relationship between the interfaces. Within the group, each interface is identified by an APS/MSP *channel number*. For information about identifying the channel number, see “Numbering Scheme” on page 81.

You must pair a working interface and its corresponding protect interface on an I/O module to form a valid linear APS 1 + 1 group. For example, on an I/O module that provides four working (primary) ports and four protect (redundant) ports, the working interface ports are numbered 0–3, and the protect interface ports are numbered 4–7. Table 6 on page 74 lists the pairings required to form four valid APS 1 + 1 groups on this I/O module. Each working/protect port pair (for example, port 0 and port 4) forms a valid APS 1 + 1 group.

Table 6: Sample Pairings for Valid APS/MSP Groups

Pair This Working Port	With This Protect Port
0	4
1	5
2	6
3	7

Automatic Switchover

Provided you have not issued the **aps lockdown** command for the protect interface, the router switches over to the protect interface if it detects signal failure. You can set the SONET/SDH alarms that determine signal failure and signal degradation.

Manual Switchover

When the router is running and you have configured the I/O module for APS/MSP, you can cause switchover by issuing the **aps force** or **aps manual** command.

Switching Mechanisms

E-series routers support both *bidirectional* and *unidirectional* APS switching modes. By default, the router uses bidirectional switching mode.

Bidirectional Switching Mode

In bidirectional switching mode, the router switches both ends of an APS pair to the same working interface or to the same protect interface when either end determines that a switch is required.

Possible reasons for initiating a bidirectional switch include:

- Detection of a signal failure
- Receipt of an “aps force” on page 95 or “aps manual” on page 96 from the local end of an APS pair
- Reversion to the working interface after a failure has been corrected and the timeout value specified in “aps revert” on page 93 has expired

The devices at both the local and remote ends of an APS pair must support bidirectional switching for the router to implement bidirectional switching mode. Otherwise, the router implements unidirectional switching mode at both ends of the APS pair.

The router detects support for bidirectional switching by interpreting the values of the K1 and K2 bytes in the SONET/SDH frame. For details about the meanings of the values of K1 and K2 bytes, see “Communication Methods” on page 75.

Unidirectional Switching Mode

In unidirectional switching mode, the router switches only one end of an APS pair to the working interface or to the protect interface when that end determines that a switch is required. Possible reasons for initiating a unidirectional switch are the same as those described in “Bidirectional Switching Mode” on page 75 for initiating a bidirectional switch.

Reversion After Switchover

A failed interface automatically reverts from the protect interface to the working interface after the router detects that the working interface is operational and the timeout value specified in “aps revert” on page 93 has expired. Reversion applies only to recovery from failures.

You can configure the router to revert to the working interface at a specified time after it recovers. This feature enables you to use the protect interface as a redundant connection that functions only when the working interface is not available.

Communication Methods

The router communicates with the remote device by using the K1 and K2 bytes in the line overhead of the SONET/SDH frame. The values of these bytes determine the switching and protect actions. Table 7 on page 76 and Table 8 on page 76 list the meanings of the values of the K1 and K2 bytes. The bytes are defined in Telcordia document GR-253—Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria, Revision 3 (September 2000). See requirement objects

R5-56 [179] and R5-58 [181] for information about bit ordering and meaning for the K1 byte; see R5-67 [190v2] for information about the K2 byte.

Table 7: Explanation of K1 Byte

Bit Value (12345678)	Meaning
Bits 1–4 represent a request.	
0000	No request
0001	Do not revert
0010	Reverse request
0011	Not used
0100	Exercise
0101	Not used
0110	Wait-to-restore
0111	Not used
1000	Manual switch
1001	Not used
1010	Low-priority signal degradation
1011	High-priority signal degradation
1100	Low-priority signal failure
1101	High-priority signal failure
1110	Forced switch
1111	Lockout of protection
Bits 5–8 represent the channel number.	
0	Channel number of protect interface
0001–1110	Channel number of working interface

Table 8: Explanation of K2 Byte

Bit Value (12345678)	Meaning
Bits 1–4 represent the channel number.	
0	Channel number of protect interface

Table 8: Explanation of K2 Byte *(continued)*

Bit Value (12345678)	Meaning
0001–1110	Channel number of working interface
Bit 5 indicates the type of redundancy.	
0	1 + 1 architecture
Bits 6–8 indicate the switching mode.	
000– 011	Reserved for future use
100	Unidirectional mode
101	Bidirectional mode
110	Line remote defect indication (RDI)
111	Line alarm indication signal (AIS)

Higher-Level Protocols

See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the higher-level protocols that the interfaces described in this chapter support.

Platform Considerations

You can configure unchannelized SONET/SDH interfaces on the following E-series routers:

- E120 router
- E320 router
- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router

This section describes the line modules and I/O modules that support SONET/SDH interfaces.

For detailed information about the modules that support SONET/SDH interfaces on ERX-14xx models, ERX-7xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.

- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that SONET/SDH modules support.

For detailed information about the modules that support SONET/SDH interfaces on the E120 router and the E320 router:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed module specifications.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the protocols and applications that SONET/SDH modules support.

OCx/STMx/DS3-ATM Line Modules

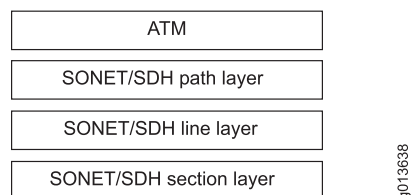
OCx/STMx/DS3-ATM line modules pair with OC3-4 I/O modules to deliver unchannelized OC3/STM1 ATM operation through four line interfaces.

OCx/STMx/DS3-ATM line modules pair with OC12 I/O modules to deliver unchannelized OC12/STM4 ATM operation through one line interface.

I/O modules that support single-mode (intermediate reach or long haul) or multimode operation through SC full duplex connectors are available. I/O modules that support SONET Automatic Protect Switching (APS) 1 + 1 redundancy and SDH Multiplex Section Protection (MSP) are also available.

Figure 5 on page 78 shows the interface stack for OCx/STMx/DS3-ATM interfaces.

Figure 5: Interface Stack for OCx/STMx/DS3-ATM Interfaces



NOTE: For a detailed description of interface types and specifiers, see *Interface Types and Specifiers* in *JUNOS Command Reference Guide*. For information about interfaces, see *Planning Your Network* in *JUNOS System Basics Configuration Guide*.

OCx/STMx POS Line Modules

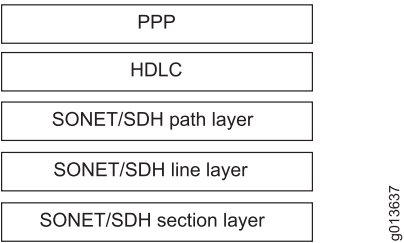
OCx/STMx POS line modules pair with OC3-4 I/O modules to deliver unchannelized OC3/STM1 POS operation through four line interfaces.

OCx/STMx POS line modules pair with OC12 I/O modules to deliver unchannelized OC12/STM4 POS operation through one line interface.

I/O modules that support single-mode (intermediate reach or long haul), or multimode operation through SC full duplex connectors are available. I/O modules that support APS/MSP are also available.

Figure 6 on page 79 shows the interface stack for OCx/STMx POS interfaces.

Figure 6: Interface Stack for OCx/STMx POS and OC48/STM16 Interfaces



OC48 Line Modules

OC48 line modules pair with OC48 FRAME I/O modules to deliver unchannelized OC48/STM16 POS operation through one line interface.

The OC48 I/O module supports single-mode (intermediate reach or long haul) operation through an SC full duplex connector.

The interface stack for the OC48/STM16 interfaces is the same as that for OCx/STMx POS interfaces (Figure 6 on page 79).

The OC48 line module can be installed in the router’s turbo slots, numbered 2 and 4. When the OC48 line module is installed in a turbo slot, it spans slots 2–3 and 4–5. The bandwidth of slot 3 or slot 5 is used for a line module in slot 2 or slot 4 if that line module requires the turbo slot.



NOTE: If a line module is installed in slot 3 or slot 5, and the line module in slot 2 or 4 requires bandwidth, the system configures the line module it detects first. The state of the other line module is displayed in the **show version** command output as disabled (cfg error).

OC3/STM1 GE/FE Line Module

The OC3/STM1 GE/FE line module pairs with the OC3-2 GE APS I/O module to deliver unchannelized OC3/STM1 ATM operation through two line interfaces and Gigabit Ethernet operation through one line interface.

The OC3-2 GE APS I/O module uses a range of small form-factor pluggable transceivers (SFPs) to support different optical modes and cabling distances, and accepts up to three LC-style fiber-optic connectors. You can configure ports 0 and 1 for OC3/STM1 ATM interfaces; port 2 is reserved for a Gigabit Ethernet interface.

The interface stack for OC3/STM1 ATM interfaces on the OC3-2 GE APS I/O module is the same as for OCx/STMx/DS3-ATM interfaces. (See Figure 5 on page 78.)

For more information about configuring a Gigabit Ethernet interface on this I/O module, see “OC3-2 GE APS I/O Module” on page 182.



NOTE: The OC3-2 GE APS I/O module does not support APS in the current release.

ES2 4G Line Module

The E120 router and the E320 router support the ES2 4G LM. Other E-series routers do not support the ES2 4G LM. For more information about modules on the E120 router and the E320 router, see the *E120 and E320 Module Guide*.

The ES2 4G LM supports IOAs that support single-mode operation (intermediate reach or long haul). IOAs are available in a halfheight size, which enables you to configure them in either of the two IOA bays that are available for each slot. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

In the current release, the ES2 4G LM pairs with IOAs to provide OCx/STMx ATM, OCx/STMx POS, Gigabit Ethernet, 10-Gigabit Ethernet, and tunnel-service interfaces.



NOTE: For more information about configuring a Gigabit Ethernet interface or 10-Gigabit Ethernet interface, see “Configuring Ethernet Interfaces” on page 175.

For more information about configuring a tunnel-service interface by using the Tunnel Server IOA, see “Managing Tunnel-Service and IPSec-Service Interfaces” on page 215.

E120 Router Configuration

The 120 Gbps switch fabric of the E120 router allocates 10 Gbps of overall bandwidth to each line module slot. The line interface on the ES2 4G LM when installed in a 120 Gbps fabric configuration is 3.9 Gbps; you can achieve this rate with random packet sizes from 64–1518 bytes or a mixture of packet sizes that represent Internet mix traffic (IMIX).

E320 Router Configuration

The 100 Gbps switch fabric of the E320 router allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slots 2 and 4). The line interface on the ES2 4G LM when installed in a 100 Gbps fabric configuration is 3.4 Gbps; you can achieve this rate with packet sizes greater than 128 bytes.

The 320 Gbps switch fabric of the E320 router allocates 10 Gbps of overall bandwidth to each line module slot. The line interface on the ES2 4G LM when installed in a 320 Gbps fabric configuration is 3.9 Gbps; you can achieve this rate with random

packet sizes from 64–1518 bytes or a mixture of packet sizes that represent Internet mix traffic (IMIX).

OCx/STMx ATM IOAs

The ES2 4G LM pairs with the ES2-S1 OC3-8 STM1 ATM IOA to deliver unchannelized OC3/STM1 ATM operation through eight line interfaces. You can install the ES2-S1 OC3-8 STM1 ATM IOA in both IOA bays.

The ES2 4G LM also pairs with the ES2-S1 OC12-2 STM4 ATM IOA to deliver unchannelized OC12/STM4 ATM operation through two line interfaces. You can install the ES2-S1 OC12-2 STM4 ATM IOA in both IOA bays.

The interface stack for both of these IOAs is the same as for OCx/STMx/DS3-ATM interfaces. (See Figure 5 on page 78.)

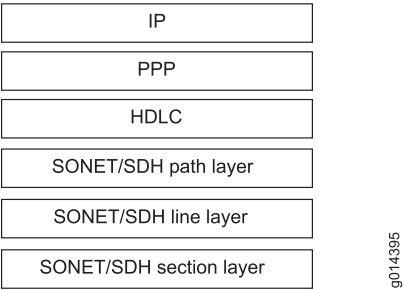
OCx/STMx POS IOAs

The ES2 4G LM pairs with the ES2-S1 OC12-2 STM4 POS IOA to deliver unchannelized OC12/STM4 POS operation through two line interfaces. You can install the ES2-S1 OC12-2 STM4 POS IOA in both IOA bays.

The ES2 4G LM also pairs with the ES2-S1 OC48 STM16 POS IOA to deliver unchannelized OC48/STM16 POS operation through one line interface. In the current release, you can install the ES2-S1 OC48 STM16 POS IOA in only one of the IOA bays per slot.

Figure 7 on page 81 shows the interface stack for OCx/STMx POS interfaces on the ES2 4G LM.

Figure 7: Interface Stack for OCx/STMx POS Interfaces



Numbering Scheme

When configuring or managing an interface, you must know the numbering scheme for identifying an interface. The numbering scheme depends on the type of E-series router that you have.

ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router

Use the *slot/port* format to identify unchannelized SONET/SDH interfaces. Interfaces that support APS/MSP also use the APS/MSP *channel number*.

- **slot**—Number of the slot in which the line module resides in the chassis.

In ERX-7xx models, line module slots are numbered 2–6; slots 0 and 1 are reserved for SRP modules. In ERX-14xx models, line module slots are numbered 0–5 and 8–13; slots 6 and 7 are reserved for SRP modules. In an ERX-310 router, line module slots are numbered 1–2; slot 0 is reserved for the SRP module.

- **port**—Number of the port on the I/O module.

On the OC3-2 GE APS I/O module, you can configure only unchannelized SONET/SDH interfaces on ports 0 and 1; port 2 is reserved for a Gigabit Ethernet interface.

On I/O modules that support APS/MSP, each primary port has a corresponding redundant port. The number of the primary port, but not that of the redundant port, is used to identify the interface. The primary port is above the corresponding redundant port on the I/O modules.

Primary port numbers range from 0 to $n-1$, where n is the total number of primary ports on the module. For example, if a module has one primary port, that port is labeled 0. On some I/O modules, redundant ports are labeled with a port number followed by the letter R. For example, port 3R is the redundant port for the primary port labeled 3. However, on some two-port modules, the primary port is labeled 0 and the redundant port is labeled 1.

On I/O modules that support APS/MSP, the port numbers for the working (primary) interfaces are assigned the lower half of the numbered interfaces, whereas the port numbers for the protect (redundant) interfaces are assigned the upper half of the numbered interfaces. For example, on an I/O module that provides four primary ports and four redundant ports, the working interface ports are numbered 0–3 and the protect interface ports are numbered 4–7. Similarly, on an I/O module that provides one primary port and one redundant port, the working interface is port 0 and the protect interface is port 1.

- **APS/MSP channel number**—Identifier of the working or protect (redundant) interface for configuration purposes. (See “Bidirectional Switching Mode” on page 75.)

The protect interface is always assigned channel number 0. The working interface is always assigned channel number 1.

See “Configuring Channelized T3 Interfaces” on page 3, for information about slot numbering.

For information about installing line modules and I/O modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

E120 Router and E320 Router

Use the slot/adaptor/port format to identify unchannelized SONET/SDH interfaces.



NOTE: The E120 router and the E320 router do not support path channelization.

- *slot*—Number of the slot in which the line module resides in the chassis.

In the E120 router, line module slots are numbered 0–5. In the E320 router, line module slots are numbered 0–5 and 11–16. For both routers, slots 6 and 7 are reserved for SRP modules; slots 8–10 are reserved for switch fabric modules (SFMs).

- *adapter*—number of the bay in which the I/O adapter (IOA) resides.

This identifier applies to the E120 and E320 routers only. 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).

- *port*—Number of the port on the IOA.

For information about installing line modules and IOAs in the E120 and E320 routers, see *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*.

Interface Specifier

The configuration examples in this chapter use the format for ERX-7xx models, ERX-14xx models, and the ERX-310 router to specify a SONET/SDH interface. (The format is described in “Numbering Scheme” on page 81 .)

For example, the following command specifies a SONET/SDH interface on port 0 of an I/O module in slot 0.

```
host1(config)#controller sonet 4/0
```

When you configure a SONET/SDH interface on an E120 router or an E320 router, you must include the adapter identifier as part of the interface specifier. For example, the following command specifies a SONET/SDH interface on port 0 of the IOA installed in the lower adapter bay (0) of slot 3.

```
host1(config)#controller sonet 3/0/0
```

For more information about interface types and specifiers on E-series models, see Interface Types and Specifiers in *JUNOS Command Reference Guide*.

Exchanging Modules

If you replace an OC3 I/O module with an OCx/STMx line module and a corresponding OC3-4 I/O module or vice versa, you must erase the configuration of the existing modules. See *slot accept* in *JUNOS System Basics Configuration Guide*.

On the E120 and E320 routers, if you replace an ES2-S1 OC3-8 STM1 ATM IOA with an ES2-S1 OC12 STM4 POS IOA, you must erase the configuration of the existing IOA. See **adapter accept** or **slot accept** in chapter Managing Modules *JUNOS System Basics Configuration Guide*.

References

For more information about MIB support for unchannelized SONET/SDH interfaces, see RFC 2558—Definitions of Managed Objects for the SONET/SDH Interface Type (March 1999).

For more information about APS/MSP, consult the following resources:

- Telcordia document GR-253—Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria, Revision 3 (September 2000)
- ITU-T G.783—Characteristics Of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks: Annex A – Multiplex Section Protection (MSP) Protocol, Commands And Operation (1990)
- Definitions of Managed Objects for SONET Linear APS Architectures—draft-ietf-atommib-sonetaps-mib-05.txt (November 2001 expiration)
- RFC 3498—Definitions of Managed Objects for Synchronous Optical Network (SONET) Linear Automatic Protection Switching (APS) Architectures (March 2003)

Configuration Tasks

When configuring an unchannelized SONET/SDH interface, you first configure ATM or POS on the interface. For details on configuring POS and ATM, see *Configuring ATM* and *Configuring packet over SONET* in *JUNOS Link Layer Configuration Guide*.

- On an OCx/STMx/DS3-ATM line module with an OC3-4 or OC12 I/O module, you can configure only ATM interfaces.
- On an OCx/STMx POS line module with an OC3-4 or OC12 I/O module, you can configure only POS interfaces.
- On an OC48 line module with an OC48 FRAME I/O module, you can configure only POS interfaces.
- On an OC3/STM1 GE/FE line module with an OC3-2 GE APS I/O module, you can configure only ATM interfaces on ports 0 and 1.

- On an ES2 4G LM with an ES2-S1 OC12-2 STM4 POS IOA or an ES2-S1 OC48 STM16 POS IOA, you can configure only POS interfaces.
- On an ES2 4G LM with an ES2-S1 OC3-8 STM1 ATM IOA or an ES2-S1 OC12-2 STM4 ATM IOA, you can configure only ATM interfaces.

Configuring the SONET/SDH Layers

When you configure ATM or POS on an interface, you automatically configure default settings at the SONET/SDH layer. To modify the default settings:

1. Select an interface on which you want to configure SONET or SDH.
2. Specify the type of interface: SONET or SDH.
3. Specify a clock source for the interface.
4. (Optional) Assign a text description or an alias to the interface.
5. Disable processing of SNMP link status information for the section and line layers of the interface.
6. Enable processing of SNMP link status information for the path layer of the interface.
7. (Not recommended) Overwrite the automatic setting for the path signal label (C2) byte.
8. Configure the router to use remote defect indications (RDIs) at the path layer to determine the operational status of a path.
9. (MPLS fast reroute over SONET/SDH interfaces) Specify the time that the router waits to set an alarm when the router records a defect at the path layer.
10. (MPLS fast reroute over SONET/SDH interfaces) Specify the time that the router waits to set an alarm when the router records a defect at the line or section layer.
11. Shut down (disable) an interface.

clock source

- Use to configure the transmit clock source for the interface.
- In most cases, accept the default option, **line**. This setting allows the interface to derive the transmit clock from the received clock. In certain circumstances, it might be appropriate to generate a clock from one of the internal sources (options **module** or **chassis**).
- Specify the keyword **line** to use a transmit clock on the line's receive data stream.
- Specify the keywords **internal module** to use the line module's internal clock.
- Specify the keywords **internal chassis** to use the router's clock.
- On a cOC3/STM1 I/O module, you can configure some ports with internal clock sources and others with line clock sources. However, all ports with internal clock sources must use either the router's clock or the module's clock. You cannot configure some ports on the I/O module to use the router's clock and others to use the module's clock.

- To change the clock source of the ports on a cOC3/STM1 I/O module from the router's clock to the module's clock or vice versa, change the clock source of all ports firstly to the line setting, and then to the new internal clock setting.

- Example

```
host1(config-controll)#clock source internal module
```

- Use the **no** version to revert to the default, **line**.
- See clock source.

controller sonet

- Use to select an interface on which you want to configure SONET or SDH.
- Use the interface specifier in *slot/port:path-channel* format (ERX-14xx models, ERX-7xx models, and the ERX-310 router) or *slot/adaptor/port* format (E120 router and E320 router). The E120 and E320 routers do not support path channelization, and therefore does not support the *path-channel* specifier.
- Example 1—Selects a SONET interface on ERX-14xx models, ERX-7xx models, or the ERX-310 router

```
host1(config)#controller sonet 4/0
```

- Example 2—Selects a SONET interface on the E320 router

```
host1(config)#controller sonet 3/0/0
```

- There is no **no** version.
- See controller sonet.

description

- Use to assign a text description or an alias to an unchannelized SONET interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 64 characters.
- Use “show controllers sonet” on page 99 to display the text description.
- Example

```
host1(config-controll)#description boston-sonet-interface
```

- Use the **no** version to remove the text description or alias.
- See description.

path description

- Use to assign a text description or an alias to an unchannelized SONET path.
- You can use this command to help you identify the interface and keep track of interface connections.

- The description or alias can be a maximum of 64 characters.
- Example

```
host1(config-controll)#path description westford
```

- Use the **no** version to remove the description.
- See path description.

path overhead c2

- Use to overwrite the automatic setting for the path signal label (C2) byte.
- By default, the value of the C2 byte for the path is determined by the layers configured above the SONET/SDH interface and set automatically. The E-series router sets this default value in accordance with RFC 2558. (See “References” on page 84.)



CAUTION: Use this command only if you know that the automatic setting does not match the setting on the remote device. Otherwise, the remote device might send an unexpected value, and the router might lose data.

- Do not specify a path identifier for unchannelized SONET/SDH interfaces.
- Example

```
host1(config-controll)#path overhead c2 20
```

- Use the **no** version to restore the default setting, in which the value of the C2 byte is determined by the layers configured above the SONET/SDH interface.
- See path overhead c2.

path shutdown

- Use to disable a path.
- Paths are enabled by default.
- Example

```
host1(config-controll)#path shutdown
```

- Use the **no** version to restart a disabled path.
- See path shutdown.

path snmp trap link-status

- Use to enable SNMP link-status processing for the path layer of the interface.
- The default is disabled.
- Do not specify a path identifier for unchannelized SONET/SDH interfaces.
- Example

host1(config-controll)#**path snmp trap link-status**

- Use the **no** version to disable SNMP link status processing.
- See path snmp trap link-status.

path trigger alarm prdi

- Use to configure the router to use remote defect indications (RDIs) at the path layer to determine the operational status of a path.
- Do not specify a path identifier for unchannelized SONET/SDH interfaces.
- Example

host1(config-controll)#**path trigger alarm prdi**

- Use the **no** version to restore the default setting, in which the software uses loss of pointer and AIS defects at the path layer to determine the operational status of a path.
- See path trigger alarm prdi.

path trigger delay

- Use to set the time that the router waits to set an alarm when the router records a defect at the path layer.
- Change this value from the default only when you are using MPLS fast reroute over a SONET/SDH interface.
 - Specify a value of 0 milliseconds if the interface does not use APS/MSP or if you want MPLS to have priority over APS/MSP.
 - Specify a value of at least 100 milliseconds if this interface uses APS/MSP and you want APS/MSP to have priority over MPLS.
- Do not specify a path identifier for unchannelized SONET/SDH interfaces.
- Example

host1(config-controll)#**path trigger delay msec 1000**

- Use the **no** version to restore the default setting, 2500 milliseconds.
- See path trigger delay.

sdh

- Use to specify that the interface supports SDH.
- Example

host1(config-controller)#**sdh**

- Use the **no** version to revert to SONET operation on this interface.
- See sdh.

shutdown

- Use to disable a SONET/SDH interface.
- SONET/SDH interfaces are enabled by default.
- Example

```
host1 (config-controll)#shutdown
```

- Use the **no** version to restart a disabled interface.
- See shutdown.

snmp trap link-status

- Use to enable SNMP link-status processing for the section and line layers of the interface.
- The default is enabled.
- Example

```
host1(config-controll)#no snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See snmp trap link-status.

trigger delay

- Use to set the time that the router waits to set an alarm when the router records a defect at the line or section layer.
- Change this value from the default only when you are using MPLS fast reroute over a SONET/SDH interface.
 - Specify a value of 0 milliseconds if the interface does not use APS/MSP or if you want MPLS to have priority over APS/MSP.
 - Specify a value of at least 100 milliseconds if this interface uses APS/MSP and if you want APS/MSP to have priority over MPLS.
- Example

```
host1(config-controll)#trigger delay msec 1000
```

- Use the **no** version to restore the default setting, 2500 milliseconds.
- See trigger delay.

Configuring APS/MSP

For APS/MSP, you must configure a working interface and a corresponding protect interface. You must also assign each pair of working and protect interfaces to a unique group.



NOTE: Configuring the working interface before you configure the protect interface is not required. You can configure the working interface before or after you configure the protect interface.

The E120 router and the E320 router does not support APS/MSP.

Configuring the Working Interface

To configure the working interface:

1. Select the interface.

```
host1(config)#controller sonet 4/0
```

2. Specify the APS group to which the working and protect interfaces will belong.

```
host1(config-controll)#aps group boston
```

3. Specify the interface as the working interface.

```
host1(config-controll)#aps working
```

aps group

- Use to specify the group to which the working and protect interfaces will belong.
- Specify the name of the APS group.
- Example

```
host1(config-controll)#aps group boston
```

- Use the **no** version to remove a group of APS interfaces.
- See **aps group**.

aps working

- Use to specify the working interface.
- Optionally, you can specify 1 as the channel number for the working interface. Because the working interface is always assigned channel number 1, this is the only valid option.
- Examples

```
host1(config-controll)#aps working  
host1(config-controll)#aps working 1
```

- Use the **no** version to prevent the interface from acting as a working interface.
- See **aps working**.

threshold

- Use to set thresholds for the bit error rates associated with APS/MSP alarms.
- This command does not apply to the working interface. You can issue this command only for the protect interface.
- Specify one of the following keywords to indicate the alarm level:
 - **sd-ber**—Bit error rate that specifies signal degradation
 - **sf-ber**—Bit error rate that specifies signal failure
- Specify an integer n in one of the following ranges, where n corresponds to a rate of 10^{-n} ($10e^{-n}$) errors per second.
 - For **sd-ber**, an integer in the range 5–9; the default value is 5
 - For **sf-ber**, an integer in the range 3–5; the default value is 3
- Example


```
host1(config-controll)#threshold sf-ber 4
```
- Use the **no** version to restore the default, 5 (for **sd-ber**) or 3 (for **sf-ber**), for the specified alarm.
- See threshold.

Configuring the Protect Interface

To configure the protect interface:

1. Select the interface.


```
host1(config)#controller sonet 4/1
```
2. Specify the APS group to which the protect and working interfaces will belong.


```
host1(config-controll)#aps group boston
```
3. Specify the protect interface.


```
host1(config-controll)#aps protect
```
4. (Optional) Prevent the protect interface from taking over automatically if the working interface fails.


```
host1(config-controll)#aps lockdown
```
5. (Optional) Enable the router to revert to the working interface when it recovers.


```
host1(config-controll)#aps revert 7
```
6. (Optional) Specify that switchover takes place in unidirectional mode.


```
host1(config-controller)#aps unidirectional
```

aps group

- Use to specify the group to which the working and protect interfaces will belong.
- Specify the name of the APS group.
- Example

```
host1(config-controll)#aps group boston
```

- Use the **no** version to remove a group of APS interfaces.
- See aps group.

aps lockdown

- Use to prevent the protect interface from taking over if the working interface fails.
- You can issue this command only for the protect interface, not for the working interface.
- The **aps lockdown** command has a higher priority than the **aps force** command, **aps manual** command, a remote reversion request, a signal failure request, or a signal degradation.
- Optionally, you can specify 0 as the channel number for the protect interface. Because the protect interface is always assigned channel number 0, this is the only valid option.
- The resulting configuration is stored in NVS for SRP module or line module reloads and SNMP.
- Examples

```
host1(config-controll)#aps lockdown  
host1(config-controll)#aps lockdown 0
```

- Use the **no** version to restore the default situation, in which the protect interface can take over if the working interface fails.
- See aps lockdown.

aps protect

- Use to configure an interface as a protect interface.
- You can issue this command only for the protect interface, not for the working interface.
- Optionally, you can specify 0 as the channel number for the protect interface. Because the protect interface is always assigned channel number 0, this is the only valid option.
- Examples

```
host1(config-controll)#aps protect  
host1(config-controll)#aps protect 0
```

- Use the **no** version to remove the protect interface from the APS group.
- See `aps protect`.

aps revert

- Use to revert to the original working interface when it recovers.
- Specify the number of minutes in the range 5–7, after which the router will switch to the working interface.
- You can issue this command only for the protect interface, not for the working interface.
- Example

```
host1(config-controller)#aps revert 7
```

- Use the **no** version to restore the default setting, in which the router does not revert to the working interface when it recovers.
- See `aps revert`.

aps unidirectional

- Use to specify that the router should switch to the protect interface using the unidirectional mode switching mechanism.
- You can issue this command only for the protect interface, not for the working interface.
- Example

```
host1(config-controller)#aps unidirectional
```

- Use the **no** version to restore the default setting, bidirectional mode.
- See `aps unidirectional`.

Configuring SONET/SDH Alarms

To configure the bit error rates that determine signal degradation and signal failure on the working interface:

1. Select the protect interface.

```
host1(config)#controller sonet 4/1
```

2. Specify the bit error rate at which the router should generate an alarm indicating signal degradation.

```
host1(config-controller)#threshold sd-ber 6
```

3. Specify the bit error rate at which the router should generate an alarm indicating signal failure and switch from the working interface to the protect interface.

```
host1(config-controller)#threshold sf-ber 5
```

threshold

- Use to set thresholds for the bit error rates associated with APS/MSP alarms.
- You can issue this command only for the protect interface. It does not apply to the working interface.
- Specify one of the following keywords to indicate the alarm level:
 - **sd-ber**—Bit error rate that specifies signal degradation
 - **sf-ber**—Bit error rate that specifies signal failure
- Specify an integer n in one of the following ranges, where n corresponds to a rate of 10^{-n} ($10e^{-n}$) errors per second.
 - For **sd-ber**, an integer in the range 5–9; the default value is 5
 - For **sf-ber**, an integer in the range 3–5; the default value is 3
- Example


```
host1(config-controll)#threshold sf-ber 4
```
- Use the **no** version to restore the default, 5 (for **sd-ber**) or 3 (for **sf-ber**), for the specified alarm.
- See threshold.

Configuration Example

The following example shows how to configure working and protect interfaces for APS/MSP.

1. Configure the working interface.

```
host1(config)#controller sonet 3/0
host1(config-controller)#aps group boston
host1(config-controller)#aps working 1
```

2. Configure the protect interface.

```
host1(config-controller)#controller sonet 3/1
host1(config-controller)#aps group boston
host1(config-controller)#aps protect 0
host1(config-controller)#aps unidirectional
host1(config-controller)#aps revert 30
host1(config-controller)#threshold sf-ber 4
```

Configuring APS Event Collection

To configure line modules to deliver APS events to the necessary SNMP traps, issue the **aps events** command from Global Configuration mode.

aps events

- Use to enable line modules to deliver APS events to the necessary SNMP traps.
- Use the *list* variable to deliver the following types of APS events:
 - all—Configure notification of all APS events
 - channel-mismatch—Configure notification of APS channel mismatches
 - feplf—Configure notification of APS far-end protection line failures
 - mode-mismatch—Configure notification of APS mode mismatches
 - psbf—Configure notification of APS protection signal byte failures
 - switchover—Configure notification of APS switchovers
- Example


```
host1(config)#aps events channel-mismatch
```
- Use the **no** version to disable the delivery of APS events from line modules to SNMP traps.
- See aps events.

Manual Switching to a Redundant Port

To switch from the working interface to the protect interface manually, issue the **aps force** command or the **aps manual** command. The **aps force** command overrides any switchover settings you configured on the protect interface; the **aps manual** command does not override those settings.

aps force

- Use to switch from the working interface to the assigned protect interface unless a request of equal or higher priority is in effect.
- You can issue this command only for the protect interface, not for the working interface.
- The **aps force** command has a higher priority than the **aps manual** command, a remote reversion request, a signal failure request on a working channel, or a signal degradation request on a working channel.
- The resulting configuration is not stored in NVS for SRP module or line module reloads; however, it is stored in NVS for use with SNMP.
- You must specify one of the following channel numbers:
 - 0—Switches from the protect interface back to the working interface
 - 1—Switches from the working interface to the protect interface
- Examples

```
host1(config-control)#aps force 0
host1(config-control)#aps force 1
```

- Use the **no** version to revert to the original working interface.
- See `aps force`.

aps manual

- Use to switch from the working interface to the protect interface unless a command of equal or higher priority is in effect.
- You can issue this command only for the working interface, not for the protect interface.
- The **aps manual** command has a higher priority than a remote reversion request.
- The resulting configuration is not stored in NVS for SRP module or line module reloads; however, it is stored in NVS for use with SNMP.
- You must specify one of the following channel numbers:
 - 0—Switches from the protect interface back to the working interface
 - 1—Switches from the working interface to the protect interface
- Examples

```
host1(config-control)#aps manual 0
host1(config-control)#aps manual 1
```

- Use the **no** version to revert to the original working interface.
- See `aps manual`.

Testing Interfaces

You can enable loopback tests at the SONET/SDH level. You can also test for connectivity between an interface and the SONET/SDH interface at the other end of the line.

Loopback Testing

To configure loopback testing at the SONET/SDH level, use “loopback” on page 96.

loopback

- Use to configure the type of loopback at the SONET/SDH layer.
- Specify one of the following options:
 - **local**—Loops the data back toward the router
 - **network**—Loops the data toward the network before the data reaches the frame.
- Example

```
host1(config)#controller sonet 4/0
host1(config-controller)#loopback network
```

- Use the **no** version to disable loopback.
- See loopback.

Testing Connectivity

Use the **path overhead j1** command to check for connectivity between the router and a SONET/SDH device at the other end of the line. This command defines:

- A message that the router sends from the specified interface to the SONET/SDH device at the other end of the line.
- A message that the router expects to receive on the specified interface from the SONET/SDH device at the other end of the line.

When you define a message that the interface sends, you must monitor receipt of that message at the remote end.

When you define a message that the interface expects to receive, you should configure the remote device to transmit the same message to the interface. You can then use the **show controllers sonet** command to compare the expected and receive messages.

You must remove trace messages before you can change the port type from SONET to SDH or vice versa. Otherwise, you see the following error message:

```
% Cannot set port mode (path trace message is set)
```

path overhead j1

- Use to define messages that the router sends to or expects to receive from a SONET/SDH device connected to one of its SONET interfaces.
- Do not specify a path identifier for unchannelized SONET interfaces.
- Specify the keyword **msg** for a message that the router transmits for this path.
- Specify the keyword **exp-msg** to define a message that the router expects to receive on this path.
- Define a message of up to 62 characters for SONET or up to 15 characters for SDH.
- Configure the remote device to send the same message that the router expects to receive on this path. You can then compare the expected and received messages in the display of the **show controllers sonet** command.
- Example for unchannelized SONET interfaces:

```
host1(config-controller)#path overhead j1 msg hello
```

- Use the **no** version to restore the default situation, in which all the characters in the transmitted or expected message are zeros.
- See path overhead j1.

Monitoring SONET/SDH Interfaces

You can monitor interface statistics and APS/MSP settings.



NOTE: The E120 router and E320 router output for **monitor** and **show** commands is identical to output from other E-series routers, except that the E120 and E320 router output also includes information about the adapter identifier in the interface specifier (*slot/adapter/port*).

Monitoring Interface Statistics

You can set statistics baselines for the section, line, and path layers using the **baseline interface sonet** commands.

To display statistics for SONET and SDH interfaces, use the **show controllers sonet** commands. Use the delta options to display statistics with the baseline subtracted.

baseline line interface sonet

- Use to set a statistics baseline for the SONET/SDH line layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total** [**delta**] keywords with the **show controllers sonet line** command to view the baseline statistics.
- Example 1—Sets a baseline for SONET line layer interfaces on ERX-14xx models, ERX-7xx models, or the ERX-310 router

```
host1#baseline line interface sonet 2/0
```

- Example 2—Sets a baseline for SONET line layer interfaces on the E320 router

```
host1#baseline line interface sonet 3/0/0
```

- There is no **no** version.
- See **baseline line interface sonet**.

baseline path interface sonet

- Use to set a statistics baseline for the SONET/SDH path layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total** [**delta**] keywords with the **show controllers sonet path** command to view the baseline statistics.
- Example 1—Sets a baseline for SONET path layer interfaces on ERX-14xx models, ERX-7xx models, or the ERX-310 router

host1#**baseline path interface sonet 2/0**

- Example 2—Sets a baseline for SONET path layer interfaces on the E320 router

host1#**baseline path interface sonet 3/0/0**

- There is no **no** version.
- See baseline path interface sonet.

baseline section interface sonet

- Use to set a statistics baseline for the SONET/SDH section layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total [delta]** keywords with the **show controllers sonet section** commands to view the baseline statistics.
- Example 1—Sets a baseline for SONET section layer interfaces on ERX-14xx models, ERX-7xx models, or the ERX-310 router

host1#**baseline section interface sonet 2/0**

- Example 2—Sets a baseline for SONET section layer interfaces on the E320 router

host1#**baseline section interface sonet 3/0/0**

- There is no **no** version.
- See baseline section interface sonet.

show controllers sonet

- Use to display the configuration for SONET and SDH interfaces.
- Field descriptions
 - Interface specifier in *slot/port* format (ERX-14xx models, ERX-7xx models, and the ERX-310 router) or *slot/adaptor/port* format (E120 and E320 routers)
 - non channelized—Unchannelized path
 - channelized—Number of channels and speed for the interface
 - ifAdminStatus—Configured status of the interface: up or down
 - description—Configured description of the controller
 - snmp trap link-status—State of SNMP link-status processing for the section and line layers of the interface: enabled or disabled
 - alarms used for operational status calculation—Types of defects that the router uses to determine the operational status of the interface at the section and line layers

- defect trigger soaking delay—Time that the router waits to set an alarm when the router records a defect at the section or line layer
- Operational Status—Physical state of the interface:
 - up—Interface is operational
 - down, failure alarm—Interface is not operational; type of defect that caused failure is specified
 - time since last status change—Time since the module was rebooted
- Loopback State—Type of loopback configured on the interface
- Mode—Type of interface: SONET or SDH
- Timing source—Type of clock source configured for the channel:
 - line—Internal clock is from the line module itself
 - chassis—Internal clock is from the configured router clock
- Receive FIFO Overruns—Number of times received FIFO was overrun
- Current section defects—Number of suspect bit patterns found in several consecutive frames in section layer
- Current line defects—Number of suspect bit patterns found in several consecutive frames in line layer
- Received SONET overhead—Section and line overhead bytes present in the receive side of the interface at any particular time
- Transmitted SONET overhead—Section and line overhead bytes present in the transmit side of the interface at any particular time
- Channel configuration—Parameters for specific controllers. The actual parameters depend on the controller.
 - ifAdminStatus—State of the controller in the software configuration: up or down
 - snmp trap link-status—State of SNMP link status processing for the path layer: enabled or disabled
 - alarms used for operational status calculation—Types of defects that the router uses to determine the operational status of the interface at the path layer
 - defect trigger soaking delay—Time that the router waits to set an alarm when the router records a defect at the path layer
 - c2 byte—Setting of path signal byte: set by upper interface type (automatic setting) or configured value

- Operational Status—Physical state of the controller: up, down, or lowerLayerDown
- time since last status change: time the controller has been in the current physical state
- Received SONET Path overhead—Path overhead bytes present in the receive side of the interface at any particular time
- Transmitted SONET Path overhead—Path overhead bytes present in the transmit side of the interface at any particular time
- Example

```

host1# show controllers sonet 1/0
oc3 1/0
non channelized
ifAdminStatus: up
description: link1
snmp trap link-status: enabled
alarms used for operational status calculation: LOS LOF AIS RDI
defect trigger soaking delay: 2500 milliseconds
Operational Status: down, failure alarm: AIS
    time since last status change: 07:33:12
Loopback State: none
Mode: sonet
Timing source: line
Receive FIFO Overruns: 0, Framers stats: 0/0
Current section defects: none
Current line    defects: AIS
Received SONET overhead:
F1      : n/a, J0      : n/a, K1      : 0xFF, K2      : 0xFF, S1
: 0xFF
Transmitted SONET overhead:
F1      : 0x00, J0      : 0x01, K1      : 0x00, K2      : 0x00, S1
: 0x00
Channel configuration:
channel = 0, path = oc3, hierarchy = 1/0, current path defects:
LowerLayerDefect
ifAdminStatus: up
snmp trap link-status: disabled
alarms used for operational status calculation: LOP AIS
defect trigger soaking delay: 2500 milliseconds
c2 byte set by upper interface type
Operational Status: lowerLayerDown
    time since last status change: 07:33:12
Received SONET Path overhead:
F2      : n/a, Z3      : n/a, Z4      : n/a, C2      : 0xFF, C2Exp
: 0x00
Transmitted SONET Path overhead:
F2      : 0x00, Z3      : 0x00, Z4      : 0x00, C2      : 0x00

```

- See show controllers sonet.

show controllers sonet line | path | section

- Use to display statistics for the different layers in channelized SONET and SDH interfaces. Figure 5 on page 78 and Figure 6 on page 79 show the layers in the interfaces.
- For definitions of the MIB statistics, see RFC 2558—Definitions of Managed Objects for the SONET/SDH Interface Type (March 1999).
- Specify an interface in *slot/port* format (ERX-14xx models, ERX-7xx models, and the ERX-310 router) or *slot/adaptor/port* format (E120 and E320 routers).
- To view statistics for a layer, specify the type of layer.
- To view all statistics for all sessions, specify the **total** keyword.
- To view baselined statistics for all intervals, specify the **delta total** keywords.
- Field descriptions

- Current Interval Counters—Statistics for the current 15-minute interval

The following fields may appear in line, path, or section:

- ES—Number of errored seconds encountered by a T1 or an E1 in an interval
- SES—Number of severely errored seconds encountered in an interval
- UAS—Number of unavailable seconds encountered in an interval
- SEFS—Number of severely errored framing seconds encountered in an interval
- (Code Violations)—Number of coding violations encountered in an interval (BIP-B1, BIP-B2, BIP-B3)
- RDI—Number of remote defect indications
- AIS—Number of alarm indication signals
- BERR-SF—Number of bit error rate signal failures
- BERR-SD—Number of bit error rate signal degrades
- LOS—Number of loss of signal alarms
- LOF—Number of loss of frame alarms
- LOP—Number of loss of pointers
- UNEQ—Number of unequipped alarms
- PLM—Number of payload mismatches
- Last Interval Counters—Statistics for the previous 15-minute interval
- Current Far End Interval Counters—Statistics for the remote connection associated with the SONET/SDH path in the current 15-minute interval

- REI—Number of remote error indications
- Far End Last Interval Counters—Statistics for the remote connection associated with the SONET/SDH path in the previous 15-minute interval
- Total Interval Counters—Statistics for all intervals or baselined statistics
- Total Far End Counters—Statistics for all remote connections associated with the SONET/SDH path
- Example 1—Shows the MIB statistics for the path layer on interface 1/0.

host1#show controllers sonet 1/0 path

Channel number 0

Number of valid intervals - 31

Time elapsed in current interval - 141

Current status = LowerLayerDefect

Current Path Interval Counters	Seconds	Counts	State
ES	0		
SES	0		
UAS	141		
RDI	141	0	Active
AIS	141	0	Active
LOP	0	0	OK
UNEQ	0	0	OK
PLM	141	0	Active
BIP-B3 (Code Violation)	0	0	

Last Path Interval Counters	Seconds	Counts
ES	0	
SES	0	
UAS	900	
RDI	900	0
AIS	900	0
LOP	0	0
UNEQ	0	0
PLM	900	0
BIP-B3 (Code Violation)	0	0

Total Path Counters	Seconds	Counts
ES	0	
SES	0	
UAS	27255	
RDI	27255	0
AIS	27255	0
LOP	0	0
UNEQ	0	0
PLM	27255	0
BIP-B3 (Code Violation)	0	0

Current Far End Path Interval Counters	Seconds	Counts
ES	0	
SES	0	
UAS	141	
REI	0	0

Far End Last Path Interval Counters	Seconds	Counts
ES	0	
SES	0	
UAS	900	
REI	0	0
Total Far End Path Counters	Seconds	Counts
ES	0	
SES	0	
UAS	27255	
REI	0	0

- Example 2—Shows the MIB statistics for the line layer on interface 1/0.

```
host1#show controllers sonet 1/0 line
```

```
Number of valid intervals - 31
Time elapsed in current interval - 114
Current status = AIS
```

Current Line Interval Counters	Seconds	Counts	State
ES	0		
SES	0		
UAS	113		
RDI	0	0	OK
AIS	113	0	Active
BERR-SF	0	0	OK
BERR-SD	0	0	OK
BIP-B2 (Code Violation)	0	0	
Last Line Interval Counters	Seconds	Counts	
ES	0		
SES	0		
UAS	900		
RDI	0	0	
AIS	900	0	
BERR-SF	0	0	
BERR-SD	0	0	
BIP-B2 (Code Violation)	0	0	
Total Line Counters	Seconds	Counts	
ES	0		
SES	0		
UAS	27227		
RDI	0	0	
AIS	27227	1	
BERR-SF	0	0	
BERR-SD	0	0	
BIP-B2 (Code Violation)	0	0	
Current Far End Line Interval Counters	Seconds	Counts	
ES	0		
SES	0		
UAS	0		
REI	0	0	
Far End Last Line Interval Counters	Seconds	Counts	
ES	0		
SES	0		

UAS	0	
REI	0	0
Total Far End Line Counters		
ES	0	
SES	0	
UAS	10	
REI	0	0

- Example 3—Shows the MIB statistics for the section layer on interface 1/0.

host1#show controllers sonet 1/0 section

Number of valid intervals - 31
 Time elapsed in current interval - 49
 Current status = No Defect

Current Section Interval Counters	Seconds	Counts	State
ES	0		
SES	0		
SEFS	0		
LOS	0	0	OK
LOF	0	0	OK
BIP-B1 (Code Violation)	0	0	

Last Section Interval Counters	Seconds	Counts
ES	0	
SES	0	
SEFS	0	
LOS	0	0
LOF	0	0
BIP-B1 (Code Violation)	0	0

Total Section Counters	Seconds	Counts
ES	1	
SES	1	
SEFS	0	
LOS	0	0
LOF	0	0
BIP-B1 (Code Violation)	1	16

- Example 4—Shows all statistics for all sessions for the section layer on interface 2/0.

host1#show controllers sonet 2/0 section total

Number of valid intervals - 31
 Time elapsed in current interval - 244

Total Section Counters	Seconds	Counts
ES	1	
SES	1	
SEFS	0	
LOS	0	0
LOF	0	0
BIP-B1 (Code Violation)	1	16

- See `show controllers sonet`.

Monitoring APS/MSP

You can use the **show aps** commands to monitor APS/MSP.

show aps

- Use to display information about interfaces on which APS/MSP is configured.
- Use the **all** keyword to display information from all APS/MSP groups. In the output, partially configured controllers are displayed with none and include only the group name.
- Field descriptions
 - `sonet x/y`—Location of the SONET/SDH interface
 - `protect group`—Name of the APS group that contains the working interface and the corresponding protect interface
 - `channel`—Number of the APS channel; 0 identifies the protect interface, 1 identifies the working interface
 - `~`—Interface is not currently active
 - `Selected`—Interface is active
 - `~ Selected`—Interface is not active
 - `Bidirectional`—Router switches to the protect interface using the bidirectional switching mechanism
 - `Unidirectional`—Router switches to the protect interface using the unidirectional mode switching mechanism
 - `Nonrevertive`—Router does not revert to the working interface when it recovers
 - `Revertive`—Router reverts to the working interface when it recovers
 - `Disabled`—APS/MSP is disabled on the interface
 - `Enabled`—APS/MSP is enabled on the interface
- Example 1

```
host1#show aps
sonet 5/1 protect group one channel 0 ~Selected Unidirectional
Nonrevertive
sonet 5/0 working group one channel 1 Selected Enabled
```

- Example 2

```
host1#show aps all
aps events: disabled
sonet 4/0 working group group-4 channel 1 Selected Enabled
```

```

sonet 4/1 protect group group-4 channel 0 ~Selected Unidirectional
Nonrevertive
sonet 2/0 working group group-2 channel 1 Selected Enabled
sonet 2/1 protect group group-2 channel 0 ~Selected Unidirectional
Nonrevertive
sonet 12/0
sonet 12/1
sonet 12/2 none      group partial-group
sonet 12/3
sonet 12/4
sonet 12/5
sonet 12/6
sonet 12/7

```

- See show aps.

show aps group

- Use to display information about all APS/MSP groups or a specified APS/MSP group.
- Field descriptions
 - Aps group—Name of the APS group for which information is displayed
 - Current Conditions—Current state of the group
 - Rx (K1/K2)—Value, meaning, and channel number of the received K1 and K2 bytes (see Table 7 on page 76 and Table 8 on page 76)
 - Tx (K1/K2)—Value, meaning, and channel number of the transmitted K1 and K2 bytes (see Table 7 on page 76 and Table 8 on page 76)
 - Counters—Statistics for APS group
 - ModeMismatch—Number of differences detected in the local and remote switching mechanisms (unidirectional or bidirectional modes)
 - ChanMismatch—Number of differences detected between the number of the channel in the transmitted K1 byte and the number of the channel in the received K2 byte
 - PSBF—Number of protection switching byte failures detected (no 3 consecutive SONET/SDH frames out of the last 12 contain identical K1 bytes)
 - FEPLF—Number of far-end protection line failures (signal failures detected on protect interface)
 - Aps channel—Number, interface specifier (in *slot/port* format), and protect/working designation of the APS channel for which information is displayed
 - aps-protect—Identifies the protect interface
 - aps-working—Identifies the working interface
 - Current Conditions—Current state of the interface for this channel

- lockedOut—Indicates that the router is configured to prevent the protect interface from taking over if the primary interface fails
- SD—Indicates that signal degradation is detected
- SF—Indicates that signal failure is detected
- switched—Indicates that the router has switched from the working interface to the protect interface
- Counters—Statistics for APS channel
 - SignalDegrades—Number of degraded signals detected
 - SignalFailures—Number of failed signals detected
 - Switchovers—Number of times the router has switched from the working interface to the protect interface
 - LastSwitchover—Length of time that the working interface was active when the router last switched from the working interface to the protect interface; a value of Not Applicable indicates that no switchovers have occurred
- Example

```

host1#show aps group
Aps group bos
  Current Conditions: PSBF
  Rx(K1/K2): 00/00, No Request on channel 0
  Tx(K1/K2): f0/05, Lockout of Protection on channel 0
  Counters
    ModeMismatch = 0
    ChanMismatch = 0
    PSBF          = 1
    FEPLF         = 0
  Aps channel 0 (5/4) (aps-protect)
    Current Conditions: SF
    Counters
      SignalDegrades = 0
      SignalFailures = 1
  Aps channel 1 (5/0) (aps-working)
    Current Conditions: None
    Counters
      SignalDegrades = 0
      SignalFailures = 0
      Switchovers    = 0
      LastSwitchover = Not Applicable

```

- See show aps.

Chapter 4

Configuring Channelized OCx/STMx Interfaces

Use the procedures described in this chapter to configure channelized OC3/STM1 and OC12/STM4 (cOCx/STMx) interfaces on E-series routers.

This chapter contains the following sections:

- Overview on page 109
- Platform Considerations on page 111
- References on page 117
- Before You Configure an Interface on page 118
- Configuration Tasks on page 119
- Configuration Examples on page 142
- Testing Interfaces on page 145
- Monitoring Interfaces on page 153

Overview

Channelized OC3/STM1 and OC12/STM4 interfaces are supported by the modules described in this chapter.

This section describes the features of cOCx/STMx interfaces.

SONET APS and SDH MSP

The router supports Automatic Protection Switching (APS) and Multiplex Section Protection (MSP) on selected I/O modules that provide SONET/SDH connections. This feature provides a redundant connection if a primary SONET/SDH connection fails. For a list of I/O modules that support APS/MSP, see *ERX Module Guide, Appendix A, Module Protocol Support*. For an overview of APS/MSP, see “Bidirectional Switching Mode” on page 75 in “Configuring Unchannelized OCx/STMx Interfaces” on page 73.

MDL/FDL Support

Interfaces on cOCx/STMx line modules support maintenance data link (MDL) messages at the T3 level and facilities data link (FDL) messages at the T1 level. For a list of the

line modules that support MDL and FDL, see *ERX Module Guide, Appendix A, Module Protocol Support*.

You can use MDL and FDL messages to determine the status of a link and to display statistics for the remote end of a connection. MDL and FDL messages do not interfere with other data transmitted over the link.

MDL Standards

You can configure channelized T3 interfaces to send MDL messages that comply with ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990). MDL messages identify a particular link by sharing common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

FDL Standards

Similarly, you can configure T1 channels to send FDL messages that comply with either or both of the following standards:

- ANSI T1.403-1989 Standard for Telecommunications—Network and Customer Installation Interfaces – DS1 Metallic Interface – Robbed-bit Signaling State Definitions (1989)

FDL messages that comply with the ANSI standard identify a particular link by sharing common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

- AT&T Technical Reference 54016—Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format (September 1989)

FDL messages that comply with the AT&T standard identify a particular link by sharing performance data and do not use common codes for data such as the equipment identifier, line identifier, frame identifier, and unit.

Timeout of Received MDL and FDL Messages

When a line module receives an MDL or FDL message string, it stores the strings for a period of 10 seconds after the last message was received. If the line module does not receive another message of any type containing the same string within 10 seconds, it erases the local copy of the message.

Most MDL and FDL message strings are common to all three types of messages that can be transmitted: path identifications, idle signals, and test signals. Certain message strings, however, are unique to a particular message type. Table 9 on page 111 briefly describes each MDL/FDL message string and indicates, with a checkmark (✓), the types of messages in which it can be sent.

Table 9: MDL and FDL Message Strings and Message Types

Message String	Description	Path Message	Idle Signal Message	Test Signal Message
eic	Equipment identification code	✓	✓	✓
fic	Frame identification code	✓	✓	✓
generator	Generator number	–	–	✓
lic	Line identification code	✓	✓	✓
pfi	Facility identification code	✓	–	–
port	Equipment port number	–	✓	–
unit	Unit identification code	✓	✓	✓

As long as another message of any type containing the same string is received within 10 seconds, the line module retains the local copy of the message string and resets the 10-second timer for that string.

For example, if a line module receives an MDL or FDL test signal message containing an eic string, and then receives a idle signal message within 10 seconds that also contains an eic string, it retains the local copy of the most recent eic string received and resets the 10-second timer for that message. However, if 10 seconds pass without the line module receiving a path identification, test signal, or idle signal message containing an eic string, the line module erases the local copy of the eic message string.

For message strings that are unique to a particular message type, the line module must receive another message of the same type containing this string in order to retain the local copy of the string and reset the timer. For example, if the line module receives a test signal message containing a generator string and does not receive another test signal message within 10 seconds, it erases the local copy of the generator string.

Frequency of FDL Path Messages

E-series routers transmit FDL path identifier messages every second. This behavior complies with the ANSI T1.403 specification (listed in “References” on page 117) and is consistent with the MDL implementation for E-series routers.

Higher-Level Protocols

See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the higher-level protocols that cOCx/STMx interfaces support.

Platform Considerations

You can configure cOCx/STMx interfaces on the following E-series routers:

- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router



NOTE: The E320 router does not support configuration of channelized OCx/STMx interfaces.

For detailed information about the modules that support cOCx/STMx interfaces on ERX-7xx models, ERX-14xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that cOCx/STMx modules support.

cOCx/STMx FO Line Module

The cOCx/STMx FO line module pairs with either a cOC3/STM1 I/O module or a cOC12/STM4 I/O module to support channelized T3 (DS3), T1, E1, FT1, and FE1 signaling. Each connection is made through standard SC connectors.

The cOCx/STMx line module supports the following:

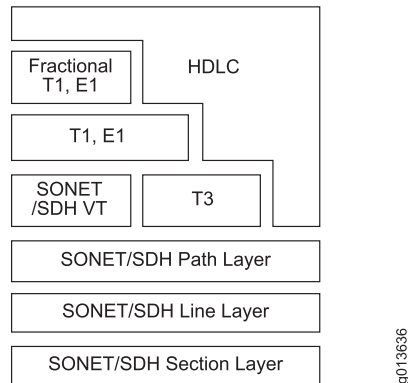
- 3 unchannelized/channelized DS3s per OC3
- 84 framed T1s per OC3/STM1
- 63 framed/unframed E1s per OC3/STM1
- 500 fractional T1/E1s per OC3/STM1

You can combine the cOCx/STMx line module with four-port cOC3/STM1 I/O modules or one-port cOC12/STM4 I/O modules. cOC3/STM1 I/O modules support one OC3/STM1 per port. cOC12/STM4 I/O modules support all four OC3/STM1s on one port.

The cOCx/STMx line module and its corresponding I/O modules can support either E1 or T1 operation. These modules cannot support E1 and T1 operation simultaneously.

Interface Stack

Figure 8 on page 113 shows the stack for cOCx/STMx interfaces.

Figure 8: Stack for cOCx/STMx Interfaces

NOTE: For a detailed description of interface types and specifiers, see Interface Types and Specifiers in *JUNOS Command Reference Guide*. For information about interfaces, see *Planning Your Network* in *JUNOS System Basics Configuration Guide*.

The *section* layer manages the transport of STS/STM frames across the physical path. This layer is responsible for frame alignment, scrambling, error detection, error monitoring, signal reception, and signal regeneration.

The *line* layer manages the transport of SONET/SDH payloads, which are embedded in a sequence of STS/STM frames in the physical medium. This layer is responsible for multiplexing and synchronization.

The *path* layer maps the user payload into a SONET/SDH format suitable for the line layer. This layer transports the actual network services (such as T1s and T3s) between SONET/SDH multiplexing devices and provides end-to-end transmission.

When you configure a cOCx/STMx interface, be sure you understand its position in the SONET or SDH hierarchy. This implementation of SONET and SDH uses the term *path* to identify an STS-1 or STM-1 line. You must know how to identify the path for the configuration and the higher-level *controllers*, such as T3 or unframed E1 over SONET VT.

SONET/SDH VT Controllers

SONET/SDH VT on cOCx/STMx interfaces support these options:

- A fractional T1 or E1 line

You assign *channel groups* of *timeslots* to configure fractional T1 or E1 over SONET/SDH VT on cOCx/STMx interfaces. A channel group is the fraction of the T1 or E1 line and comprises up to 24 T1 timeslots or up to 31 E1 timeslots. The default channel group speed for both T1 and E1 is 64 Kbps; 56 Kbps is also available.

- An unframed E1 line

Unframed E1 lines have no timeslots reserved for framing. The router creates one channel for an unframed E1 line and assigns the number one to that channel.



NOTE: To configure a whole T1 or E1 line, assign 24 T1 or 31 E1 timeslots to a channel group or configure an unframed E1 line.

To identify a controller over SONET/SDH VT, you must consider the multiplexing for SONET and SDH *virtual tributaries*. In SONET, an STS-1 frame can be divided into seven virtual tributary (VT) groups. Similarly, for SDH, an STM-0 frame can be divided into seven tributary units (TUs). Each group or unit contains a number of virtual tributaries; that number depends on the VT type or TU name. Table 10 on page 114 lists the VT types and TU names that the router supports.

Table 10: Tributary Standards That cOCx/STMx Interfaces Support

VT Type (SONET)	TU Name (SDH)	Number of Tributaries in a Group	Signal Standard
VT1.5	TU-11	4	T1
Not supported	TU-12	3	E1

Figure 9 on page 114 shows the structure for SONET, and Figure 10 on page 115 shows the structure for SDH.

Figure 9: SONET Multiplexing

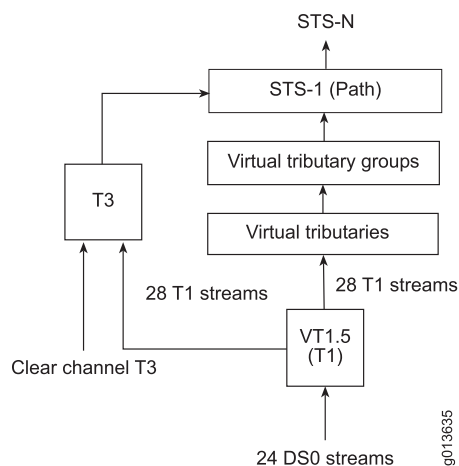
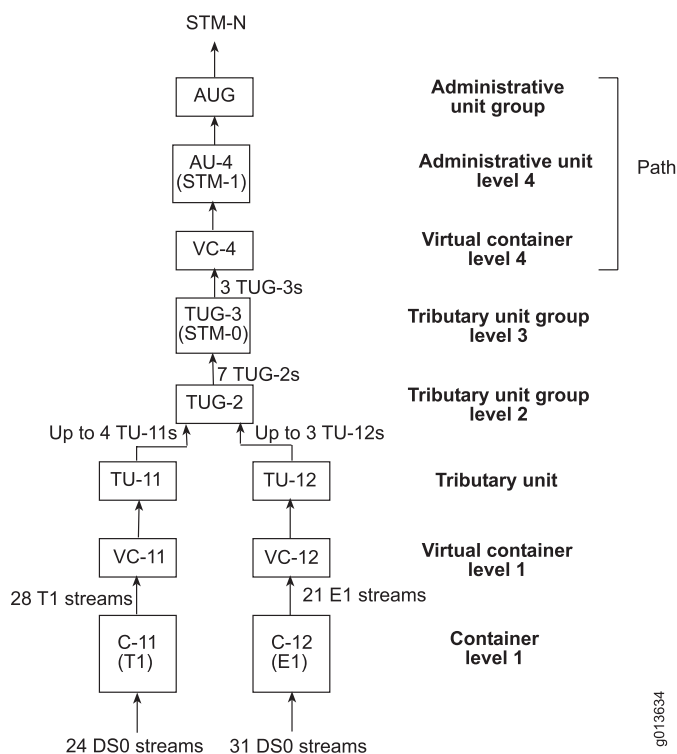


Figure 10: SDH Multiplexing

For both SONET/SDH VT configurations, you must identify the path and controllers above the path layer. Table 11 on page 115 shows the identifiers for these configurations, and Table 12 on page 115 provides definitions for the identifiers.

Table 11: Identifiers for SONET/SDH VT Controllers

Configuration	Identifier	Example
Unframed E1	<i>pathChannel/pathPayload/tributaryGroup/tributaryNumber/channelNumber</i>	10/1/2/2/1
NOTE: The router automatically assigns the channel number one to an unframed E1 line.		
Fractional T1 or E1	<i>pathChannel/pathPayload/tributaryGroup/tributaryNumber/channelGroup</i>	10/1/2/2/1

Table 12: Definitions for Identifiers for SONET/SDH VT Controllers

Identifier	Definition	Value
<i>pathChannel</i>	An STS-1 or STM-1 line	A number in the range 1–2147483648
<i>pathPayload</i>	Number of the payload within the path	In SONET mode, <i>pathPayload</i> is always 1. In SDH mode, <i>pathPayload</i> is the number of the TUG-3 group.

Table 12: Definitions for Identifiers for SONET/SDH VT Controllers (continued)

Identifier	Definition	Value
<i>tributaryGroup</i>	Number of the tributary group within the path	In SONET mode, <i>tributary group</i> is the number of the VT group. In SDH mode, <i>tributaryGroup</i> is the number of the TUG-2 group.
<i>tributaryNumber</i>	Number of the tributary within the group	In SONET mode, <i>tributaryNumber</i> is the number of the VT. In SDH mode, <i>tributaryNumber</i> is the number of the TUG-1 group or tributary unit.
<i>channelGroup</i>	A fraction of a T1 or an E1 line	A number in the range 1-24 for T1 or 1-31 for E1

T3 Controllers

You can configure the STS-1 frame to carry a single T3 signal through asynchronous mapping. As Figure 9 on page 114 shows, T3 on cOCx/STMx interfaces supports the following options:

- An unchannelized T3 controller
- A T3 controller channelized to DS0 (fractional T1). To configure fractional T1 over T3 on cOCx/STMx interfaces, you assign *timeslots* (also known as *subchannels*) to the T1 channel. Each T1 channel supports 24 T1 timeslots.

For any configuration, you must identify the path and each controller in the layers above the path layer. For example, for a T3 controller channelized to T1, you must identify the path channel, the T3 channel, and the T1 channel. Table 13 on page 116 presents the identifiers for the T3 configurations.

Table 13: Identifiers for T3 Controllers

Configuration	Identifier	Example
Unchannelized T3	<i>pathChannel/ds3-channel-number</i>	1/1
T3 channelized to DS0	<i>pathChannel/ds3Channel-number/ds1-channel-number/subchannelNumber</i>	1/1/10/15

HDLC

You must configure HDLC over the T3, unframed E1, or fractional T1/E1 line that you configure on an interface. As Figure 8 on page 113 shows, HDLC is at the top layer of the interface stack.

Numbering Scheme

A cOCx/STMx interface is identified by the *slot/port* format, where:

- *slot*—Number of the slot in which the line module resides in the chassis. In ERX-7xx models, line module slots are numbered 2-6 (slots 0 and 1 are reserved for SRP modules). In ERX-14xx models, line module slots are numbered 0-5 and 8-13 (slots 6 and 7 are reserved for SRP modules). In an ERX-310 router, line module slots are numbered 1-2 (slot 0 is reserved for the SRP module).
- *port*—Number of the port on the I/O module

A cOC3/STM1 I/O module has four ports. Each port accepts one pair of SC-style fiber connectors.

The cOC12/STM4 I/O module has one or two ports. On an I/O module that supports two ports, one port is active (primary) and the other is redundant. Cabling both ports provides a redundant path to the interface. If the active port fails, the redundant port automatically becomes active. You can configure only port 0 on a cOC12/STM4 I/O module. Port 0 accepts one pair of SC-style fiber connectors.

On I/O modules that support APS/MSP, the port numbers for the working (primary) interfaces are assigned the lower half of the numbered interfaces, whereas the port numbers for the protect (redundant) interfaces are assigned the upper half of the numbered interfaces. For example, on an I/O module that provides one primary port and one redundant port, the working interface is port 0 and the protect interface is port 1.

- *APS/MSP channel number*—Identifier of the working or protect interface for configuration purposes

The protect interface is always assigned channel number 0. The working interface is always assigned channel number 1.

For information about installing line modules and I/O modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

References

For more information about MIB support for cOCx/STMx interfaces, consult the following resources:

- RFC 1661—The Point-to-Point Protocol (PPP) (July 1994)
- RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999)
- RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999)
- RFC 2558—Definitions of Managed Objects for the SONET/SDH Interface Type (March 1999)

For more information about APS/MSP, consult the following resources:

- Telcordia document GR-253—Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria, Revision 3 (September 2000)
- ITU-T G.783—Characteristics Of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks: Annex A – Multiplex Section Protection (MSP) Protocol, Commands And Operation (1990)
- Definitions of Managed Objects for SONET Linear APS Architectures—draft-ietf-atommib-sonetaps-mib-05.txt (November 2001 expiration)
- RFC 3498—Definitions of Managed Objects for Synchronous Optical Network (SONET) Linear Automatic Protection Switching (APS) Architectures (March 2003)

For more information about bit error rate test (BERT) patterns, consult the following resources:

- ITU O.151—Error performance measuring equipment operating at the primary rate and above (October 1992)
- ITU O.153—Basic parameters for the measurement of error performance at bit rates below the primary rate (October 1992)
- T1M1.3 Working Group—A Technical Report on Test Patterns for DS1 Circuits (November 1993)
- ANSI T1.404-1994 Standard for Telecommunications—Network-to-Customer – DS3 Metallic Interface Specification (1994)

For more information about MDL/FDL support on cOCx/STMx interfaces, consult the following resources:

- ANSI T1.107a-1990 Standard for Telecommunications—Digital Hierarchy – Supplement to Formats Specification (August 1990)
- ANSI T1.403-1989 Standard for Telecommunications—Network and Customer Installation Interfaces – DS1 Metallic Interface – Robbed-bit Signaling State Definitions (1989)
- AT&T Technical Reference 54016—Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format (September 1989)

Before You Configure an Interface

Before you configure a cOCx/STMx interface, verify the following:

- You have installed the line module and the I/O module correctly.
- Each configured line is able to transmit data to and receive data from your switch connections.

For more information about installing modules, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

Make sure you also have the following information available:

- Framing type, clock source, and the cable length for each controller
- Framing type, line code, and clock source for each channel
- Timeslot mapping and line speed for each fractional channel
- HDLC channel information, such as data inversion information, CRC type, idle character, MTU, and MRU

Configuration Tasks

The following sections describe how to configure the layers on cOCx/STMx interfaces.

SONET/SDH Configuration Tasks

To configure SONET/SDH on a cOCx/STMx interface:

1. Select an interface.
2. Specify a clock source for the interface.
3. Specify that the mode be SDH, or accept the default mode, SONET.
4. (Optional) Assign a text description or an alias to the interface.
5. (Optional) Disable processing of SNMP link status information for the section and line layers of the interface.
6. Configure the path for the interface.
7. (Optional—not recommended) Overwrite the automatic setting for the path signal label (C2) byte.
8. (Optional) Enable processing of SNMP link status information for the path layer of the interface.
9. (Optional) Configure the router to use remote defect indications (RDIs) at the path layer to determine the operational status of a path.
10. (MPLS fast reroute over SONET/SDH interfaces) Specify the time duration after which the router sets an alarm when it records a defect at the path layer.
11. (MPLS fast reroute over SONET/SDH interfaces) Specify the time duration after which the router sets an alarm when it records a defect at the line or section layer.
12. Configure APS/MSP for the interface.

For information about configuring APS/MSP, see “Configuring APS/MSP” on page 89 in “Configuring Unchannelized OCx/STMx Interfaces” on page 73.

You must now configure the next layer on the interface: E1, T1, or E3. See “T1/E1 Configuration Tasks” on page 124 or “T3 Configuration Tasks” on page 130.

clock source

- Use to configure the transmit clock source for the interface.
- For production networks, configure all STMx ports on the line module for internal chassis timing. You must also ensure that the chassis reference clock is of good quality — Stratum 3 or better, recovered either from a known good STM port or from one of the BITS inputs.
- Although the CLI enables you to specify the keywords **internal module** to use the line module's internal clock, in a production network we recommend that you do not do this. Instead, specify the keywords **internal chassis** to use the router's internal clock.
- For production networks, never specify the keyword **line** to use the line's receive clock as the transmit clock. Although the CLI enables this configuration, it is not supported because jitter transfer is not compliant for this timing and because pointer adjustments takes place on the outgoing link.
- In a nonproduction network, you can configure some ports with internal clock sources and others with line clock sources. However, all ports with internal clock sources must use either the router's clock or the module's clock. You cannot configure some ports on the I/O module to use the router's clock and others to use the module's clock.
- To change the clock source of the ports on a cOC3/STM1 I/O module from the router's clock to the module's clock or vice versa, first change the clock source of all ports to the line setting, and then to the new internal clock setting.
- Example

```
host1(config-controll)#clock source internal chassis
```

- Use the **no** version to revert to the default, **line**.
- See clock source.

controller sonet

- Use to select an interface on which you want to configure channelized SONET or SDH.
- Example

```
host1(config)#controller sonet 4/0
```

- There is no **no** version.
- See controller sonet.

description

- Use to assign a text description or an alias to a channelized SONET interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 64 characters.
- Use the **show controllers sonet** command to display the text description.
- Example

host1(config-controll)#**description boston-sonet-interface**

- Use the **no** version to remove the text description or alias.
- See description.

path

- Use to configure paths over channelized SONET and SDH interfaces.
- Specify the correct identifier for the type of interface. See Interface Types and Specifiers in *JUNOS Command Reference Guide* for details of the syntax.
- Example for a cOC3/STM1 interface

host1(config-controller)#**path 2 oc1**

- Example for a cOC12/STM4 interface in SONET mode

host1(config-controller)#**path 2 oc1 1/2**

- Example for a cOC12/STM4 interface in SDH mode

host1(config-controller)#**path 2 stm1 2**

- Use the **no** version to delete a SONET or SDH path.
- See path.

path description

- Use to assign a text description or an alias to a channelized SONET path.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 64 characters.
- Example

host1(config-controll)#**path 2 description westford**

- Use the **no** version to remove the description.
- See path description.

path overhead c2

- Use to overwrite the automatic setting for the path signal label (C2) byte.
- By default, the value of the C2 byte for the path is determined by the layers configured above the SONET/SDH interface and set automatically. The E-series router sets this default value in accordance with RFC 2558. (See “References” on page 117.)



CAUTION: Use this command only if you know that the automatic setting does not match the setting on the remote device. Otherwise, the remote device might send an unexpected value, and the router might lose data.

- Example

```
host1(config-controll)#path 2 overhead c2 20
```

- Use the **no** version to restore the default setting, in which the value of the C2 byte is determined by the layers configured above the SONET/SDH interface.
- See path overhead c2.

path shutdown

- Use to disable a specified path.
- Paths are enabled by default.
- Example

```
host1(config-controll)#path 2 shutdown
```

- Use the **no** version to restart a disabled path.
- See path shutdown.

path snmp trap link-status

- Use to enable SNMP link status processing for the path layer of the interface.
- The default is disabled.
- Example

```
host1(config-controll)#path 2 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See path snmp trap link-status.

path trigger alarm prdi

- Use to configure the router to use remote defect indications (RDIs) at the path layer to determine the operational status of a path.
- Example

```
host1(config-controll)#path 2 trigger alarm prdi
```

- Use the **no** version to restore the default setting, in which the software uses loss of pointer and AIS defects at the path layer to determine the operational status of a path.
- See path trigger alarm prdi.

path trigger delay

- Use to set the time duration after which the router sets an alarm when it records a defect at the path layer.
- Change this value from the default only when you are using MPLS fast reroute over a SONET/SDH interface.
 - Specify a value of 0 milliseconds if this interface does not use APS/MSP or if MPLS should have priority over APS/MSP.
 - Specify a value of at least 100 milliseconds if this interface uses APS/MSP and if APS/MSP should have priority over MPLS.
- Example


```
host1(config-controll)#path 2 trigger delay msec 1000
```
- Use the **no** version to restore the default setting, 2500 milliseconds.
- See path trigger delay.

sdh

- Use to specify that the interface supports SDH.
- Example


```
host1(config-controller)#sdh
```
- Use the **no** version to revert to SONET operation on this interface.
- See sdh.

snmp trap link-status

- Use to enable SNMP link status processing for the section and line layers of the interface.
- The default is enabled.
- Example


```
host1(config-controll)#no snmp trap link-status
```
- Use the **no** version to disable SNMP link status processing.
- See snmp trap link-status.

trigger delay

- Use to set the time duration after which the router sets an alarm when it records a defect at the line or section layer.
- Change this value from the default only when you are using MPLS fast reroute over a SONET/SDH interface.
 - Specify a value of 0 milliseconds if the interface does not use APS/MSP or if MPLS should have priority over APS/MSP.
 - Specify a value of at least 100 milliseconds if this interface uses APS/MSP and if APS/MSP should have priority over MPLS.

- Example

```
host1(config-controll)#trigger delay msec 1000
```

- Use the **no** version to restore the default setting, 2500 milliseconds.
- See trigger delay.

Configuring Higher Layers

You must now configure the next layer on the interface: E1, T1, or T3. See “T1/E1 Configuration Tasks” on page 124 or “T3 Configuration Tasks” on page 130.

T1/E1 Configuration Tasks

Before you configure T1 or E1 on an interface, you must configure SONET or SDH. See “SONET/SDH Configuration Tasks” on page 119.

To configure a T1 or an E1 over SONET or SDH on a cOCx/STMx interface:

1. Configure a tributary for the path.
2. (Optional) Assign a text description or an alias to the interface.
3. Configure one of the following:
 - An unframed E1 line. (See “Configuring T1 and E1 Lines” on page 125.)
 - A T1 or an E1 line. (See “Configuring T1 and E1 Lines” on page 125.)

For detailed examples, see “Configuration Examples” on page 142.

path ds1|e1

- Use to create and configure SONET tributaries, SDH tributaries, and T1 or E1 on the path.
- Example

```
host1(config-controller)#path 2 ds1 1/7/4 vt15
```

- Use the **no** version to delete SONET and SDH tributaries.
- See path ds1|e1.

path ds1|e1 description

- Use to assign a text description or an alias to a T1/E1 over SONET/SDH VT layer on channelized SONET and SDH interfaces.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show controllers sonet ds1|e1” on page 159 to display the text description.
- Example

```
host1(config-controller)#path 2 ds1 1/7/4 description nyc01
```

- Use the **no** version to remove the text description or alias.
- See path ds1 |e1 description.

Configuring an Unframed E1 Line

Use the following command to configure an unframed E1 line.

path e1 unframed

- Use to configure an unframed E1 on the path.
- You cannot configure a mixture of T1 and E1 lines on the same cOCx/STMx line module.
- When you issue this command, the router creates one channel for the unframed E1 line, and assigns the number one to that channel.
- Example

```
host1(config-controller)#path 1 e1 1/7/4  
host1(config-controller)#path 1 e1 1/7/4 unframed
```

- Use the **no** version to delete an unframed E1 interface from the path.
- See path e1 unframed.

Configuring T1 and E1 Lines

You can configure T1 and E1 interfaces on paths and tributaries. To do so, complete the following steps:

1. Configure the clock source. You must coordinate this setting with the other end of the line to establish which end is the transmit (internal) clock and which is the receive (line) clock.
2. (Optional) Configure the framing format.
3. (Optional) Enable processing of SNMP link status information about an interface and its associated tributary.
4. Configure the T1 or E1 line parameters.
5. (Optional) Enable processing of SNMP link status information about a channel group.
6. (Optional—T1 only) Configure FDL messages.
7. (Optional) Assign a text description or an alias to the interface.

path ds1 |e1 channel-group description

- Use to assign a text description or an alias to a DS1 (T1) or an E1 channel group for channelized SONET and SDH interfaces.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show controllers sonet ds1 | e1” on page 159 to display the text description.
- Example

```
host1(config-controller)#path 10 e1 1/5/1 channel-group 4
description westford e1 151.4
```

- Use the **no** version to remove the text description or alias.
- See path ds1 | e1 channel-group description.

path ds1 | e1 channel-group shutdown

- Use to disable a T1 or an E1 channel group.
- T1 and E1 channel groups are enabled by default.
- Example

```
host1 (config-controll)#path 12 e1 1/4/1 channel-group 2 shutdown
```

- Use the **no** version to restart a disabled channel group.
- See path ds1 | e1 channel-group shutdown.

path ds1 | e1 channel-group snmp trap link-status

- Use to enable SNMP link status processing for a T1 or an E1 channel group.
- The default is disabled.
- Example

```
host1(config-controll)#path 2 ds1 1/1/1 channel-group 2 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing for a T1 or an E1 channel group.
- See path ds1 | e1 channel-group snmp trap link-status.

path ds1 | e1 channel-group timeslots

- Use to configure T1 or E1 line parameters.
- You cannot configure a mixture of T1 and E1 lines on the same cOCx/STMx line module.
- Specify a T1 or E1 channel group number, and assign a range of timeslots.
- To configure a whole T1 or E1 line, assign all the timeslots to the channel group.
- You can specify a line speed that applies to all DS0 timeslots assigned to a channel group.

- Example

```
host1(config-controll)#path 2 ds1 1/1/1 channel-group 2 timeslots 5-6
```

- Use the **no** version to remove the timeslots from the channel group.
- See path ds1 |e1 channel-group timeslots.

path ds1 |e1 clock source

- Use to configure the transmit clock source for the T1 or E1 interface.
- Select a clock as follows:
 - Specify the keyword **line** to use a transmit clock recovered from the line's receive data stream.
 - Specify the keywords **internal module** to use the line module's internal clock.
 - Specify the keywords **internal chassis** to use the router's clock.
- You can usually accept the default option, **line**, to use a transmit clock recovered from the line's receive data stream, except in rare cases such as back-to-back router tests. When performing back-to-back router tests, configure one end of the line as **internal** and the other end as **line**.
- On a cOC3/STM1 I/O module, you can configure some interfaces with internal clock sources and others with line clock sources. However, all interfaces with internal clock sources must use either the router's clock or the module's clock. You cannot configure some interfaces on the I/O module to use the router's clock and others to use the module's clock.
- To change the clock source of the interfaces on a cOC3/STM1 I/O module from the router's clock to the module's clock or vice versa, first change the clock source of all ports to the line setting, and then to the new internal clock setting.
- Example

```
host1(config-controll)#path 12 e1 1/4/1 clock source line
```

- Use the **no** version to restore the default value, line.
- See path ds1 |e1 clock source.

path ds1 |e1 framing

- Use to configure the framing format for a T1 or an E1 interface.
- For T1, specify **esf** (extended superframe) or **sf** (superframe). The default is **esf**.
- The HDLC idle character differs from non-E-series implementations. For T1 interfaces, if you configure SF, the router sets the HDLC idle character to 0xFF. If you configure ESF, the router sets the HDLC idle character to 0x7E.
- For E1, specify **crc4** or **no-crc4**. The default is **crc4**.
- Choose a framing format that is compatible with the framing format at the other end of the line.
- Example

```
host1(config-controll)#path 12 e1 1/4/1 framing no-crc4
```

- Use the **no** version to restore the default value.
- See `path ds1 |e1 framing`.

path ds1 |e1 snmp trap link-status

- Use to enable SNMP link status processing for a T1 or an E1 interface and its associated tributary.
- The default is disabled.
- Example

```
host1(config-controll)#path 2 ds1 1/1/1 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See `path ds1 |e1 snmp trap link-status`.

Configuring T1 Interfaces to Send FDL Messages

You can configure a T1 interface to send FDL messages. To configure FDL:

1. Specify a SONET interface.

```
host1(config)#controller sonet 8/0
```

2. Specify the standard for transmission of FDL messages on both ends of the T1 connection.

```
host1(config-controll)#path 2 ds1 1/1/1 fdl ansi
```

3. (Optional) Configure the interface to operate in an FDL carrier environment.

```
host1(config-controll)#path 2 ds1 1/1/1 fdl carrier
```

4. (Optional) Specify the FDL messages.

```
host1(config-controll)#path 2 ds1 1/1/1 fdl string eic "ERX-1410"  
host1(config-controll)#path 2 ds1 1/1/1 fdl string lic "Bldg 10"  
host1(config-controll)#path 2 ds1 1/1/1 fdl string fic "GY788"  
host1(config-controll)#path 2 ds1 1/1/1 fdl string unit 080001
```

5. Enable transmission of FDL messages.

```
host1(config-controll)#path 2 ds1 1/1/1 fdl transmit idle-signal
```

path ds1 fdl

- Use to specify the FDL standard for the interface.
- Specify the keyword **ansi** to support the ANSI FDL standard (see “References” on page 117).

- Specify the keyword **att** to support the AT&T FDL standard (see “References” on page 117).
- Specify the keyword **all** to support both the ANSI and AT&T standards.
- Specify the keyword **none** to remove the current FDL mode settings.
- You can configure a different standard on each T1 channel.
- Example

```
host1(config-controll)#path 2 ds1 1/1/1 fdl att
```

- Use the **no** version to restore the default, none.
- See path ds1 fdl.

path ds1 fdl carrier

- Use to specify that an interface is used in the carrier environment.
- Example

```
host1(config-controll)#path 2 ds1 1/1/1 fdl carrier
```

- Use the **no** version to restore the default situation, in which the T1 interface does not operate in the carrier environment.
- See path ds1 fdl carrier.

path ds1 fdl string

- Use to configure an FDL message as defined in the ANSI T1.403 specification.



NOTE: The router sends these FDL messages only if you have issued the path ds1 fdl command with the **ansi** or **all** keyword and then issued the path ds1 fdl transmit command.

- Example

```
host1(config-controll)#path 2 ds1 1/1/1 fdl string eic "ERX-1440"
```

- Use the **no** version to restore the default value to the specified FDL message or to all FDL messages.
- See path ds1 fdl string.

path ds1 fdl transmit

- Use to configure the router to send the specified type of FDL message on the T1 channel.
- By default, the router sends no FDL messages.



NOTE: The router sends FDL messages specified with the `path ds1 fdl` string command only if you have issued the `path ds1 fdl` command with the **ansi** or **all** keyword. If you specified the **att** keyword with the `path ds1 fdl` command, the router sends only performance data.

- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.
- Specify the keyword **test-signal** to transmit test signals every second.
- Example

```
host1(config-controll)#path 2 ds1 1/1/1 fdl transmit path-id
```

- Use the **no** version to disable transmission of the specified FDL message or all FDL messages.
- See `path ds1 fdl transmit`.

Disabling Interfaces and Channel Groups

To disable interfaces and channel groups, use the following commands.

path ds1|e1 shutdown

- Use to disable a T1 or an E1 interface.
- T1 and E1 interfaces are enabled by default.
- Example

```
host1 (config-controll)#path 12 e1 1/4/1 shutdown
```

- Use the **no** version to restart a disabled interface.
- See `path ds1|e1 shutdown`.

Configuring Higher Layers

You must configure HDLC over the top layer of the T1/E1 interface. See “HDLC Channel Configuration Tasks” on page 139.

T3 Configuration Tasks

Before you configure T3 on an interface, you must configure SONET or SDH on the interface. See “SONET/SDH Configuration Tasks” on page 119.

To configure T3 over SONET or SDH on a cOCx/STMx interface, complete the following actions:

1. Configure a T3 path over the SONET and SDH interfaces.

2. Configure T3 line parameters (for both clear channel T3 lines and multiplexed T3 lines composed of fractional T1 lines).
3. (Optional) Configure T1 or fractional T1 line parameters.

For detailed examples, see “Configuration Examples” on page 142.

path ds3

- Use to create and configure a T3 path over SONET and SDH interfaces.
- Example

```
host1(config-controller)#path 2 ds3 1 channelized
```

- Use the **no** version to delete a path.
- See path ds3.

Configuring T3 Line Parameters

Complete the following steps to configure T3 line parameters. Configure these parameters for both clear channel and multiplexed T3 lines.

1. Configure the clock source. You must coordinate this setting with the other end of the line to establish which end is the transmit (internal) clock and which is the receive (line) clock.
2. (Optional) Assign a text description or an alias to the interface.
3. (Optional) Configure the framing format.
4. (Optional) Enable processing of SNMP link status information about an interface.
5. (Optional) Configure MDL settings.
6. (Optional) Configure T1 channels.

path ds3 clock source

- Use to configure the transmit clock source for the T3 line.
- Select a clock as follows:
 - Specify the keyword **line** to use a transmit clock recovered from the line's receive data stream.
 - Specify the keywords **internal module** to use the line module's internal clock.
 - Specify the keywords **internal chassis** to use the router's clock.
- You can usually accept the default option, **line**, to use a transmit clock recovered from the line's receive data stream, except in rare cases such as back-to-back router tests. When performing back-to-back router tests, configure one end of the line as **internal** and the other end as **line**.
- On a cOC3/STM1 I/O module, you can configure some interfaces with internal clock sources and others with line clock sources. However, all interfaces with internal clock sources must use either the router's clock or the module's clock.

You cannot configure some interfaces on the I/O module to use the router's clock and others to use the module's clock.

- To change the clock source of the interfaces on a cOC3/STM1 I/O module from the router's clock to the module's clock or vice versa, first change the clock source of all ports to the line setting, and then to the new internal clock setting.
- Example

```
host1(config-controll)#path 12 ds3 1 clock source line
```

- Use the **no** version to restore the default value, **line**.
- See path ds3 clock source.

path ds3 description

- Use to assign a text description or an alias to a T3 (DS3) over channelized SONET/SDH interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show controllers sonet ds3” on page 161 to display the text description.
- Example

```
host1(config-controller)#path 12 ds3 1 description boston_t3
```

- Use the **no** version to remove the text description or alias.
- See path ds3 description.

path ds3 framing

- Use to configure the framing format for a T3 interface.
- Specify c-bit parity framing or m23 multiplexer framing.
- Example

```
host1(config-controll)#path 12 ds3 1 framing m23
```

- Use the **no** version to restore the default value, c-bit parity framing.
- See path ds3 framing.

path ds3 shutdown

- Use to disable a T3 interface.
- T3 interfaces are enabled by default.
- Example

```
host1(config-controll)#path 12 ds3 1 shutdown
```

- Use the **no** version to restart a disabled interface.
- See path ds3 shutdown.

path ds3 snmp trap link-status

- Use to enable SNMP link status processing for a T3 interface.
- The default disables SNMP link status processing.
- Example

```
host1(config-controll)#path 12 ds3 1 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing.
- See path ds3 snmp trap link-status.

Configuring T3 Interfaces to Send MDL Messages

You can configure a T3 interface to send MDL messages. MDL messages are supported only when the T3 framing is set for C-bit parity, the default setting.

To configure a T3 interface to send MDL messages:

1. Specify a SONET interface.

```
host1(config)#controller sonet 8/0
```

2. (Optional) Configure the interface to operate in an MDL carrier environment.

```
host1(config-controll)#path 12 ds3 1 mdl carrier
```

3. Specify the MDL messages.

```
host1(config-controll)#path 12 ds3 1 mdl string eic "ERX 1410"  
host1(config-controll)#path 12 ds3 1 mdl string fic "FG786"  
host1(config-controll)#path 12 ds3 1 mdl string lic "Bldg 2"  
host1(config-controll)#path 12 ds3 1 mdl string pfi "Site 1"  
host1(config-controll)#path 12 ds3 1 mdl string port 0800  
host1(config-controll)#path 12 ds3 1 mdl string unit 080001
```

4. Enable transmissions of MDL messages.

```
host1(config-controll)#path 12 ds3 1 mdl transmit path-id  
host1(config-controll)#path 12 ds3 1 mdl transmit idle-signal  
host1(config-controll)#path 12 ds3 1 mdl transmit test-signal
```

path ds3 mdl carrier

- Use to specify that an interface is used in the carrier environment.
- Example

```
host1(config-controll)#path 12 ds3 1 mdl carrier
```

- Use the **no** version to restore the default situation, in which the interface does not operate in the carrier environment.
- See `path ds3 mdl carrier`.

path ds3 mdl string

- Use to specify an MDL message.
- Example


```
host1(config-controll)#path 12 ds3 1 mdl string port 0800
```
- Use the **no** version to restore the default value to the specified MDL message or to all MDL messages.
- See `path ds3 mdl string`.

path ds3 mdl transmit

- Use to enable transmission of MDL messages.
- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.
- Specify the keyword **test-signal** to transmit test signals every second.
- Example


```
host1(config-controll)#path 12 ds3 1 mdl transmit test-signal
```
- Use the **no** version to disable transmission of the specified type of MDL messages or all MDL messages.
- See `path ds3 mdl transmit`.

Configuring T1 Channels on T3 Interfaces

To configure T1 and fractional T1 channels over T3 interfaces:

1. Configure the T1 path.
2. Configure the clock source.

You must coordinate this setting with the other end of the line to establish which end is the transmit (internal) clock and which is the receive (line) clock.

3. (Optional) Assign a text description or an alias to the interface.
4. (Optional) Configure the framing format.
5. (Optional) Enable processing of SNMP link status information about an interface.
6. Configure the T1 line parameters.

You can specify parameters for a single channel, multiple individual channels, ranges of channels, or any combination of the three types of specifications. For example:

```
host1(config-controll)#path 12 ds3 1 t1 25-28
```

7. (Optional) Enable processing of SNMP link status information about a channel group.

path ds3 t1

- Use to create and configure the T1 path over SONET and SDH interfaces.
- Example

```
host1(config-controll)#path 12 ds3 1 t1 25-28
```

- Use the **no** version to delete a path.
- See path ds3 t1.

path ds3 t1 clock source

- Use to configure the transmit clock source for the T3 line.
- Use a transmit clock recovered from the line's receive data stream, except in rare cases such as back-to-back router tests. When performing back-to-back router tests, configure one end of the line as **internal** and the other end as **line**.
- Specify the keyword **line** to use a transmit clock recovered from the line's receive data stream.
- Specify the keywords **internal module** to use the line module's internal clock.
- Specify the keywords **internal chassis** to use the router's clock.
- On a cOC3/STM1 I/O module, you can configure some ports with internal clock sources and others with line clock sources. However, all ports with internal clock sources must use either the router's clock or the module's clock. You cannot configure some ports on the I/O module to use the router's clock and others to use the module's clock.
- To change the clock source of the ports on a cOC3/STM1 I/O module from the router's clock to the module's clock or vice versa, change the clock source of all ports first to the line setting, and then to the new internal clock setting.
- Example

```
host1(config-controll)#path 12 ds3 1 t1 28 clock source internal chassis
```

- Use the **no** version to restore the default value, line clocking.
- See path ds3 t1 clock source.

path ds3 t1 description

- Use to assign a text description or an alias to a T1 or fractional T1 channel on a T3 (DS3) over channelized SONET/SDH interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use "show controllers sonet ds3" on page 161 to display the text description.

- Examples

```
host1(config-controller)#path 12 ds3 1 t1 28 description boston_t1_on_t3
host1(config-controller)#path 12 ds3 1 t1 28/5
description washington_fractional_t1_on_t3
```

- Use the **no** version to remove the text description or alias.
- See path ds3 t1 description.

path ds3 t1 framing

- Use to configure the T1 framing format for a T3 interface.
- You must specify either **esf** (extended superframe) or **sf** (superframe) framing.
- The framing format you choose must be compatible with the framing format at the other end of the line.
- Example

```
host1(config-controll)#path 12 ds3 1 t1 28 framing sf
```

- Use the **no** version to restore the default value, esf framing.
- See path ds3 t1 framing.

path ds3 t1 shutdown

- Use to disable T1 channels or a subchannel.
- T1 channels and subchannels are enabled by default.
- Examples

```
host1(config-controll)#path 12 ds3 t1 5,9,14-17 shutdown
host1(config-controll)#path 12 ds3 t1 28/5 shutdown
```

- Use the **no** version to restart a disabled interface.
- See path ds3 t1 shutdown.

path ds3 snmp trap link-status

- Use to enable SNMP link status processing for T1 channels or a subchannel.
- The default disables SNMP link status processing.
- Examples

```
host1(config-controll)#path 2 ds3 3 t1 28 snmp trap link-status
host1(config-controll)#path 2 ds3 3 t1 28/5 snmp trap link-status
```

- Use the **no** version to disable SNMP link status processing for a T1 channel.
- See path ds3 snmp trap link-status.

path ds3 t1 timeslots

- Use to assign a range of DS0 timeslots to a subchannel as a single data stream.
- You can specify a line speed for all DS0 timeslots assigned to a subchannel.
- Examples

```
host1(config-controll)#path 2 ds3 1 t1 28 timeslots 1-10
host1(config-controll)#path 2 ds3 1 t1 28/1 timeslots 1-10 speed 56
```

- Use the **no** version to delete the fractional T1 circuit.
- See path ds3 t1 timeslots.

Configuring T1 Channels to Send FDL Messages

To configure T1 channels to send FDL messages:

1. Specify a SONET interface.

```
host1(config)#controller sonet 8/0
```

2. Specify the standard for transmission of FDL messages on both ends of the T1 connection.

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl ansi
```

3. (Optional) Configure the interface to operate in an FDL carrier environment.

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl carrier
```

4. (ANSI signals) Specify the FDL messages.

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl string eic "ERX-1410"
host1(config-controll)#path 2 ds3 1 t1 28 fdl string lic "Bldg 10"
host1(config-controll)#path 2 ds3 1 t1 28 fdl string fic "GY788"
host1(config-controll)#path 2 ds3 1 t1 28 fdl string unit 080001
```

5. Enable transmission of FDL messages.

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl transmit idle-signal
```

path ds3 t1 fdl

- Use to specify the FDL standard for the interface.
- Specify the T1 channels in the range 1 through 28.
- Specify the keyword **ansi** to support the ANSI FDL standard (see “References” on page 117).
- Specify the keyword **att** to support the AT&T FDL standard (see “References” on page 117).
- Specify the keyword **all** to support both the ANSI and AT&T standards
- Specify the keyword **none** to remove the current FDL mode settings

- You can configure a different standard on each T1 channel.
- Example

```
host1(config-controll)#path 2 ds3 1 t1 20-28 fdl att
```

- Use the **no** version to restore the default, no specified FDL standard.
- See `path ds3 t1 fdl`.

path ds3 t1 fdl carrier

- Use to specify that T1 channels are used in the carrier environment.
- Example

```
host1(config-controll)#path 2 ds3 1 t1 4,6,10-14 fdl carrier
```

- Use the **no** version to restore the default situation, in which the T1 channel does not operate in the carrier environment.
- See `path ds3 t1 fdl carrier`.

path ds3 t1 fdl string

- Use to configure an FDL message as defined in the ANSI T1.403 specification.



NOTE: The router sends these FDL messages only if you have issued the `path ds3 t1 fdl` command with the **ansi** or **all** keyword and then issued the `path ds3 t1 fdl transmit` command.

- Example

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl string eic "ERX-1440",
```

- Use the **no** version to restore the default value to the specified FDL message or to all FDL messages.
- See `path ds3 t1 fdl string`.

path ds3 t1 fdl transmit

- Use to configure the router to send the specified type of FDL message.
- By default, the router sends only FDL performance data messages.



NOTE: The router sends FDL messages specified with the `path ds3 t1 fdl string` command only if you have issued the `path ds3 t1 fdl` command with the **ansi** or **all** keyword. If you specified the **att** keyword with the `path ds3 t1 fdl` command, the router sends only performance data.

- Specify the keyword **path-id** to transmit path identifications every second.
- Specify the keyword **idle-signal** to send idle signals every second.

- Specify the keyword **test-signal** to transmit test signals every second.
- Example

```
host1(config-controll)#path 2 ds3 1 t1 28 fdl transmit path-id
```

- Use the **no** version to disable transmission of the specified FDL message or all FDL messages.
- See path ds3 t1 fdl transmit.

Configuring Higher Layers

You must configure HDLC over the top layer of the T3 interface. See “HDLC Channel Configuration Tasks” on page 139.

HDLC Channel Configuration Tasks

You must configure HDLC over the T3, T1, unframed E1, or fractional T1/E1 line that you configure on an interface. As Figure 8 on page 113 shows, HDLC must be the top layer of the interface stack.

To configure an HDLC channel, specify a serial interface. For example:

```
host1(config)#interface serial 4/0:1/1/1/1
```

Optional Tasks

The following configuration tasks are optional when you configure an HDLC channel on a channelized T3 interface:

- Configure the CRC.
- Configure the HDLC idle character.
- Enable data inversion on the interface.
- Set the MRU.
- Set the MTU.
- Assign a text description or an alias to the serial interface.

crc

- Use to configure the size of the CRC.
- Specify the number of bits (16 or 32) that are used to calculate the frame check sequence (FCS). Both the sender and receiver must use the same setting.
- The CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data.
- A 32-bit CRC should be used to protect longer streams at faster rates and, therefore, provide better ongoing error detection.
- Example

host1(config-if)#**crc 32**

- Use the **no** version to restore the default, 16.
- See crc.

idle-character

- Use to configure the HDLC idle character.
- The idle character is sent between HDLC packets.
- Specify one of the following idle characters:
 - **flags**—Sets the idle character to 0x7E
 - **marks**—Sets the idle character to 0xFF
- Example

host1(config-ifs)#**idle-character marks**

- Use the **no** version to restore the default value, 0x7E (flags).
- See idle-character.

interface serial

- Use to specify a serial interface.
- Example for unframed E1 interface

host1(config)#**interface serial 4/0:1/1/1/1/1**

- Example for fractional T1/E1 interface

host1(config)#**interface serial 4/0:1/1/1/1/1**

- Example for unchannelized T3 interface

host1(config)#**interface serial 4/0:1/1**

- Example for T3 interface channelized to fractional T1

host1(config)#**interface serial 4/0:1/1/10/22**

- Use the **no** version to remove the interface.
- See interface serial.

invert data

- Use to enable data stream inversion for the interface.
- Enable data stream inversion only if it is turned on at the other end of the line.
- Example

host1(config-if)#**invert data**

- Use the **no** version to disable the feature.
- See invert data.

mtu

- Use to configure the MTU size for the interface.
- Specify a value in the range 4–9996 bytes.
- Coordinate this value with the network administrator on the other end of the line.
- If you set this value with a different value for another protocol, such as IP, the router uses the lower value. The lower MTU might cause unexpected results in the network.
- Example

```
host1(config-if)#mtu 1500
```

- Use the **no** version to restore the default, 1600 bytes.
- See mtu.

serial description

- Use to configure the MTU size for the interface.
- Specify a value in the range 4–9996 bytes.
- You should coordinate this value with the network administrator on the other end of the line.
- You can set a different MTU value in higher-level protocols, such as IP. If you do, the router uses the lower value. The lower MTU might cause unexpected results in the network.
- Example

```
host1(config-if)#mtu 1500
```

- Use the **no** version to restore the default, 1600 bytes.
- See mtu.

serial description

- Use to assign a text description or an alias to a serial HDLC interface.
- You can use this command to help you identify the interface and keep track of interface connections.
- The description or alias can be a maximum of 80 characters.
- Use “show interfaces serial” on page 172 to display the text description.
- Example

```
host1(config-if)#serial description ottawa012 hdlc channel
```

- Use the **no** version to remove the text description or alias.
- See serial description.

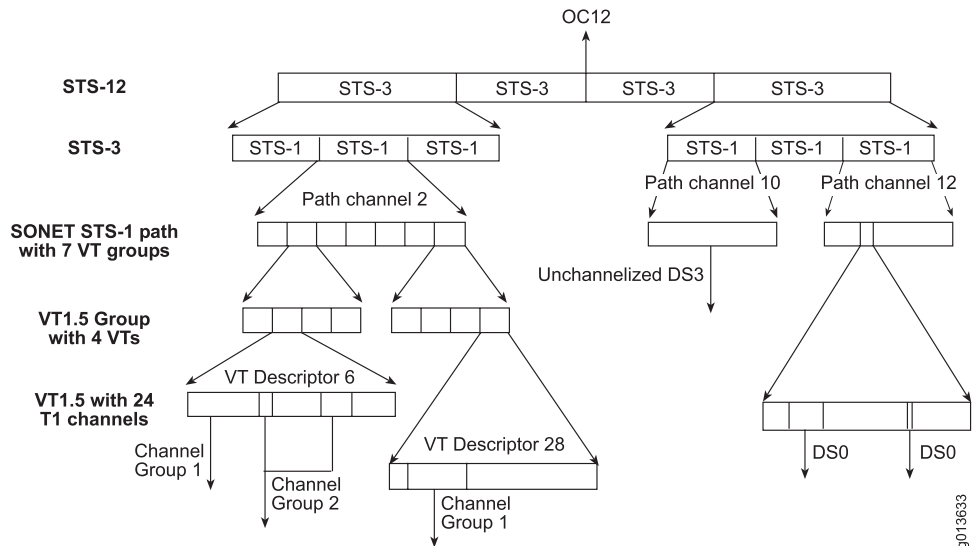
Configuration Examples

This section provides some configuration examples to illustrate how to use the CLI commands.

Example 1: Configuring Interfaces in SONET Mode

The following example illustrates how to configure T1 lines on channelized SONET interfaces, as shown in Figure 11 on page 142.

Figure 11: Configuring Fractional T1 in SONET Mode



1. Select an OC-12 SONET controller.

```
host1(config)#controller sonet 4/0
```
2. Configure two STS-1 paths.

```
host1(config-controller)#path 2 oc1 1/2  
host1(config-controller)#path 10 oc1 4/1
```
3. Configure two VT1.5 tributaries on SONET path channel 2.

```
host1(config-controller)#path 2 ds1 1/2/2 vt15  
host1(config-controller)#path 2 ds1 1/7/4 vt15
```
4. Configure two fractional T1 lines on VT 1/2/2 in path 2.

```
host1(config-controller)#path 2 ds1 1/2/2 channel-group 1 timeslots 1-10
host1(config-controller)#path 2 ds1 1/2/2 channel-group 2 timeslots 11, 21-26
```

- Configure a fractional T1 line on VT 1/7/4 in path 2.

```
host1(config-controller)#path 2 ds1 1/7/4 channel-group 1 timeslots 2-7
```

- Configure an unchannelized T3 on SONET path channel 10.

```
host1(config-controller)#path 10 ds3 1 unchannelized
```

- Configure a channelized T3 on SONET path channel 12.

```
host1(config-controller)#path 12 ds3 1 channelized
```

- Configure a T1 channel on the channelized T3 on SONET path channel 12.

```
host1(config-controller)#path 12 ds3 1 t1 4
```

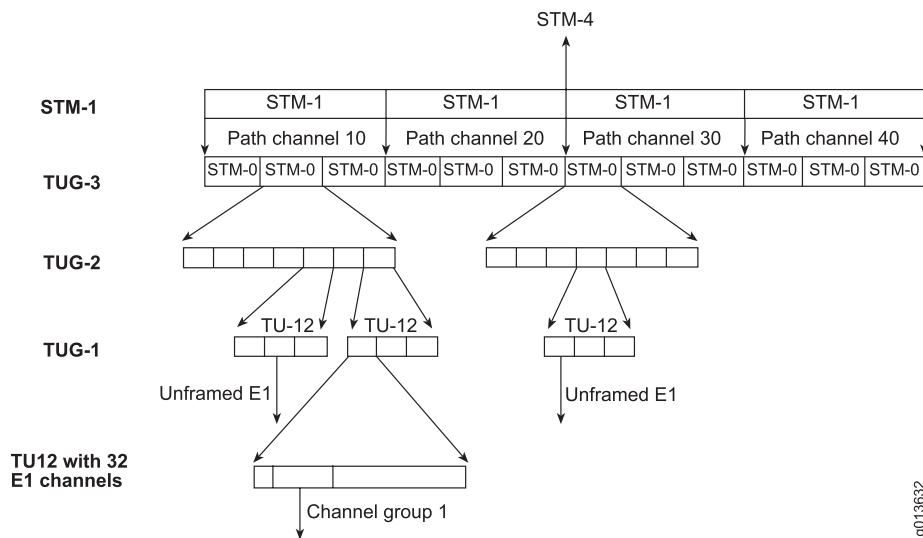
- Configure two fractional T1 lines on the T3 in path channel 12.

```
host1(config-controller)#path 12 ds3 1 t1 4/1 timeslots 3-8
host1(config-controller)#path 12 ds3 1 t1 4/2 timeslots 20
```

Example 2: Configuring Interfaces in SDH Mode

The following example illustrates how to configure fractional E1 and unframed E1 lines in SDH mode, as shown in Figure 12 on page 143.

Figure 12: Configuring Fractional E1 and Unframed E1 in SDH Mode



- Select an OC-12 SONET controller.

```
host1(config)#controller sonet 4/0
```

2. Switch to SDH mode.

```
host1(config-controller)#sdh
```

3. Configure four STM-1 paths. An OC-12 interface has four STM-1 paths.

```
host1(config-controller)#path 10 stm1 1  
host1(config-controller)#path 20 stm1 2  
host1(config-controller)#path 30 stm1 3  
host1(config-controller)#path 40 stm1 4
```

4. Configure a TU-12 on TUG-2 #7 on TUG-3 #2 of path 10.

```
host1(config-controller)#path 10 e1 2/7/1 tu12
```

5. Configure a TU-12 on TUG-2 #5 on TUG-3 #2 of path 10.

```
host1(config-controller)#path 10 e1 2/5/2 tu12
```

6. Configure a fractional E1 line on tributary 2/7/1 of path 10.

```
host1(config-controller)#path 10 e1 2/7/1 channel-group 1 timeslots 2-5
```

7. Configure an unframed E1 line on tributary 2/5/2 of path 10.

```
host1(config-controller)#path 10 e1 2/5/2 unframed
```

8. Configure a TU-12 on TUG-2 #4 on TUG-3 #1 of path 30.

```
host1(config-controller)#path 30 e1 1/4/1 tu12
```

9. Configure an unframed E1 line on tributary 1/4/1 of path 30.

```
host1(config-controller)#path 30 e1 1/4/1 unframed
```

Example 3: Configuring Frame Relay

The following example illustrates how to configure Frame Relay on VT 1/7/4 in path 2 of the configuration shown in Figure 11 on page 142.

1. Select the interface on which you want to configure Frame Relay.

```
host1(config)#interface serial 4/0:2/1/7/4/1
```

2. Specify Frame Relay as the encapsulation method on the interface.

```
host1(config-if)#encapsulation frame-relay ietf
```

3. Configure the interface as a DTE, DCE, or NNI.

```
host1(config-if)#frame-relay intf-type dce
```

Example 4: Configuring PPP

The following example illustrates how to configure PPP on VT 1/2/2 in path 2 of the configuration shown in Figure 11 on page 142.

1. Select the interface on which you want to configure PPP.

```
host1(config)#interface serial 4/0:2/1/2/2/1
```

2. Specify PPP as the encapsulation method on the interface.

```
host1(config-if)#encapsulation ppp
```

Testing Interfaces

Testing interfaces allows you to troubleshoot problems and to check the quality of links at various layers in the interface stack. The router supports the following test options:

- Transmission of BERT patterns to remote devices
- Receipt of BERT patterns from remote devices
- Local loopback—The ability to loop the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network
- Network loopback—The ability to loop the data toward the network before the data reaches the frame
- Remote loopback, which provides:
 - The ability to request that remote devices enter into loopback
 - The ability to be placed in loopback by remote devices
- Connectivity tests to remote devices

Sending BERT Patterns

The router can send BERT patterns from different layers in the interface stack. For a list of the modules that support bit error rate tests (BERTs), see *ERX Module Guide, Appendix A, Module Protocol Support*.

To send BERT patterns:

1. Select a controller.
2. Configure a specific layer in the interface to generate BERT patterns.

For information about BERT patterns, see “References” on page 117.

```
path ds1|e1 bert
```

- Use to enable bit error rate tests using the specified pattern at the T1/E1 over SONET/SDH VT layer.
- Unlike other configuration commands, “path ds1 |e1 bert” on page 146 is not stored in NVRAM.
- Specify one of the following options:
 - **2^11**—Pseudorandom test pattern, 2047 bits in length
 - **2^15**—Pseudorandom test pattern, 32,767 bits in length
 - **2^20-0153**—Pseudorandom test pattern, 1,048,575 bits in length
- Specify the duration of the test in the range 1–1440 minutes.
- Optionally, specify the **unframed** keyword to overwrite the framing bits.
- Example

```
host1(config-controll)#path 12 ds1 1/3/4 bert pattern 2^11 interval 10
unframed
```

- Use the **no** version to stop the test that is running.
- See path ds1 |e1 bert.

path ds3 bert

- Use to enable bit error rate tests using the specified pattern at the T3 layer.
- Unlike other configuration commands, “path ds3 bert” on page 146 is not stored in NVRAM.
- Specify one of the following options:
 - **0s**—Repetitive test pattern of all zeros, 00000...
 - **1s**—Repetitive test pattern of all ones, 11111...
 - **2^9**—Pseudorandom test pattern, 511 bits in length
 - **2^11**—Pseudorandom test pattern, 2047 bits in length
 - **2^15**—Pseudorandom test pattern, 32,767 bits in length
 - **2^20**—Pseudorandom test pattern, 1,048,575 bits in length
 - **2^20-QRSS**—Pseudorandom QRSS test pattern, 1,048,575 bits in length
 - **2^23**—Pseudorandom test pattern, 8,388,607 bits in length
 - **alt-0-1**—Repetitive alternating test pattern of zeros and ones, 01010101...
- Specify the duration of the test in the range 1–1440 minutes.
- Example

```
host1(config-controll)#path 12 ds3 2 bert pattern 0s interval 10
```

- Use the **no** version to stop the test that is running.
- See path ds3 bert.

path ds3 t1 bert

- Use to enable bit error rate tests using the specified pattern at the T1 over T3 layer.
- Unlike other configuration commands, “path ds3 t1 bert” on page 147 is not stored in NVRAM.
- Specify one of the following options:
 - **2^11**—Pseudorandom test pattern, 2047 bits in length
 - **2^15**—Pseudorandom test pattern, 32,767 bits in length
 - **2^20-0153**—Pseudorandom test pattern, 1,048,575 bits in length
- Specify the duration of the test in the range 1–1440 minutes.
- Optionally, specify the **unframed** keyword to overwrite the framing bits.
- Example

```
host1(config-controll)#path 12 ds3 2 t1 14 bert pattern 2^11 interval 10  
unframed
```

- Use the **no** version to stop the test that is running.
- See path ds3 t1 bert.

Receiving BERT Patterns

The router can receive BERT patterns from a remote device at the T1/E1 over SONET/SDH VT and T1/E1 over T3 layers. To receive BERT patterns, configure the interface on the router for network payload loopback and the remote interface to use the line clock. Inaccurate results might occur if you use other loopback modes or clock sources.

When the router is synchronized with and receiving BERT patterns from a remote device, the router records the number of bit errors and the number of bits received. To view these statistics, issue the **show controllers sonet** command.

Enabling Local or Network Loopback

You can enable loopback tests on the router at the following layers in the interface stack:

- SONET/SDH section layer
- T1/E1 over SONET/SDH VT layer
- T3 layer
- T1/E1 over T3 layer

See “Interface Stack” on page 112 for a description of the layers.

To enable local or network loopback:

1. Select a controller.
2. Configure local or network loopback at the desired layers in the interface.

loopback

- Use to configure the type of loopback at the SONET/SDH section layer.
- Specify one of the following options:
 - **local**—Loops the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network.
 - **network**—Loops the data toward the network before the data reaches the frame.
- Example

```
host1(config)#controller sonet 4/0
host1(config-controller)#loopback network
```

- Use the **no** version to disable loopback.
- See loopback.

path ds1|e1 loopback

- Use to configure a loopback at the T1/E1 over SONET/SDH VT layer.
- Specify one of the following options:
 - **local**—Loops the router output data back toward the router at the T1/E1 framer; on supported line modules, also sends an alarm indication signal (AIS) out toward the network.
 - **network { line | payload }**
 - Specify the line keyword to loop the data back toward the network before the T1/E1 framer and automatically set a local loopback at the HDLC controllers.
 - Specify the payload keyword to loop the payload data back toward the network at the T1/E1 framer and automatically set a local loopback at the HDLC controllers.

- Example

```
host1(config-controll)#path 12 ds1 1/3/4 loopback network line
```

- Use the **no** version to clear the local loopback configuration.
- See path ds1|e1 loopback.

path ds3 loopback

- Use to configure a loopback at the T3 layer.
- Specify one of the following options:
 - **local**—Loops the data back toward the router; on supported line modules, also sends an alarm indication signal (AIS) out toward the network.
 - **network { line | payload }**
 - Specify the line keyword to loop the data toward the network before the data reaches the framer.
 - Specify the payload keyword to loop the data toward the network after the framer has processed the data.
- Example


```
host1(config-controll)#controller sonet 5/0
host1(config-controll)#path 12 ds3 1 loopback local
```
- Use the **no** version to turn off the loopback.
- See path ds3 loopback.

path ds3 t1 loopback

- Use to configure a loopback at the T1 over T3 layer.
- Specify one of the following options:
 - **local**—Loops the router output data back toward the router at the T1 framer; on supported line modules, also sends an alarm indication signal (AIS) out toward the network.
 - **network { line | payload }**
 - Specify the line keyword to loop the data back toward the network before the T1 framer and automatically set a local loopback at the HDLC controllers.
 - Specify the payload keyword to loop the payload data back toward the network at the T1 framer and automatically set a local loopback at the HDLC controllers.
- Example


```
host1(config-controll)#path 12 ds3 2 t1 14 loopback network line
```
- Use the **no** version to clear the local loopback configuration.
- See path ds3 t1 loopback.

Enabling Remote Loopback Testing

You can configure the router to request that compatible devices connected at the following layers enter into a loopback:

- T1 over SONET/SDH VT layer

- T1 over T3 layer
- T3 layer

You can also configure the router to start loopback testing when it receives an appropriate signal from a device connected at any of these layers.

For a list of the modules that support remote loopback, see *ERX Module Guide, Appendix A, Module Protocol Support*.



NOTE: There is no protocol that allows remote loopback on E1 links.

To enable remote loopback:

1. Select a controller.
2. Configure remote loopback at the desired layers in the interface.

path ds1|e1 loopback remote

- Use to place a remote device, connected at the T1 over SONET/SDH VT layer, in loopback.
- Specify one of the following options:
 - **line fdl ansi** (T1 only)—Sends a repeating 16-bit ESF data link code word (00001110 11111111) to the remote end requesting that it enter into a network line loopback. Specify the **ansi** keyword to enable the remote line facilities data link (FDL) ANSI bit loopback on the T1 line, according to the ANSI T1.403 specification.
 - **line fdl bellcore** (T1 only)—Sends a repeating 16-bit ESF data link code word (00010010 11111111) to the remote end requesting that it enter into a network line loopback. Specify the **bellcore** keyword to enable the remote line FDL Bellcore bit loopback on the T1 line, according to the Bellcore TR-TSY-000312 specification.
 - **payload [fdl] [ansi]** (T1 only)—Sends a repeating 16-bit ESF data link code word (00010100 11111111) to the remote end requesting that it enter into a network payload loopback. Enables the remote payload FDL ANSI bit loopback on the T1 line. You can optionally specify **fdl** and **ansi**.
- Example


```
host1(config-controll)#path 12 ds1 1/3/4 loopback remote line fdl ansi
```
- Use the **no** version to send the 16-bit ESF data link code word to deactivate the loopback at the remote end, depending on the last activate request sent to the remote end.
- See `path ds1|e1 loopback`.

path ds1 remote-loopback

- Use to enable the router to accept remote loopback requests from a remote device connected at the T1 over SONET/SDH VT layer.
- Example

```
host1(config-controll)#path 12 ds1 1/3/4 remote-loopback
```

- Use the **no** version to restore the default, which is to reject remote loopback requests.
- See path ds1 remote-loopback.

path ds3 equipment loopback

- Use to enable or disable the router's ability to enter into a loopback initiated by a remote device connected at the T3 layer.



NOTE: Remote loopback is available only on frame-based T3 interfaces configured to use C-bit framing.

- Specify one of the following loopback options:
 - **customer**—Enables the router to enter into loopback when it receives an appropriate signal from the remote interface
 - **network**—Disables the router's ability to enter into loopback when it receives an appropriate signal from the remote interface; this is the default behavior
- Examples

```
host1(config-controll)#path 12 ds3 2 equipment customer loopback  
host1(config-controll)#path 12 ds3 2 equipment network loopback
```

- Use the **no** version to restore the default behavior, which disables the router's ability to be placed in loopback by a remote device. Using the **no** version has the same effect as issuing the command with the network keyword.
- See path ds3 equipment loopback.

path ds3 loopback remote

- Use to place a remote device, connected at the T3 layer, in loopback.
- Specify the **remote** keyword to send a far end alarm code in the C-bit framing, as defined in ANSI T1.404, to notify the remote end to activate or (when you use the **no** version) deactivate the line loopback.



NOTE: Remote loopback is available only on frame-based T3 interfaces configured to use C-bit framing.

- Example

```
host1(config)#controller sonet 5/0  
host1(config-controll)#path 12 ds3 1 loopback remote
```

- Use the **no** version to turn off the loopback.
- See path ds3 loopback.

path ds3 t1 loopback remote

- Use to place a remote device, connected at the T1 over T3 layer, in loopback.
- Specify one of the following options:
 - **line fdl ansi**—Sends a repeating 16-bit ESF data link code word (00001110 11111111) to the remote end requesting that it enter into a network line loopback. Specify the ansi keyword to enable the remote line FDL ANSI bit loopback on the T1 line, according to the ANSI T1.403 specification.
 - **line fdl bellcore**—Sends a repeating 16-bit ESF data link code word (00010010 11111111) to the remote end requesting that it enter into a network line loopback. Specify the bellcore keyword to enable the remote line FDL Bellcore bit loopback on the T1 line, according to the Bellcore TR-TSY-000312 specification.
 - **payload [fdl] [ansi]**—Sends a repeating 16-bit ESF data link code word (00010100 11111111) to the remote end requesting that it enter into a network payload loopback. Enables the remote payload FDL ANSI bit loopback on the T1 line. You can specify **fdl** or **ansi**.
- Example

```
host1(config-controll)#path 12 ds3 2 t1 14 loopback remote payload
```

- Use the **no** version to send the 16-bit ESF data link code word to deactivate the loopback at the remote end, depending on the last activate request sent to the remote end.
- See path ds3 t1 loopback.

path ds3 t1 remote-loopback

- Use to enable the router to accept remote loopback requests from a remote device connected at the T1 over T3 layer.
- Example


```
host1(config-controll)#path 12 ds3 2 t1 14 remote-loopback
```
- Use the **no** version to restore the default, which is to reject remote loopback requests.
- See path ds3 t1 remote-loopback.

Testing Connectivity

Use the **path overhead j1** command to check for connectivity between the router and a SONET/SDH device at the other end of the line. This command defines:

- A message that the router sends from the specified interface to the SONET/SDH device at the other end of the line.

- A message that the router expects to receive on the specified interface from the SONET/SDH device at the other end of the line.

When you define a message that the interface sends, you must monitor receipt of that message at the remote end.

When you define a message that the interface expects to receive, you should configure the remote device to transmit the same message to the interface. You can then use the **show controllers sonet** command to compare the expected and received messages.

path overhead j1

- Use to define messages that the router sends to or expects to receive from a SONET/SDH device connected to a cOCx/STMx interface.
- Specify a path identifier between 1 and 2,147,483,648 for a cOCx/STMx interface.
- Specify the keyword **msg** for a message that the router transmits for this path.
- Specify the keyword **exp-msg** to define a message that the router expects to receive on this path.
- Define a message of up to 62 characters for SONET or up to 15 characters for SDH.
- Configure the remote device to send the same message that the router expects to receive on this path. You can then compare the expected and received messages in the display of the **show controllers sonet** command.
- Example for cOCx/STMx interface:


```
host1(config-controller)#path 2 overhead j1 exp-msg goodbye
```
- Use the **no** version to restore the default situation, in which all the characters in the transmitted or expected message are zeros.
- See path overhead j1.

Monitoring Interfaces

To display statistics for channelized SONET and SDH interfaces, use the **show controllers sonet** command. The following section describes some of the options for the command and shows some sample displays.

From User Exec mode, use the following **show** commands to monitor and display the T3, T1/E1, and HDLC serial data channel information:

- Display E1 or T1 statistics for E1 or T1 over a VT.

```
host1#show controllers sonet 2/0 e1
```

- Display T3 statistics.

```
host1#show controllers sonet 2/1 ds3
```

- Display statistics for the section, line, path, and tributary layers.

host1#**show controllers sonet 2/1 section**

- Display the configuration for channelized SONET and SDH interfaces.

host1#**show controllers sonet 2/0 configuration**

- Display statistics for serial interfaces.

host1#**show interfaces serial 2/0:1/1/1/1/1**

Setting a Baseline

You can set statistics baselines for serial interfaces, subinterfaces, and circuits using the **baseline interface serial** command. You can also set statistics baselines for the section, line, and path layers using the **baseline interface sonet** command. Use the delta options with the **show** commands to display statistics with the baseline subtracted.

Output Filtering

You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See *Command Line Interface* in *JUNOS System Basics Configuration Guide*, for details.

baseline interface serial

- Use to set a statistics baseline for serial interfaces.
- The router implements the baseline by reading and storing the statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the delta keyword with the **show interfaces serial** command to view the baseline statistics.
- Example

host1#**baseline interface serial 2/0:1/1**

- There is no **no** version.
- See baseline interface.

baseline line interface sonet

- Use to set a statistics baseline for the SONET/SDH line layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total** [**delta**] keywords with the **show controllers sonet line** command to view the baseline statistics.

- Example

```
host1#baseline line interface sonet 2/0
```

- There is no **no** version.
- See baseline line interface sonet.

baseline line path interface sonet

- Use to set a statistics baseline for the SONET/SDH path layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total** [**delta**] keywords with the **show controllers sonet path** command to view the baseline statistics.
- Example

```
host1#baseline path interface sonet 2/0:1
```

- There is no **no** version.
- See baseline path interface sonet.

baseline line section interface sonet

- Use to set a statistics baseline for the SONET/SDH section layer.
- The router implements the baseline by reading and storing the MIB statistics at the time the baseline is set and then subtracting this baseline whenever baseline-relative statistics are retrieved.
- Use the **total** [**delta**] keywords with the **show controllers sonet section** command to view the baseline statistics.
- Example

```
host1#baseline section interface sonet 2/0
```

- There is no **no** version.
- See baseline section interface sonet.

show controllers sonet configuration

- Use to display the configuration for channelized SONET and SDH interfaces.
- Specify an interface in *slot/port* format.
- To view information for a controller and all layers above that controller, specify a controller. For example, to view all controllers on interface 3/0, use **show controllers sonet 3/0 configuration**. To view information for path 1 only, use **show controllers sonet 3/0:1 configuration**.
- Field descriptions

- Interface specifier in slot/port format
- channelized—Number of channels and speed for the interface
- ifAdminStatus—Configured status of the interface: up or down
- description—Configured description of the controller
- snmp trap link-status—State of SNMP link status processing for the section and line layers of the interface: enabled or disabled
- alarms used for operational status calculation—Types of defects that the router uses to determine the operational status of the interface at the section and line layers
- defect trigger soaking delay—Time that the router waits to set an alarm when the router records a defect at the section or line layer
- Operational Status—Physical state of the interface:
 - up—Interface is operational
 - down, failure alarm—Interface is not operational; type of defect that caused failure is specified
 - time since last status change—Time since the line module was rebooted
- Loopback State—Type of loopback configured at this layer in the interface, or none
- Last Remote Loopback Request Sent
- BERT test—Number of current test and total number of tests
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
- Mode—Type of interface: SONET or SDH
- Timing source—Type of clock source configured for the channel:
 - internal module—Internal clock is from the line module itself
 - chassis—Internal clock is from the configured router clock
- Current section alarms—Number of suspect bit patterns found in several consecutive frames in section layer, or none
- Current line alarms—Number of suspect bit patterns found in several consecutive frames in line layer

- Channel configuration—Parameters for specific controllers; the actual parameters depend on the controller.
- ifAdminStatus—State of the controller in the software configuration: up or down
- ifOperStatus—Physical state of the controller: up or down
- Time since last status change—Time the controller has been up or down
- Alarms—Number of suspect bit patterns found in several consecutive frames
- snmp trap link-status—State of SNMP link status processing for the controller: enabled or disabled
- alarms used for operational status calculation—Types of defects that the router uses to determine the operational status of the interface at the path layer
- defect trigger soaking delay—Time that the router waits to set an alarm when the router records a defect at the path layer
- c2 byte—Setting of path signal byte: set by upper interface type (automatic setting) or configured value
- Operational Status—Physical state of this layer: up, down, or lowerLayerDown
 - time since last status change—Time since the line module was rebooted
- Framing—Type of framing configured for the controller:
 - c-bit parity framing (for T3 interfaces)
 - M23 multiplexer framing (for T3 interfaces)
 - crc4—Cyclic redundancy check (for E1 interfaces)
 - no-crc4—No cyclic redundancy check (for E1 interfaces)
 - esf—Extended superframe (for T1 interfaces)
 - sf—Superframe (for T1 interfaces)
- Line Code—Type of line coding the router assigned to the controller: B8ZS or AMI
- Clock source—Type of clock source configured for the channel:
 - module—Internal clock is from the line module itself
 - chassis—Internal clock is from the configured router clock
- J1 transmit trace message—Trace message sent to the remote device
- J1 expected trace message—Trace message expected from the remote device
- J1 received trace message—Trace message received from the remote device
- Example 1

```

host1#show controllers sonet 3/0 configuration
oc12 3/0
non channelized
ifAdminStatus: up
description: link1
snmp trap link-status: enabled
alarms used for operational status calculation: LOS LOF AIS RDI
defect trigger soaking delay: 2500 milliseconds
Operational Status: up
    time since last status change: 00:03:30
Loopback State: none
Mode: sonet
Timing source: internal module
Receive FIFO Overruns: 0, Reconfigurations: 0
Current section defects: none
Current line    defects: none

Channel configuration:
channel = 0, path = oc12, hierarchy = 1/1/0/0, current path defects: none

ifAdminStatus: up
snmp trap link-status: disabled
alarms used for operational status calculation: LOP AIS
defect trigger soaking delay: 2500 milliseconds
c2 byte override 20
Operational Status: up
    time since last status change: 00:03:30
J1 transmit trace message: sonet3/0
J1 expected trace message: sonet4/0
J1 received trace message: sonet4/0

```

- Example 2—If you do not specify the layer in the interface, the router shows the configuration for all layers, whether or not you specify the keyword **configuration**.

```

host1#show controllers sonet 2/1
oc3 2/1
channelized (3 channels, oc1 minimum speed)
ifAdminStatus: up
description: link1
snmp trap link-status: enabled
alarms used for operational status calculation: LOS LOF AIS RDI
defect trigger soaking delay: 2500 milliseconds
Operational Status: up
    time since last status change: 00:03:30
Operational Status: up
    time since last status change: 00:06:49
Loopback State: none
Mode: sonet
Timing source: internal module
Current section alarms: none
Current line alarms    : none

Channel configuration:
channel = 1, path = oc1, hierarchy = 1/1/1/1, current path alarms: none
ifAdminStatus: up
snmp trap link-status: disabled
alarms used for operational status calculation: LOP AIS
defect trigger soaking delay: 2500 milliseconds
c2 byte override 20

```

```

Operational Status: up
    time since last status change: 00:06:49
Ds3 1, unchannelized
    ifOperStatus = ifOperUp
    snmp trap link-status = disabled
Framing is C-BIT, Line Code is B3ZS, Clock Source is Internal - Module

```

- Example 3—This example displays the configuration for T3 1/1 on slot 2, port 1.

```

host1#show controllers sonet 2/1:1/1
oc3 2/1
channelized (3 channels, oc1 minimum speed)
ifAdminStatus: up
description: link1
snmp trap link-status: enabled
alarms used for operational status calculation: LOS LOF AIS RDI
defect trigger soaking delay: 2500 milliseconds
Operational Status: up
    time since last status change: 00:03:30
Loopback State: none
Mode: sonet
Timing source: internal module
Current section alarms: none
Current line alarms : none

Channel configuration:
channel = 1, path = oc1, hierarchy = 1/1/1/1, current path alarms: none
ifAdminStatus: up
snmp trap link-status: disabled
alarms used for operational status calculation: LOP AIS
defect trigger soaking delay: 2500 milliseconds
c2 byte override 20
Operational Status: up
    time since last status change: 00:05:37
Ds3 1, unchannelized
    ifOperStatus = ifOperUp
    snmp trap link-status = disabled
Framing is C-BIT, Line Code is B3ZS, Clock Source is Internal - Module

```

- See show controllers sonet.

show controllers sonet ds1|e1

- Use to display E1 or T1 (DS1) statistics for the different layers in channelized SONET and SDH interfaces. Figure 8 on page 113 shows the layers in the interface.
- For definitions of the MIB statistics, see RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999).
- Specify an interface in *slot/port* format.
- To view information for a specific controller in a layer, enter the specifier for the controller and the type for the controller. For example, to view the E1 controller 1/1/1 on path 1 on the interface 4/0, enter **show controllers sonet 4/0:1/1/1 e1**.

- To view information for all controllers above a particular layer, enter the specifier for the layer and the type for the controller. For example, to view all E1 controllers on the interface 4/0 path 1, enter **show controllers sonet 4/0:1 e1**.
- To view E1 or T1 statistics for a layer, specify the controller type, e1 or ds1.
- To view the configuration for a controller or all controllers in a layer, omit the controller type.
- Field descriptions
 - Description—Text description or alias if configured for the interface
 - BERT test—Number of current test and total number of tests
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapsed in current interval—Reported in 15-minute intervals
 - Errored seconds—Number of errored seconds encountered by a T1 or an E1 in the current interval
 - Severely errored seconds—Number of severely errored seconds encountered by a T1 or an E1 in the current interval
 - Severely errored frame seconds—Number of severely errored framing seconds encountered by a T1 or an E1 in the current interval
 - Unavailable seconds—Number of unavailable seconds encountered by a T1 or an E1 in the current interval
 - Clock slip seconds—Number of clock slips encountered by a T1 or an E1 in the current interval
 - Path code violations—Number of coding violations encountered by a T1 or an E1 in the current interval
 - Line errored seconds—Number of line errored seconds encountered by a T1 or an E1 in the current interval
 - Bursty errored seconds—Number of bursty errored seconds encountered by a T1 or an E1 in the current interval
 - Degraded minutes—Number of minutes that a T1 or an E1 line is degraded
 - Line code violations—Number of line code violations encountered by a T1 or an E1 in the current interval

- Example—This example displays statistics for all the E1 lines on the interface 2/0.

```

host1#show controllers sonet 2/0 e1
E1 1/1/1

Description: boston111 e1
BERT test - 2 in 11
Test Interval 1 minute(s), Running - Status is Sync
0 minute(s), 33 second(s) left in test interval
Sync count           = 1
Received bit count = 41472000
Error bit count      = 0

Number of valid interval - 0
Time elapse in current interval - 0

Current Interval Counters
Errored seconds           = 0
Severely errored second  = 0
Severely errored frame seconds = 0
Unavailable seconds      = 0
Clock slip seconds       = 0
Path code violations     = 0
Line errored seconds     = 0
Bursty errored seconds   = 0
Degraded minutes        = 0
Line code violations     = 0

24 Hour Total Counters
Errored seconds           = 0
Severely errored second  = 0
Severely errored frame seconds = 0
Unavailable seconds      = 0
Clock slip seconds       = 0
Path code violations     = 0
Line errored seconds     = 0
Bursty errored seconds   = 0
Degraded minutes        = 0
Line code violations     = 0

```

- See show controllers sonet.

show controllers sonet ds3

- Use to display T3 statistics for the different layers in channelized SONET and SDH interfaces. Figure 8 on page 113 shows the layers in the interface.
- For definitions of the MIB statistics, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).
- Specify an interface in *slot/port* format.
- To view information for a specific controller in a layer, enter the specifier for the controller and the type for the controller. For example, to view T3 controller 1 on path 1 on the interface 4/0, enter **show controllers sonet 4/0:1/1 ds3**.
- To view information for all controllers above a particular layer, enter the specifier for the layer and the type for the controller. For example, to view all DS3 controllers on the interface 4/0, enter **show controllers sonet 4/0 ds3**.

- To view T3 statistics for a layer, specify the controller type, **ds3**.
- To view the configuration for a controller or all controllers in a layer, omit the controller type.
- Field descriptions
 - Description—Text description or alias if configured for the interface
 - BERT test—Number of current test and total number of tests
 - Test interval—Length of the BERT test
 - status—Sync (controller is synchronized with remote device) or NoSync (controller is not synchronized with remote device)
 - Sync count—Number of times the pattern detector synchronized with the incoming data pattern
 - Received bit count—Number of bits received
 - Error bit count—Number of bits with errors
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapse in current interval—Time (seconds) passed in current interval
 - Current Interval Counters—Statistics for the current 15-minute interval
 - P-bit errored seconds—Number of errored seconds encountered by a T3
 - P-bit severely errored seconds—Number of severely errored seconds encountered by a T3
 - Severely errored frame seconds—Number of severely errored framing seconds encountered by a T3
 - Unavailable seconds—Number of unavailable seconds encountered by a T3
 - Line code violations—Number of line code violations encountered by a T3
 - P-bit coding violations—Number of coding violations encountered by a T3
 - Line errored seconds—Number of line errored seconds encountered by a T3
 - C-bit coding violations—Number of C-bit coding violations encountered by a T3
 - C-bit errored seconds—Number of C-bit errored seconds encountered by a T3
 - C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3
 - 24 Hour Total counters—Statistics for last 24 hours
- Example 1—This example shows all T3 controllers on the interface 2/1.

```

host1#show controllers sonet 2/1 ds3
Ds3 1
Description: ottawa211 ds3
Number of valid interval - 0
Time elapse in current interval - 696

Current Interval Counters
P-bit errored seconds          = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds           = 541
Line code violations           = 0
P-bit coding violations        = 0
Line errored seconds          = 0
C-bit coding violations        = 0
C-bit errored seconds         = 0
C-bit severely errored seconds = 0

24 Hour Total Counters
P-bit errored seconds          = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds           = 0
Line code violations           = 0
P-bit coding violations        = 0
Line errored seconds          = 0
C-bit coding violations        = 0
C-bit errored seconds         = 0
C-bit severely errored seconds = 0

```

- Example 2—This example shows statistics for the T3 controller 1/1 on interface 2/0.

```

host1#show controllers sonet 2/0:1/1 ds3
Ds3 1
Description: ottawa2011 ds3
Number of valid interval - 0
Time elapse in current interval - 534

Current Interval Counters
P-bit errored seconds          = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds           = 117
Line code violations           = 0
P-bit coding violations        = 0
Line errored seconds          = 0
C-bit coding violations        = 0
C-bit errored seconds         = 0
C-bit severely errored seconds = 0

24 Hour Total Counters
P-bit errored seconds          = 0
P-bit severely errored seconds = 0
Severely errored frame seconds = 0
Unavailable seconds           = 0
Line code violations           = 0
P-bit coding violations        = 0
Line errored seconds          = 0

```

```

C-bit coding violations          = 0
C-bit errored seconds          = 0
C-bit severely errored seconds = 0

```

- See `show controllers sonet`.

`show controllers sonet line | path | section | tributary`

- Use to display statistics for the different layers in channelized SONET and SDH interfaces. Figure 8 on page 113 shows the layers in the interface.
- For definitions of the MIB statistics, see RFC 2558—Definitions of Managed Objects for the SONET/SDH Interface Type (March 1999).
- Specify an interface in *slot/port* format.
- To view information for a specific controller in a layer, enter the specifier for the controller and the type for the controller. For example, to view tributary 1/1/1 on path 1 of interface 4/0, enter **`show controllers sonet 4/0:1/1/1 tributary`**.
- To view information for all controllers above a particular layer, enter the specifier for the layer and the type for the controller. For example, to view all tributaries on path 1 of interface 4/0, enter **`show controllers sonet 4/0:1 tributary`**.
- To view statistics for a layer, specify the type of layer.
- To view the configuration for a controller or all controllers in a layer, omit the controller type.
- To view all statistics for all sessions, specify the **`total`** keyword.
- To view baselined statistics for all intervals, specify the **`delta total`** keywords.
- Field descriptions
 - Current Interval Counters—Statistics for the current 15-minute interval
 - Errored seconds—Number of errored seconds encountered by a T1 or an E1 in an interval
 - Severely errored seconds—Number of severely errored seconds encountered in an interval
 - Severely errored framing seconds—Number of severely errored framing seconds encountered in an interval
 - Coding violations—Number of coding violations encountered in an interval
 - Unavailable seconds—Number of unavailable seconds encountered in an interval
 - Last Interval Counters—Statistics for the previous 15-minute interval
 - Current Far End Interval Counters—Statistics for the remote connection associated with the SONET/SDH path in the current 15-minute interval

- Last Far End Interval Counters—Statistics for the remote connection associated with the SONET/SDH path in the previous 15-minute interval
- Total interval counters—Shows the statistics for all intervals or baselined statistics
- Example 1—This example shows the MIB statistics for the section layer on interface 2/1.

```

host1#show controllers sonet 2/1 section
Current Section Interval Counters
Current status                = No Defect
Errored seconds               = 0
Severly errored seconds      = 0
Severely errored framing seconds = 0
Coding violations             = 0

Last Section Interval Counters
Errored seconds               = 0
Severly errored seconds      = 0
Severely errored framing seconds = 0
Coding violations             = 0

```

- Example 2—This example illustrates the behavior of the **baseline section interface sonet** command. The examples show the MIB statistics of the section layer before and after the command is issued.

```

host1#show controllers sonet 2/0 section total
Number of valid intervals - 0
Time elapsed in current interval - 192

Current Section Interval Counters
Current status                = No Defect
Errored seconds               = 68
Severly errored seconds      = 68
Severely errored framing seconds = 2
Coding violations             = 4018

Total Section Counters
Errored seconds               = 68
Severly errored seconds      = 68
Severely errored framing seconds = 2
Coding violations             = 4018

host1#baseline section interface sonet 2/0

host1#show controllers sonet 2/0 section total delta
Number of valid intervals - 0
Time elapsed in current interval - 209
Current Section Interval Counters
Current status                = No Defect
Errored seconds               = 68
Severly errored seconds      = 68
Severely errored framing seconds = 2
Coding violations             = 4018

Total Section Counters
Errored seconds               = 0

```

```

Severly errored seconds          = 0
Severly errored framing seconds = 0
Coding violations                 = 0

```

- Example 3—This example shows the MIB statistics for the line layer on interface 2/1.

```

host1#show controllers sonet 2/1 line
Current Line Interval Counters
Current status                  = No Defect
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 190
Last Line Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 900

Current Far End Line Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 0

Far End Last Line Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 0

```

- Example 4—This example shows the MIB statistics for the path layer on interface 2/1.

```

host1#show controllers sonet 2/1 path
Channel number 1
Current Path Interval Counters
Current status                  = No Defect
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 248

Last Path Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 0
Current Far End Path Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0
Coding violations               = 0
Unavailable seconds            = 248

Far End Last Path Interval Counters
Errored seconds                 = 0
Severly errored seconds        = 0

```

```
Coding violations           = 0
Unavailable seconds        = 0
```

- Example 5—This example displays the tributary statistics for all tributaries on interface 4/0, path 1.

```
host1#show controllers sonet 4/0:1 tributary
Tributary 1/1/1
Current Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Last Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Current Far End Path Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Far End Last Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
```

- Example 6—This example displays the tributary statistics for the tributary 1/1/1 on path 1 on slot 4, port 0.

```
host1#show controllers sonet 4/0:1/1/1 tributary
Tributary 1/1/1
Current Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Last Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Current Far End Path Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
Far End Last Tributary Interval Counters
  Errored seconds           = 0
  Severly errored seconds   = 0
  Coding violations          = 0
  Unavailable seconds       = 0
```

- See show controllers sonet.

show controllers sonet remote

- Use to display MIB statistics for the remote end of a channelized T3 interface configured for MDL or for the remote end of a T1 channel configured for FDL.
- Specify the all option to display detailed information for all 15-minute intervals.
- For definitions of the MIB statistics for a T3 connections, see RFC 2496—Definitions of Managed Objects for the DS3/E3 Interface Types (January 1999).
- For definitions of the MIB statistics for a T1 connections, see RFC 2495—Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types (January 1999).
- Field descriptions for a T3 interface
 - Far End MDL Carrier bit—Status of MDL configuration on remote device connected to T3 interface
 - set—MDL is configured for carrier mode
 - not set—MDL is not configured for carrier mode
 - Far End Equipment Identification Code—eic string sent by remote device for MDL
 - Far End Line Identification Code—lic string sent by remote device for MDL
 - Far End Frame Identification Code—fic string sent by remote device for MDL
 - Far End Unit Identification Code—unit string sent by remote device for MDL
 - Far End Facility Identification Code—pfi string sent by remote device for MDL
 - Far End Generator Number—generator string sent by remote device for MDL
 - Far End Port Number—port string sent by remote device for MDL
 - Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
 - Time elapse in current interval—Number of seconds that have passed in the 15-minute (900-second) interval
 - C-bit errored seconds—Number of C-bit errored seconds encountered by a T3 in the current interval
 - C-bit severely errored seconds—Number of C-bit severely errored seconds encountered by a T3 in the current interval
 - C-bit coding violations—Number of C-bit coding violations encountered by a T3 in the current interval
 - Unavailable seconds—Number of unavailable seconds encountered by a T3 in the current interval
 - Invalid seconds—Number of seconds when statistics were not collected
- Field descriptions for a T1 channel

- DS1—Identifier of T1 channel
- Number of valid intervals—Number of 15-minute intervals since the line module was last powered on or reset
- Time elapse in current interval—Number of seconds that have passed in the 15-minute (900-second) interval
- Far End FDL Carrier bit—Status of FDL configuration on remote device connected to T1 channel
 - set—FDL is configured for carrier mode
 - not set—FDL is not configured for carrier mode
- Far End Equipment Identification Code—eic string sent by remote device for FDL
- Far End Line Identification Code—lic string sent by remote device for FDL
- Far End Frame Identification Code—fic string sent by remote device for FDL
- Far End Unit Identification Code—unit string sent by remote device for FDL
- Far End Facility Identification Code—pfi string sent by remote device for FDL
- Far End Generator Number—generator string sent by remote device for FDL
- Far End Port Number—port string sent by remote device for FDL
- Errored seconds—Number of errored seconds encountered by a T1 in the current interval
- Severely errored seconds—Number of severely errored seconds encountered by a T1 in the current interval
- Severely errored frame seconds—Number of severely errored framing seconds encountered by a T1 in the current interval
- Unavailable seconds—Number of unavailable seconds encountered by a T1 in the current interval
- Clock slip seconds—Number of clock slips encountered by a T1 in the current interval
- Path code violations—Number of coding violations encountered by a T1 in the current interval
- number of coding violations encountered by a T1 in the current interval
- Line errored seconds—Number of line errored seconds encountered by a T1 in the current interval
- Bursty errored seconds—Number of bursty errored seconds encountered by a T1 in the current interval
- Degraded minutes—Number of minutes that a T1 line is degraded

- Example 1—In this example, a T3 interface is specified.

```

host1#show controllers sonet 5/0:1/1 remote
Far End MDL Carrier bit is not set
Far End Equipment Identification Code is the null string
Far End Line Identification Code is the null string
Far End Frame Identification Code is the null string
Far End Unit Identification Code is the null string
Far End Facility Identification Code is the null string
Far End Generator Number is the null string
Far End Port Number is the null string

Number of valid interval - 3
Time elapse in current interval - 756

Ds3 Current Interval Counters
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
C-bit coding violations        = 0
Unavailable seconds           = 0
Invalid seconds                = 0

Ds3 Last Interval Counters
C-bit errored seconds          = 0
C-bit severely errored seconds = 0
C-bit coding violations        = 0
Unavailable seconds           = 0
Invalid seconds                = 0

Ds3 24 Hour Total Counters
C-bit errored seconds          = 1
C-bit severely errored seconds = 1
C-bit coding violations        = 330
Unavailable seconds           = 0
Invalid seconds                = 0

```

- Example 2—In this example, a T1 channel on a T3 over channelized SONET interface is specified.

```

host1#show controllers sonet 5/0:1/1/1 remote
DS1 10/1:1
Number of valid interval - 0
Time elapse in current interval - 0

Far End FDL Carrier bit is not set
Far End Equipment Identification Code is the null string
Far End Line Identification Code is the null string
Far End Frame Identification Code is the null string
Far End Unit Identification Code is the null string
Far End Facility Identification Code is the null string
Far End Port Number is the null string
Far End Generator Number is the null string

DS1 Current Interval Counters
Errored seconds          = 0
Severely errored second = 0
Severely errored frame seconds = 0
Unavailable seconds     = 0
Clock slip seconds      = 0
Path code violations     = 0

```

```

Line errored seconds          = 0
Bursty errored seconds        = 0
Degraded minutes              = 0

```

```

DS1 24 Hour Total Counters
Errored seconds               = 0
Severely errored second       = 0
Severely errored frame seconds = 0
Unavailable seconds           = 0
Clock slip seconds            = 0
Path code violations           = 0
Line errored seconds          = 0
Bursty errored seconds        = 0
Degraded minutes              = 0

```

- Example 3—In this example, a T1 over channelized SONET interface is specified.

```

host1#show controllers sonet 5/0:1/1/2/2 remote
DS1 10/1:1
Number of valid interval - 0
Time elapse in current interval - 0

Far End FDL Carrier bit is not set
Far End Equipment Identification Code is the null string
Far End Line Identification Code is the null string
Far End Frame Identification Code is the null string
Far End Unit Identification Code is the null string
Far End Facility Identification Code is the null string
Far End Port Number is the null string
Far End Generator Number is the null string

DS1 Current Interval Counters
Errored seconds               = 0
Severely errored second       = 0
Severely errored frame seconds = 0
Unavailable seconds           = 0
Clock slip seconds            = 0
Path code violations           = 0
Line errored seconds          = 0
Bursty errored seconds        = 0
Degraded minutes              = 0

DS1 24 Hour Total Counters
Errored seconds               = 0
Severely errored second       = 0
Severely errored frame seconds = 0
Unavailable seconds           = 0
Clock slip seconds            = 0
Path code violations           = 0
Line errored seconds          = 0
Bursty errored seconds        = 0
Degraded minutes              = 0

```

- See show controllers sonet remote.

show interfaces serial

- Use to display information about the serial interfaces you specify.
- Field descriptions
 - Serial Interface—Location of the interface
 - Description—Text description or alias if configured for the interface
 - ifOperStatus—Physical state of the interface
 - ifOperDown—Interface is not functioning
 - ifOperLowerLayerDown—Lower layer in the interface stack is not functioning
 - ifOperNotPresent—Module has been removed from the chassis
 - ifOperTesting—Interface is being tested
 - ifOperUp—Interface is functioning
 - snmp trap link-status—Enabled or disabled
 - Encapsulation—Layer 2 encapsulation display; options: ppp, frame-relay ietf, mlppp, mlframe-relay ietf, hdlc
 - Crc type checking—Size of the CRC
 - Hdlc mru—Current size of the MRU
 - Hdlc mtu—Current size of the MTU
 - Hdlc interface speed—Current line speed of the interface
 - Hdlc idle-character—Current idle character
 - Invert data disabled—Status of the data inversion feature
 - Ds0 mode—Nx56 or Nx64
 - 5 minute input rate—Data rates based on the traffic received in the last five minutes
 - 5 minute output rate—Data rates based on the traffic sent in the last five minutes
 - Interface Statistics
 - Packets received—Number of packets received on the interface
 - Bytes received—Number of bytes received on the interface
 - Errored packets received—Number of packets with errors received on the interface
 - Packets sent—Number of packets sent on the interface
 - Bytes sent—Number of bytes sent on the interface
 - Errored packets sent—Number of packets with errors sent from the interface

- Example

```

host1#show interfaces serial 2/0:1/1/1/1/1
Serial Interface at 2/0:1/1/1/1/1
Description: toronto20 hdlc channel
ifOperStatus = ifOperUp
snmp trap link-status = disabled
Encapsulation hdlc
Crc type checking - CRC16
Hdlc mru = 1600
Hdlc mtu = 1600
Hdlc interface speed = 1536000
Hdlc idle-character marks
Invert data disabled, Ds0 time slot map = 0xffffffff
Ds0 mode = Nx64

5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
Interface statistics
Packets received          100
Bytes received            1300
Errored packets received   1
Packets sent              100
Bytes send                1436
Errored packets sent       0

```

- See show interfaces.

Monitoring APS/MSP

For information about monitoring APS/MSP, see “Monitoring APS/MSP” on page 106 in “Configuring Unchannelized OCx/STMx Interfaces” on page 73.

Chapter 5

Configuring Ethernet Interfaces

This chapter describes how to configure Ethernet interfaces on E-series routers.

Most of the procedures described here do not apply to the Fast Ethernet management port on the SRP module. You can, however, select and display statistics for that port by using commands described in this chapter. For information about managing the Fast Ethernet port on the SRP module, see *JUNOS System Basics Configuration Guide*.

This chapter contains the following sections:

- Ethernet Overview on page 175
- Ethernet Interface Platform Considerations on page 176
- Fast Ethernet I/O Modules on page 178
- Gigabit Ethernet I/O Modules and IOAs on page 179
- 10-Gigabit Ethernet IOAs on page 191
- Ethernet References on page 195
- High-Density Ethernet on page 196
- Managing Port Redundancy on Gigabit Ethernet I/O Modules on page 196
- Configuration Tasks for Ethernet on page 198
- Configuring the Physical Interface on page 198
- Disabling Ethernet Interfaces on page 204
- Monitoring Ethernet Interfaces on page 205

Ethernet Overview

Ethernet modules support the following Ethernet interfaces:

- Fast Ethernet
- Gigabit Ethernet
- 10-Gigabit Ethernet

This section describes features that are available with Ethernet interfaces.

Ethernet modules use the Address Resolution Protocol (ARP) to obtain MAC addresses for outgoing Ethernet frames. For more information about ARP, see *JUNOS IP, IPv6, and IGP Configuration Guide*.



NOTE: Read “Configuration Tasks for Ethernet” on page 198 before you begin to configure an Ethernet interface.

Features

Ethernet interfaces support the following features:

- Routing of IP packets.
- Quality of Service (QoS) classification.
- High-density Ethernet. (For information, see “High-Density Ethernet” on page 196 .)
- Virtual LAN (VLAN) configurations. (For information, see *JUNOS Link Layer Configuration Guide* .)
- Stacked Virtual LAN (S-VLAN) configurations. (For information, see *JUNOS Link Layer Configuration Guide*.)
- IEEE 802.3ad link aggregation configurations. (For information, see *JUNOS Link Layer Configuration Guide*.)
- Configurations with upper-layer protocols. (For information, see *JUNOS Link Layer Configuration Guide*.)
- Layer 2 Tunneling Protocol (L2TP. For information, see *JUNOS Link Layer Configuration Guide*.)
- Multinetting. (For information, see *JUNOS Link Layer Configuration Guide*.)

Ethernet Interface Platform Considerations

You can configure Ethernet interfaces on the following E-series routers:

- E120 router
- E320 router
- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router

This section describes the line modules and I/O modules that support Ethernet interfaces.

For detailed information about the modules that support Fast Ethernet and Gigabit Ethernet interfaces on the ERX-14xx models, ERX-7xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed specifications of these modules.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that Ethernet modules support.

For detailed information about the modules that support Gigabit Ethernet and 10-Gigabit Ethernet interfaces on the E120 router and the E320 router:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed specifications of these modules.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the protocols and applications that Ethernet modules support.

Numbering Scheme

When configuring or managing an interface, you must know the numbering scheme for identifying an interface. The numbering scheme depends on the type of E-series router that you have.

ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router

Use the *slot/port [.subinterface]* format to identify Ethernet interfaces and subinterfaces.

- *slot*—Number of the slot in which the line module resides in the chassis.

In ERX-7xx models, line module slots are numbered 2-6; slots 0 and 1 are reserved for SRP modules. In ERX-14xx models, line module slots are numbered 0-5 and 8-13; slots 6 and 7 are reserved for SRP modules. In an ERX-310 router, line module slots are numbered 1-2; slot 0 is reserved for the SRP module.

- *port*—Number of the port on the I/O module.

On the OC3-2 GE APS I/O module, you can configure only a Gigabit Ethernet interface in port 2; ports 0 and 1 are reserved for OC3/STM1 ATM interfaces.

- *subinterface*—Subinterface number of the protocol or VLAN subinterface.

For information about installing line modules and I/O modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

E120 Router and E320 Router

Use the *slot/adaptor/port [.subinterface]* format to identify Ethernet interfaces and subinterfaces.

- *slot*—Number of the slot in which the line module resides in the chassis.

In the E120 router, line module slots are numbered 0–5. In the E320 router, line module slots are numbered 0–5 and 11–16. For both routers, slots 6 and 7 are reserved for SRP modules; slots 8–10 are reserved for switch fabric modules (SFM).

- *adapter*—Number of the bay in which the I/O adapter (IOA) resides.

This identifier applies to the E120 and E320 routers only. 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).

- *port*—Number of the port on the IOA
- *subinterface*—Subinterface number of the protocol or VLAN subinterface

For information about installing line modules and IOAs in the E120 and E320 routers, see *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*.

Interface Specifier

The configuration task examples in this chapter use the format for ERX-7xx models, ERX-14xx models, and the ERX-310 router to specify an Ethernet interface. (The format is described in “Numbering Scheme” on page 177.)

For example, the following command specifies a Fast Ethernet interface on port 0 of an I/O module in slot 4.

```
host1(config)#interface fastEthernet 4/0
```

When you configure a Gigabit Ethernet interface or a 10-Gigabit Ethernet interface on E120 or E320 routers, you must include the adapter identifier as part of the interface specifier. For example, the following command specifies a Gigabit Ethernet interface on port 0 of the IOA installed in the upper adapter bay of slot 3.

```
host1(config)#interface gigabitEthernet 3/0/0
```

For more information about interface types and specifiers on E-series models, see Interface Types and Specifiers in *JUNOS Command Reference Guide*.

Fast Ethernet I/O Modules

Fast Ethernet interfaces are supported on two I/O modules: the FE-8 I/O module and the FE-8 SFP I/O module.

FE-8 I/O Module

ERX-7xx models, ERX-14xx models, and the ERX-310 router all support the FE-8 I/O module.

An FE-8 I/O module accepts up to eight RJ-45 connectors.

FE-8 SFP I/O Module

ERX-7xx models, ERX-14xx models, and the ERX-310 router all support the FE-8 SFP I/O module.

The FE-8 SFP I/O module uses a range of small form-factor pluggable transceivers (SFPs) to support different optical modes and cabling distances. The I/O module supports up to eight LC-style fiber-optic connectors.

Unlike all other Fast Ethernet and Gigabit Ethernet I/O modules, the FE-8 SFP I/O module does not support automatic negotiation of the line speed and duplex mode by the router. For more information, see “duplex” on page 200 and “speed” on page 204.

Gigabit Ethernet I/O Modules and IOAs

Gigabit Ethernet interfaces are supported on the following modules:

- GE I/O module
- GE-2 SFP I/O module
- GE-8 I/O module
- OC3-2 GE APS I/O module
- ES2-S1 GE-4 IOA
- ES2-S1 GE-8 IOA
- ES2-S3 GE-20 IOA

GE I/O Module

ERX-7xx models, ERX-14xx models, and the ERX-310 router all support the GE I/O module.

You can pair any of the following types of GE I/O modules with the GE/FE line module:

- The GE I/O SFP module uses a range of SFPs to support different optical modes and cabling distances. The I/O module accepts up to two pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances. Alternatively, the I/O module supports up to two pairs of copper SFPs.
- The GE I/O MULTI MODE module accepts up to two pairs (Tx/Rx) of SC-style fiber-optic connectors.
- The GE I/O SINGLE MODE module accepts up to two pairs (Tx/Rx) of SC-style fiber-optic connectors.

The GE I/O module has two ports: one port (port 0) is active (also known as *primary*), and the other port (port 0R) is redundant. If the active port fails, the redundant port automatically becomes active.

You can configure only port 0 for a Gigabit Ethernet interface; you cannot configure redundant port 0R. Cabling both ports provides a redundant path to the Gigabit Ethernet interface.

GE-2 SFP I/O Module

The ERX-1440 router and the ERX-310 router both support the GE-2 SFP I/O module. Other E-series routers do not support the GE-2 SFP I/O module. The GE-2 SFP I/O module was previously called the 2XGE APS I/O module.

The GE-2 SFP I/O module pairs with the GE-2 line module and the GE-HDE line module. You can install the GE-2 line module or the GE-HDE line module and its corresponding GE-2 SFP I/O module in slot 1 or slot 2 of an ERX-310 router or in any slot of an ERX-1440 router.

The GE-2 SFP I/O module can use either fiber-optic or copper SFPs. The I/O module accepts up to two pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances. Alternatively, the I/O module supports up to two pairs of copper SFPs.

Ports on GE-2 SFP I/O Module

The GE-2 SFP I/O module has four ports: two ports (port 0 and port 1) are active (also known as *primary*), and the other two ports (port 0R and port 1R) are redundant. If an active port fails, its corresponding redundant port automatically becomes active.

You can configure only port 0 and port 1 for a Gigabit Ethernet interface; you cannot configure redundant ports 0R and 1R. Cabling an active port and its corresponding redundant port (that is, port 0 and port 0R, or port 1 and port 1R) provides a redundant path to the Gigabit Ethernet interface.

Bandwidth and Line Rate Considerations

When the GE-2 line module or the GE-HDE line module is installed in the ERX-1440 router, it delivers full bandwidth of 2 Gbps per port only when installed in slot 2 or slot 4, and when the SRP-40G+ module is used in the router. When the module is installed in any other ERX-1440 slot, it delivers a maximum bandwidth of 2 Gbps per line module (1 Gbps maximum at the ingress and 1 Gbps maximum at the egress). Therefore, of the maximum 24 possible ports for the module in an ERX-1440 chassis (that is, two ports in each of 12 slots), full bandwidth is delivered only on a maximum of four ports (those in slots 2 and 4).

When the GE-2 line module or the GE-HDE line module is installed in either the ERX-1440 router or the ERX-310 router and both ports are active, line rate performance is achieved only with packets that are 174 bytes or larger. The module might not achieve line rate with packets that are smaller than 174 bytes.

GE-8 I/O Module

The ERX-1440 router and the ERX-310 router both support the GE-8 I/O module. Other E-series routers do not support the GE-8 I/O module.

The GE-8 I/O module pairs with the GE-HDE line module to provide Gigabit Ethernet operation through eight line interfaces.



NOTE: The GE-8 I/O module has a logical port, numbered port 8, that is reserved for the hardware multicast packet replication feature. For more information, see *JUNOS Multicast Routing Configuration Guide*.

You can install the GE-HDE line module and its corresponding GE-8 I/O module in slot 1 or slot 2 of an ERX-310 router or in any slot of an ERX-1440 router.

The GE-8 I/O module can use either fiber-optic or copper SFPs. The I/O module accepts up to eight pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances. Alternatively, the I/O module supports up to eight pairs of copper SFPs.

Bandwidth and Line Rate Considerations

When the GE-HDE line module is installed in the ERX-1440 router, it delivers full bandwidth of 4 Gbps per line module (2 Gbps at the ingress and 2 Gbps at the egress) only when installed in slot 2 or slot 4, and when the SRP-40G+ module is used in the router. When the module is installed in any other ERX-1440 slot, it delivers a maximum bandwidth of 2 Gbps per line module (1 Gbps maximum at the ingress and 1 Gbps maximum at the egress). Therefore, of the maximum 96 possible ports for the module in an ERX-1440 chassis (that is, eight ports in each of 12 slots), full bandwidth is delivered only on a maximum of 16 ports (those in slots 2 and 4).

When the GE-HDE line module is installed in either the ERX-1440 router or the ERX-310 router and all ports are active, line rate performance is achieved only with packets that are 174 bytes or larger. The module might not achieve line rate with packets that are smaller than 174 bytes.

Table 14 on page 181 lists the average data rate on the GE-HDE line module and GE-8 I/O module combination when installed in an ERX-310 router or in slots 2 or 4 of an ERX-1440 router.

Table 14: Average Data Rate for ERX-310 Router or in Slots 2 or 4 of an ERX-1440 Router

Port Combination	Average Data Rate per GE-8 I/O Module (> 174 Byte Packets)	Average Data Rate per GE-HDE Line Module
Ports 1–8	250 Mbps per port	250 Mbps per port
Any four ports	500 Mbps per port	500 Mbps per port
Any two ports	1 Gbps per port	1 Gbps per port

Table 15 on page 182 lists the average data rate on the GE-HDE line module and GE-8 I/O module combination when installed in all other slots on the ERX-1440.

Table 15: Average Data Rate When Installed in All Other Slots on an ERX-1440 Router

Port Combination	Average Data Rate per GE-8 I/O Module (> 174 Byte Packets)	Average Data Rate per GE-HDE Line Module
Ports 1–8	125 Mbps per port	125 Mbps per port
Any four ports	250 Mbps per port	250 Mbps per port
Any two ports	500 Mbps per port	500 Mbps per port

Managing High-Density Ethernet

The overall data rate for the GE-HDE line module is 2 Gbps; therefore, the I/O module becomes highly oversubscribed because of the wire rate of the line module. The data rate of the GE-8 I/O module is limited with larger frames, and the packet rate is limited with smaller frames.

Currently, flow control using MAC pause frames is disabled on the GE-8 I/O module. The I/O module does not transmit or receive pause frames.

For more information about high-density Ethernet, see “High-Density Ethernet” on page 196.

OC3-2 GE APS I/O Module

ERX-7xx models, ERX-14xx models, and the ERX-310 router all support the OC3-2 GE APS I/O module.

The OC3-2 GE APS I/O module pairs with the OC3/STM1 GE/FE line module to provide Gigabit Ethernet operation through one line interface and OC3 STM1 ATM operation through two line interfaces.

The OC3-2 GE APS I/O module uses a range of SFPs to support different optical modes and cabling distances, and accepts up to three LC-style fiber-optic or copper SFPs. You can configure only port 2 for Gigabit Ethernet interfaces; port 0 and port 1 are reserved for OC3/STM1 ATM interfaces.

For more information about configuring OC3/STM-1 ATM interfaces on this I/O module, see “OC3/STM1 GE/FE Line Module” on page 79.



NOTE: The OC3-2 GE APS I/O module does not support APS in the current release.

ES2-S1 GE-4 IOA

The E120 router and the E320 router support the ES2-S1 GE-4 IOA. Other E-series routers do not support the ES2-S1 GE-4 IOA.

The ES2-S1 GE-4 IOA pairs with the ES2 4G line module (LM). For more information about the ES2 4G LM, see “ES2 4G Line Module” on page 80.

The ES2-S1 GE-4 IOA is offered in a halfheight size that enables you to configure it in one of two IOA bays that are available for each slot. You can install the ES2-S1 GE-4 IOA in only one of the IOA bays per slot. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

The ES2-S1 GE-4 IOA has four ports. The IOA can use either fiber-optic or copper SFPs. The IOA accepts up to four pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances. Alternatively, the IOA supports up to eight pairs of copper SFPs.

The ES2-S1 GE-4 IOA does not support port redundancy.

ES2-S1 GE-8 IOA

The E120 router and the E320 router support the ES2-S1 GE-8 IOA. Other E-series routers do not support the ES2-S1 GE-8 IOA.

The ES2-S1 GE-8 IOA is offered in a halfheight size that enables you to configure it in either of the two IOA bays that are available for each slot. You can install the ES2-S1 GE-8 IOA in both IOA bays. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

The ES2-S1 GE-8 IOA has eight ports. The IOA can use either fiber-optic or copper SFPs. The IOA accepts up to four pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances. Alternatively, the IOA supports up to eight pairs of copper SFPs.



NOTE: The ES2-S1 GE-8 IOA has a logical port, numbered port 8, that is reserved for the hardware multicast packet replication feature. For more information, see *JUNOS Multicast Routing Configuration Guide*.

The ES2-S1 GE-8 IOA pairs with either the ES2 4G line module (LM), ES2 10G LM, and the ES2 10G ADV LM to provide access services.

ES2 4G LM Combination

For more information about the ES2 4G LM, see “ES2 4G Line Module” on page 80.

When paired with the ES2 4G LM, you can combine the ES2-S1 GE-8 IOA in a slot with one of the following IOA types:

- ES2-S1 OC3-8 ATM IOA
- ES2-S1 OC12-2 ATM IOA
- ES2-S1 OC12-2 POS IOA

Bandwidth and Line Rate Considerations

Table 16 on page 184 lists the average data rate on the ES2-S1 GE-8 IOA when installed in E120 and E320 routers with one ES2 4G LM installed.

Table 16: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 4G LM

Port Combination	100 Gbps Configuration (E320 Router)	120 Gbps and 320 Gbps Configurations (E120 and E320 Routers)		
	Average Data Rate per GE-8 IOA (> 128 Byte Packets)	Average Data Rate per ES2 4G LM	Average Data Rate per GE-8 IOA (> 128 Byte Packets)	Average Data Rate per ES2 4G LM
All eight ports	412.5 Mbps per port	412.5 Mbps per port	475 Mbps per port	475 Mbps per port
Any four ports	825 Mbps per port	825 Mbps per port	950 Mbps per port	950 Mbps per port
Any two ports	1 Gbps per port	1 Gbps per port	1 Gbps per port	1 Gbps per port

Table 17 on page 184 lists the average data rate on two ES2-S1 GE-8 IOAs when installed in E120 and E320 routers with one ES2 4G LM installed.

Table 17: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 4G LM

Port Combination	100 Gbps Configuration (E320 Router)		120 Gbps and 320 Gbps Configurations (E120 and E320 Routers)	
	Average Data Rate per GE-8 IOA (> 128 Byte Packets)	Average Data Rate per ES2 4G LM	Average Data Rate per GE-8 IOA (> 128 Byte Packets)	Average Data Rate per ES2 4G LM
All sixteen ports	206.25 Mbps per port	206.25 Mbps per port	237.5 Mbps per port	237.5 Mbps per port
Any eight ports	412.5 Mbps per port	412.5 Mbps per port	475 Mbps per port	475 Mbps per port
Any four ports	825 Mbps per port	825 Mbps per port	950 Mbps per port	950 Mbps per port
Any two ports	1 Gbps per port	1 Gbps per port	1 Gbps per port	1 Gbps per port

Table 18 on page 185 lists the average data rate when combining an ES2-S1 GE-8 IOA in one adapter bay with the ES2-S1 OC3-8 ATM IOA, or the ES2-S1 OC12-2 ATM IOA, or the ES2-S1 OC12-2 POS IOA in another adapter bay. Because the OC3/STM1 and OC12/STM4 IOAs use less than half of the full bandwidth of the ES2 4G LM, the router allocates these IOAs as much bandwidth as they can use. The ES2-S1 GE-8 IOA uses any remaining bandwidth.

Each OC12/STM4 port has a maximum theoretical bandwidth of 622 Mbps. Each OC3/STM1 port has a maximum theoretical bandwidth of 155 Mbps. Therefore, the

OC12/STM4 IOAs have a maximum theoretical bandwidth of 1.244 Gbps and the OC3/STM1 IOA has an maximum theoretical bandwidth of 1.244 Gbps.

Table 18: Average Data Rate for ES2-S1 GE-8 IOA Combined with Other IOA Types in Same Slot

Average Data Rate per GE-8 IOA (> 128 Byte Packets)	Average Data Rate per OC12/STM4 IOA	100 Gbps Configuration (E320 Router) Average Data Rate per ES2 4G LM	120 Gbps and 320 Gbps Configurations (E120 and E320 Routers) Average Data Rate per ES2 4G LM
257 Mbps per port (Ports 0–7)	622 Mbps per port (Ports 0 and 1)	GE-8 IOA—257 Mbps per port	GE-8 IOA—319.5 Mbps per port
		OC12/STM4—622 Mbps per port	OC12/STM4—622 Mbps per port
334.75 Mbps per port (Ports 0–7)	622 Mbps (Port 1)	GE-8 IOA—334.75 Mbps per port	GE-8 IOA—397.25 Mbps per port
		OC12/STM4 IOA—622 Mbps for port 1	OC12/STM4 IOA—622 Mbps for port 1
387.5 Mbps per port (Ports 0–7)	100 Mbps per port (Ports 0 and 1)	GE-8 IOA—387.5 Mbps per port	GE-8 IOA—450 Mbps per port
		OC12/STM4 IOA—100 Mbps per port	OC12/STM4 IOA—100 Mbps per port

Managing High-Density Ethernet

With a 100 Gbps fabric configuration, the overall data rate for the ES2 4G LM with ES2-S1 GE-8 IOAs is 3.3 Gbps. With a 120 Gbps fabric configuration or a 320 Gbps fabric configuration, the overall data rate for the ES2 4G LM with ES2-S1 GE-8 IOAs is 3.8 Gbps. In both configurations, the line module becomes highly oversubscribed because of the IOA available wire rate. When paired with the ES2 4G LM, the data rate of the ES2-S1 GE-8 IOA is bandwidth limited with larger frames, and the packet rate is limited with smaller frames.



NOTE: The overall data rate of the ES2-S1 GE-8 IOA is 0.1 Gbps less than other IOAs that pair with the ES2 4G LM because of fair bandwidth allocation across the eight ports.

Currently, flow control using MAC pause frames is disabled on the ES2-S1 GE-8 IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196.

ES2 10G LM Combination

When paired with the ES2 10G LM, you can only combine the ES2-S1 GE-8 IOA in a slot with another ES2-S1 GE-8 IOA.

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G LMs and ES2-S1 GE-8 IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G LMs and ES2-S1 GE-8 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G LMs and ES2-S1 GE-8 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Bandwidth and Line Rate Considerations

Each ES2-S1 GE-8 IOA is connected to the ES2 10G LM through a 5 Gbps bus. Therefore, the aggregate bandwidth of any IOA is limited to 5 Gbps.

Table 19 on page 186 lists the average data rate on the ES2-S1 GE-8 IOA when installed in E120 and E320 routers with one ES2 10G LM installed.

Table 19: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 10G LM

Port Combination	100 Gbps, 120 Gbps, or 320 Gbps Configuration
	Average Data Rate per GE-8 IOA (> 128 Byte Packets)
Any five ports	1 Gbps per port
All eight ports	625 Mbps per port

Table 20 on page 187 lists the average data rate of two ES2-S1 GE-8 IOAs when installed in E120 and E320 routers with one ES2 10G LM installed.

Table 20: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 10G LM

Port Combination	100 Gbps, 120 Gbps, or 320 Gbps Configuration Average Data Rate per GE-8 IOA (> 128 Byte Packets)
All sixteen ports	625 Mbps per port
Any five ports on each IOA	1 Gbps per port

Managing High-Density Ethernet

When installed in an E120 router or an E320 router with any SRP module combination, the overall data rate for the ES2 10G LM with one ES2-S1 GE-8 IOA is limited to 5 Gbps. The overall data rate for the ES2 10G LM with two ES2-S1 GE-8 IOAs is limited to 10 Gbps. In all configurations, the line module can become oversubscribed because of the IOA available wire rate (8 Gbps).

Currently, flow control using MAC pause frames is disabled on the ES2-S1 GE-8 IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196.

ES2 10G ADV LM Combination

You can combine an ES2-S1 GE-8 IOA in a slot only with another ES2-S1 GE-8 IOA when paired with the ES2 10G ADV LM.

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G ADV LMs and ES2-S1 GE-8 IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G ADV LMs and ES2-S1 GE-8 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G ADV LMs and ES2-S1 GE-8 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Bandwidth and Line Rate Considerations

Each ES2-S1 GE-8 IOA is connected to the ES2 10G ADV LM through a 5 Gbps bus. Therefore, the aggregate bandwidth of any IOA is limited to 5 Gbps.

Table 21 on page 188 lists the average data rate on the ES2-S1 GE-8 IOA when installed in E120 and E320 routers with one ES2 10G ADV LM installed.

Table 21: Average Data Rate for One ES2-S1 GE-8 IOA Installed with an ES2 10G ADV LM

Port Combination	100 Gbps, 120 Gbps, or 320 Gbps Configuration
	Average Data Rate per GE-8 IOA (> 128 Byte Packets)
Any five ports	1 Gbps per port
All eight ports	625 Mbps per port

Table 22 on page 188 lists the average data rate of two ES2-S1 GE-8 IOAs when installed in E120 and E320 routers with one ES2 10G ADV LM installed.

Table 22: Average Data Rate for Two ES2-S1 GE-8 IOAs Installed with an ES2 10G ADV LM

Port Combination	100 Gbps, 120 Gbps, or 320 Gbps Configuration
	Average Data Rate per GE-8 IOA (> 128 Byte Packets)
All sixteen ports	625 Mbps per port
Any five ports on each IOA	1 Gbps per port

Managing High-Density Ethernet

When installed in an E120 router or an E320 router with any SRP module combination, the overall data rate for the ES2 10G ADV LM with one ES2-S1 GE-8 IOA is limited to 5 Gbps. The overall data rate for the ES2 10G ADV LM with two ES2-S1 GE-8 IOAs is limited to 10 Gbps. In all configurations, the line module can become oversubscribed because of the IOA available wire rate (8 Gbps).

Currently, flow control using MAC pause frames is disabled on the ES2-S1 GE-8 IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196.

ES2-S3 GE-20 IOA

The E120 router and the E320 router support the ES2-S3 GE-20 IOA. Other E-series routers do not support the ES2-S3 GE-20 IOA.

The ES2-S3 GE-20 IOA pairs with the ES2 10G LM or the ES2 10G ADV LM to provide Gigabit Ethernet operation through 20 line interfaces.

The ES2-S3 GE-20 IOA is offered in a full-height size that uses both adapter bays. The IOA is identified by the software as adapter bay 0. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

The IOA can use either fiber-optic or copper SFPs. The IOA accepts up to four pairs (Tx/Rx) of LC-style fiber-optic connectors that support different optical modes and cabling distances.

The ES2-S3 GE-20 IOA does not support port redundancy.

ES2 10G LM Combination

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Bandwidth and Line Rate Considerations

Table 23 on page 189 lists the average data rate on the ES2-S3 GE-20 IOA when installed in E120 and E320 routers with one ES2 10G LM installed.

Table 23: Average Data Rate for One ES2-S3 GE-20 IOA Installed with an ES2 10G LM

100 Gbps, 120 Gbps, or 320 Gbps Configuration	
Port Combination	Average Data Rate per GE-20 IOA (> 128 Byte Packets)
Any 10 ports	1 Gbps per port
All 20 ports	500 Mbps per port

Managing High-Density Ethernet

When installed in an E120 router or an E320 router with any SRP module combination, the overall data rate for the ES2 10G LM with one ES2-S3 GE-20 IOA is limited to 10 Gbps. The line module can become oversubscribed because of the IOA available wire rate (20 Gbps).

Currently, flow control using MAC pause frames is disabled on the ES2-S3 GE-20 IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196 .

ES2 10G ADV LM Combination

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G ADV LMs and ES2-S3 GE-20 IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G ADV LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 ADV LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Bandwidth and Line Rate Considerations

Table 24 on page 190 lists the average data rate on the ES2-S3 GE-20 IOA when installed in E120 and E320 routers with one ES2 10G ADV LM installed.

Table 24: Average Data Rate for One ES2-S3 GE-20 IOA Installed with an ES2 10G ADV LM

100 Gbps, 120 Gbps, or 320 Gbps Configuration	
Port Combination	Average Data Rate per GE-20 IOA (> 128 Byte Packets)
Any 10 ports	1 Gbps per port
All 20 ports	500 Mbps per port

Managing High-Density Ethernet

When installed in an E120 router or an E320 router with any SRP module combination, the overall data rate for the ES2 10G ADV LM with one ES2-S3 GE-20 IOA is limited to 10 Gbps. The line module can become oversubscribed because of the IOA available wire rate (20 Gbps).

Currently, flow control using MAC pause frames is disabled on the ES2-S3 GE-20 IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196.

10-Gigabit Ethernet IOAs

10-Gigabit Ethernet interfaces are supported on the ES2-S1 10GE IOA and the ES2-S1 10GE PR IOA. For more information about 10-Gigabit Ethernet, see IEEE Standard 802.3ae.

ES2-S1 10GE IOA

The E120 router and the E320 router support the ES2-S1 10GE IOA. Other E-series routers do not support the ES2-S1 10GE IOA.

The ES2-S1 10GE IOA pairs with the ES2 4G LM to provide a 10-Gigabit Ethernet interface. For more information about the ES2 4G LM, see “ES2 4G Line Module” on page 80.

The ES2-S1 10GE IOA is offered in a full-height size that uses both adapter bays. The IOA is identified by the software as adapter bay 0. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

The ES2-S1 10GE IOA has one port, uses a range of 10-gigabit small form-factor pluggable transceivers (XFPs) to support different optical modes and cabling distances, and accepts one LC-style fiber-optic connector.

Managing High-Density Ethernet

With a 100 Gbps fabric configuration, the overall data rate for the ES2 4G LM with the ES2-S1 10GE IOA is 3.4 Gbps for large packets. With a 120 Gbps or a 320 Gbps fabric configuration, the overall data rate for the ES2 4G LM with the ES2-S1 10GE IOA is 3.9 Gbps for large packets. In all configurations, the line module becomes highly oversubscribed because of the available wire rate on the IOA. When paired with the ES2 4G LM, the data rate of the ES2-S1 10GE IOA is bandwidth limited with larger frames, and the packet rate is limited with smaller frames.

Currently, flow control using MAC pause frames is disabled on the ES2-S1 10GE IOA. The IOA does not transmit or receive pause frames.

For more information about high-density Ethernet on E-series routers, see “High-Density Ethernet” on page 196 .

ES2-S2 10GE PR IOA

The E120 router and the E320 router support the ES2-S2 10GE PR IOA. Other E-series routers do not support the ES2-S2 10GE PR IOA.

The ES2-S2 10GE PR IOA is offered in a full-height size that uses both adapter bays. The IOA is identified by the software as adapter bay 0. For more information about installing IOAs, see the *E120 and E320 Hardware Guide*.

The ES2-S2 10GE PR IOA has one port, uses a range of XFPs to support different optical modes and cabling distances, and accepts 10 LC-style fiber-optic connectors.

The single port on the ES2-S2 10GE PR IOA has a redundant port. If the active port fails, the redundant port automatically becomes active. You can configure only the active port for a 10-Gigabit Ethernet interface; you cannot configure the redundant port. Cabling both ports provides a redundant path to the 10-Gigabit Ethernet interface.

The ES2-S2 10GE PR IOA pairs with the ES2 10G Uplink LM to provide uplink services or the ES2 10G LM or the ES2 10G ADV LM to provide access services.

ES2 10G Uplink LM Combination

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G Uplink LMs and ES2-S2 10GE PR IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G Uplink LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G Uplink LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Uplink Operation

The ES2 10G Uplink LM and ES2-S2 10GE PR IOA combination provides an uplink connection from the core network to the edge rather than traditional broadband access services such as PPPoE, transparent bridging, and subscriber interfaces.

The combination can receive and transmit full duplex line rate of 10 GB (10 GB at the ingress and 10 GB at the egress). The IOA can also support 9.6 Kbps jumbo packets at both the ingress and egress.

Multicast

The ES2 10G Uplink LM can receive multicast traffic, including all multicast control protocols. The ES2 10G Uplink LM can also transmit multicast control protocol frames and multicast data frames to perform multicast egress elaboration.

L2TP

An E-series router can be configured as either an L2TP access concentrator (LAC) or an L2TP network server (LNS). The ES2 10G Uplink LM and ES2-S2 10GE PR IOA combination supports an E-series router configured as a LAC only for traffic to or from an LNS. The ES2 10G Uplink LM and ES2-S2 10GE PR IOA combination supports both sides of the L2TP LNS function (LAC facing and core facing).

Flow Control and Policy

The ES2 10G Uplink LM and ES2-S2 10GE PR IOA combination does not support quality of service (QoS) functionality that is available on other ASIC-based Ethernet modules.

Although the ES2 10G Uplink LM does not support scheduling and shaping for egress traffic, the LM does account for the traffic class of packets through the fabric so that high priority packets are scheduled for transmission to the line module before lower priority packets. Packets that arrive at the line module are processed and transmitted using a flow-through scheme.

Currently, flow control using MAC pause frames is disabled on the ES2-S2 10GE PR IOA. The IOA does not transmit or receive pause frames. Instead, the system prioritizes control traffic over non-control traffic (that is, data). For a list of types of control traffic, see “High-Density Ethernet” on page 196 .

For information about configuring policies on the ES2 10G Uplink LM and ES2-S2 10GE PR IOA, see *JUNOS Policy Management Configuration Guide*.

ES2 10G LM Combination

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G LMs and ES2-S2 10GE PR IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Access Operation

The ES2 10G LM and ES2-S2 10GE PR IOA combination provides traditional broadband access services such as PPPoE and subscriber interfaces. It also supports both sides of the L2TP LNS and LAC function.

The combination can receive and transmit full duplex line rate of 10 GB (10 GB at the ingress and 10 GB at the egress). The IOA can also support 9.6 Kbps jumbo packets at both the ingress and egress.

Multicast

The ES2 10G LM can receive multicast traffic, including all multicast control protocols. The ES2 10G LM can also transmit multicast control protocol frames and multicast data frames to perform multicast egress elaboration.

Flow Control and Policy

The ES2 10G LM and ES2-S2 10GE PR IOA combination supports QoS functionality that is available on other ASIC-based Ethernet modules.

Currently, flow control using MAC pause frames is disabled on the ES2-S2 10GE PR IOA. The IOA does not transmit or receive pause frames. Instead, the system prioritizes control traffic over non-control traffic (that is, data). For a list of types of control traffic, see “High-Density Ethernet” on page 196 .

For information about configuring policies on the ES2 10G LM and ES2-S2 10GE PR IOA, see *JUNOS Policy Management Configuration Guide*.

ES2 10G ADV LM Combination

With a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G ADV LMs and ES2-S2 10GE PR IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.

With a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G ADV LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

With a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G ADV LMs and ES2-S2 10GE PR IOAs. You can install a combination in any of the line module slots, each of which is allocated 10 Gbps of overall bandwidth.

Access Operation

The ES2 10G ADV LM and ES2-S2 10GE PR IOA combination provides traditional broadband access services such as PPPoE and subscriber interfaces. It also supports both sides of the L2TP LNS and LAC function.

The combination can receive and transmit full duplex line rate of 10 GB (10 GB at the ingress and 10 GB at the egress). The IOA can also support 9.6 Kbps jumbo packets at both the ingress and egress.

Multicast

The ES2 10G ADV LM can receive multicast traffic, including all multicast control protocols. The ES2 10G ADV LM can also transmit multicast control protocol frames and multicast data frames to perform multicast egress elaboration.

Flow Control and Policy

The ES2 10G ADV LM and ES2-S2 10GE PR IOA combination supports QoS functionality that is available on other ASIC-based Ethernet modules.

Currently, flow control using MAC pause frames is disabled on the ES2-S2 10GE PR IOA. The IOA does not transmit or receive pause frames. Instead, the system prioritizes control traffic over non-control traffic (that is, data). For a list of types of control traffic, see “High-Density Ethernet” on page 196 .

For information about configuring policies on the ES2 10G ADV LM and ES2-S2 10GE PR IOA, see *JUNOS Policy Management Configuration Guide*.

Ethernet References

For more information about Ethernet implementations, consult the following resources:

- IEEE 802.1q (Virtual LANs)
- IEEE 802.1w (Rapid Reconfiguration of Spanning Tree)
- IEEE 802.3 (Fast Ethernet and Gigabit Ethernet)
- IEEE 802.3u (Fast Ethernet only)
- IEEE 802.3z (Gigabit Ethernet only)
- IEEE 802.3ae (10-Gigabit Ethernet only)
- IEEE 802.3ad (Link Aggregation)
- RFC 826—An Ethernet Address Resolution Protocol (November 1982)

For more information about MIB support for Ethernet interfaces, consult the following resources:

- RFC 2863—The Interfaces Group MIB (June 2000)
- RFC 2668—Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs) (August 1999)
- RFC 2665—Definitions of Managed Objects for the Ethernet-like Interface Types (August 1998)

High-Density Ethernet

The following modules support high-density Ethernet:

- GE-HDE line module and GE-8 I/O module combination
- ES2 4G LM and ES2-S1 10GE IOA module combination
- ES2 4G LM and ES2-S1 GE-8 IOA module combination

In the current release, you cannot configure port parameters for high-density Ethernet. Instead, JUNOS contains a packet classifier that enables the module to *intelligently drop* certain packets when the module becomes oversubscribed. The packet classifier inspects each incoming packet to determine whether to classify it as control traffic. To enhance network stability, the packet classifier prioritizes control traffic over non-control traffic (that is, data). The packet classifier randomly drops non-control packets when the interface is oversubscribed.

When the I/O module or IOA is oversubscribed, the packet classifier prioritizes the following types of control traffic:

- PPP discovery or PPP session
- Address Resolution Protocol (ARP)
- 802.3ad (link aggregation)
- 802.3 Spanning Tree Protocol (STP)
- IPv4 and IPv6 DHCP server
- IPv4 and IPv6 DHCP host
- IPv6 Neighbor Discovery
- IPv4 virtual router alert
- IPv4 and IPv6 Internet Group Management Protocol (IGMP)
- IPv4 packets with a type of service (ToS) precedence value set to Internetwork Control (C0)
- IPv6 packets with a traffic class precedence value set to Internetwork Control (C0)

Managing Port Redundancy on Gigabit Ethernet I/O Modules

By default, the software manages port redundancy on GE I/O modules automatically. However, you can manage redundancy on GE I/O modules as follows:

- Specify the time that the router waits for a port on a GE I/O module to become active before the router switches to the redundant port.
- Force a GE I/O module to switch operation from one port to the other.
- Disable port redundancy by specifying operation on one port only.

If you manage port redundancy manually, the router retains the manual configuration after the module reboots.

You can monitor the port redundancy configuration with the **show interfaces gigabitEthernet** command.



NOTE: The router manages failover in the same way for the GE I/O Modules and the GE-2 SFP I/O module.

link failover force

- Use to force a GE I/O module to switch operation from one port to the other.
- Select an interface on the GE I/O module before you issue this command.
- Example

```
host1(config)#interface gigabitEthernet 5/0
host1(config-if)#link failover force
```

- There is no **no** version.
- See link failover force.

link failover timeout

- Use to specify the time that the router waits for a port on a GE I/O module to become active before the router switches to the redundant port.
- Select an interface on the GE I/O module before you issue this command.
- Specify a time in the range 100–10,000 ms.
- Example

```
host1(config)#interface gigabitEthernet 5/0
host1(config-if)#link failover timeout 1000
```

- Use the **no** version to restore the default situation in which the router sets this time automatically.
- See link failover timeout.

link selection

- Use to disable redundancy on a GE I/O module by allowing operation on the specified port only.
- Select an interface on the GE I/O module before you issue this command.
- Example

```
host1(config)#interface gigabitEthernet 5/0
host1(config-if)#link selection secondary
```

- Use the **no** version to restore the default situation in which port redundancy is enabled.
- See link selection.

Configuration Tasks for Ethernet

This section describes the options for configuring Ethernet interfaces.

You configure an Ethernet interface based on the requirements for your router configuration and the protocols you plan to route on the interface. Because you can configure an interface in different ways, Ethernet configuration tasks are divided into three primary areas. These areas are further described in separate sections in this chapter.

- **Configuring the physical interface**—You must perform basic configuration steps for all interfaces. This task begins with selecting an Ethernet interface and setting parameters such as line speed and MTU.
- **Configuring VLANs and stacked VLANs (S-VLANs)**—After you configure the physical interface, you must decide whether to configure the Ethernet interface with or without VLANs or S-VLANs. VLANs and S-VLANs enable you to multiplex multiple IP interfaces and PPPoE interfaces over a single physical Ethernet port. If you are not configuring with VLANs or S-VLANs, proceed to “Configuring Ethernet Interfaces” on page 175.
- **Configuring upper-layer protocols**—You must determine which upper-layer protocols, such as MPLS, to configure on the interface. This section focuses on non-VLAN configurations. You can configure some upper-layer protocols, such as PPPoE, with or without VLANs. For more information, see *JUNOS Link Layer Configuration Guide*.

Configuring the Physical Interface

This section describes how to complete the basic configuration for a Fast Ethernet, Gigabit Ethernet, or 10-Gigabit Ethernet interface. CLI examples are provided with the individual command descriptions.

To configure an Ethernet interface:

1. Select an Ethernet interface.
2. (Optional) Specify the line speed and duplex mode.
3. (Optional) Specify the MTU.
4. (Optional) Set the time interval at which the router records bit and packet rates.
5. (Optional) Associate a name with the interface.
6. (Optional) Validate MAC addresses on a per interface basis.

7. (Optional) Enable the debounce timer and set the time interval that the interface waits before reporting a state change to the upper-layer protocols.
8. (Optional) Modify the interval that the interface waits before reporting a state change to the upper-layer protocols.

debounce

- Use to enable the debounce configuration and set the interval, in seconds, for which an interface must maintain a given state—for example, up or down—before the interface reports the state change to the upper-layer protocols.



NOTE: Debounce configuration is supported for all Ethernet module combinations on E-series routers.

- When a link briefly goes up or down, the momentary loss of signal can cause a temporary service interruption for connection-oriented protocols such as PPPoE. Configuring the debounce interval prevents the router from prematurely tearing down and rebuilding the PPPoE connections during such brief network outages.
- Specify the interval, in seconds, for which an interface must maintain a given state before the state change is reported to the upper-layer links. The range is 1–5 seconds and the default interval is 1 second.
- Observe the following guidelines when you configure the debounce feature for Ethernet interfaces:
 - In networks where a link alternates between the up and down state for brief periods, we recommend that you set a longer debounce interval to prevent the router from prematurely and unnecessarily tearing down and rebuilding the PPPoE connections during brief network outages.
 - In networks where the interface changes to a down state and remains in the down state for long periods of time, we recommend that you set a shorter debounce interval to minimize the latency (delay) required for the interface to notify the upper-layer protocols of the state change. When you set a longer debounce interval, the latency increases.
 - We recommend that you disable the debounce feature in networks that require faster link status notifications to upper links.
 - The debounce feature is not supported for Ethernet interfaces on which either IEEE 802.3ad link aggregation is configured.
- The setting of the **debounce** command persists after you reboot the router.
- Example


```
host1(config-if)#debounce 3
```
- Use the **no** version to restore the default behavior, which disables debounce on the interface.
- See **debounce**.

debounce-interval

- Use to modify the minimum time an Ethernet interface must maintain a given state—for example, up or down—before the interface notifies the upper-layer protocols of the state change. The interval can be in the range 1–5 seconds.



NOTE: Debounce configuration is supported for all Ethernet module combinations on E-series routers.

- You can configure this command only if you have enabled the debounce timer feature using the **debounce** command. After you enable this feature, you can use the **debounce-interval** command to modify the debounce interval.
- The setting of the **debounce-interval** command persists after you reboot the router.
- Example

```
host1(config-if)#debounce—interval 4
```

- Use the **no** version to restore the default value, 1 second.
- See `debounce-interval`.

duplex

- Use to specify the duplex mode.
- This command also works on the Fast Ethernet port on the SRP module on all E-series routers. For more information, see *JUNOS System Basics Configuration Guide*.



NOTE: If you set either the line speed or duplex mode to automatically negotiate by using the **automatically negotiate** keyword, the router negotiates both parameters. You can specify different values to prevent the router from negotiating these parameters.

Automatic negotiation is not supported for the FE-8 SFP I/O module. For this I/O module, full duplex mode is the default.

- Example

```
host1(config-if)#duplex full
```

- Use the **no** version to revert to the default, either automatically negotiate or full duplex (FE-8 SFP I/O module only)
- See `duplex`.

ethernet description

- Use to associate a text description of up to 64 characters with an Ethernet interface.
- This command does not work for the Fast Ethernet port on the SRP module.

- The description is displayed in the output for **show configuration**, **show interfaces fastEthernet**, **show interfaces gigabitEthernet**, and **show interfaces tenGigabitEthernet** commands.

- Example

```
host1(config-if)#ethernet description abcd1234
```

- Use the **no** version to remove the description from the interface.
- See ethernet description.

interface fastEthernet

- Use to select a Fast Ethernet interface on a line module.
- You can also use it to select a Fast Ethernet management port on an SRP I/O module (ERX-7xx models, ERX-14xx models, and the ERX-310 router) or an SRP IOA (E120 and E320 routers). For information about managing the Fast Ethernet port on the SRP module, see *JUNOS System Basics Configuration Guide*.
- Use the *slot/port* [*.subinterface*] format for Fast Ethernet interfaces on ERX-7xx models, ERX-14xx models, and the ERX-310 router. Use the *slot/adaptor/port* format for the SRP IOA on the E120 or E320 routers; the port on the SRP IOA is always identified by 0.
- Example 1—Selects a Fast Ethernet interface on ERX-7xx models, ERX-14xx models, or the ERX-310 router

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

- Example 2—Selects the Fast Ethernet management port on an E320 router

```
host1(config)#interface fastEthernet 6/0/0
```

- Use the **no** version to remove IP from an interface or subinterface. You must issue the **no** version from the highest level down; you cannot remove an interface or subinterface if the one above it still exists.
- See interface fastEthernet.

interface gigabitEthernet

- Use to select a Gigabit Ethernet interface.



NOTE: On the GE I/O module, you can configure only the primary port, 0. The router automatically uses the redundant port, 0R, if the primary port fails.

On the GE-2 SFP I/O module, you can configure only the primary ports, 0 and 1. The router automatically uses the corresponding redundant port, 0R or 1R, if the primary port fails.

On the OC3-2 GE APS I/O module, you can configure only port 2. Ports 0 and 1 are reserved for OC3/STM1 ATM interfaces. This I/O module does not support redundant ports in the current release.

On the ES2-S1 GE-4 IOA, you can configure all four ports.

On the ES2-S1 GE-8 IOA, you can configure all eight ports.

-
- Use the *slot/port* [*subinterface*] format for Gigabit Ethernet interfaces on ERX-7xx models, ERX-14xx models, or the ERX-310 router; use the *slot/adapter/port* format for Gigabit Ethernet interfaces on the E120 and E320 routers.
 - Example 1—Selects a Gigabit Ethernet interface on ERX-7xx models, ERX-14xx models, and the ERX-310 router

```
host1(config)#interface gigabitEthernet 1/0
host1(config)#interface gigabitEthernet 2/1
```

- Example 2—Selects a Gigabit Ethernet interface on the E320 router

```
host1(config)#interface gigabitEthernet 4/0/1
```

- Use the **no** version to remove IP from an interface. You must issue the no version from the highest level down; you cannot remove an interface or subinterface if the one above it still exists.
- See interface gigabitEthernet.

interface tenGigabitEthernet

- Use to select a 10-Gigabit Ethernet interface on the E120 router or the E320 router.



NOTE: On the ES2-S2 10GE PR IOA, you can configure only the primary port, 0. The router automatically uses the redundant port, 0R, if the primary port fails.

-
- Use the *slot/adapter/port* format.
 - Example—Selects a 10-Gigabit Ethernet interface on the ES2-S1 10GE IOA

```
host1(config)#interface tenGigabitEthernet 4/0/1
```

- Use the **no** version to remove IP from an interface. You must issue the **no** version from the highest level down; you cannot remove an interface or subinterface if the one above it still exists.
- See interface tenGigabitEthernet.

ip mac-validate

- Use to enable or disable MAC address validation on a per interface basis.
- Use the **strict** keyword to prevent transmission of IP packets that do not reside in the validation table.
- Use the **loose** keyword to enable IP packets to pass through even though the packets do not have entries in the validation table. Only packets that have matching IP–MAC pair entries in the table are validated.
- The default behavior is not to perform MAC address validation.
- Example

```
host1(config)#interface gigabitEthernet 2/0
host1(config-if)#ip address 4.4.4.2 255.255.255.0
host1(config-if)#ip mac-validate strict
host1(config-if)#exit
```

- Use the **no** version to disable the command.



NOTE: For additional information about MAC address validation, see the **arp validate** command description in *JUNOS IP, IPv6, and IGP Configuration Guide*.

- See ip mac-validate.

load-interval

- Use to set the time interval at which the router calculates bit and packet rate counters.
- This command does not work for the Fast Ethernet port on the SRP module.
- Specify a multiple of 30 seconds, in the range 30–300 seconds.
- The default value is 300 seconds.
- Example

```
host1(config-if)#load-interval 90
```

- Use the **no** version to restore the default time interval, 300 seconds.
- See load-interval.

mtu

- Use to specify the MTU for an interface.
- Specify a value in the range 64–9188 bytes. The range for FE-8 I/O modules is 64–9042 bytes.

- This command does not work for the Fast Ethernet port on the SRP module.
- Example

```
host1(config-if)#mtu 9000
```

- Use the **no** version to specify the default, 1518.
- See mtu.

speed

- Use to specify the line speed.
- This command also works on the Fast Ethernet port on the SRP module on all E-series routers. For more information, see *JUNOS System Basics Configuration Guide*.



NOTE: If you set either the line speed or duplex mode to automatically negotiate by using the **automatically negotiate** keyword, the router negotiates both parameters. You can specify different values to prevent the router from negotiating these parameters.

Automatic negotiation is not supported for the FE-8 SFP I/O module. For this I/O module, the default speed is 100 Mbps.

- Example

```
host1(config-if)#speed 10
```

- Use the **no** version to revert to the default, either automatically negotiate or 100 Mbps (FE-8 SFP I/O module only).
- See speed.

Disabling Ethernet Interfaces

Use the **shutdown** command to disable an Ethernet interface.

shutdown

- Use to disable an Ethernet interface.
- Example

```
host1(config-if)#shutdown
```

- Use the **no** version to restart a disabled Ethernet interface.
- See shutdown.

Monitoring Ethernet Interfaces

This section explains how to use the **show** commands to display the physical characteristics and the configured settings for Ethernet interfaces.



NOTE: The E120 router and E320 router output for **monitor** and **show** commands is identical to output from other E-series routers, except that the E120 and E320 router output also includes information about the adapter identifier in the interface specifier (*slot/adapter/port*).

Setting Statistics Baselines

The router stores statistics in counters that reset only when you reboot. However, you can establish a baseline for Ethernet statistics by setting a group of reference counters to zero.

baseline interface fastEthernet | gigabitEthernet | tenGigabitEthernet

- Use to establish a baseline for Fast Ethernet, Gigabit Ethernet, or 10-Gigabit Ethernet statistics on a line module or an SRP module.
- Use the **delta** keyword with the **show interfaces fastEthernet**, the **show interfaces gigabitEthernet**, or the **show interfaces tenGigabitEthernet** command to display baselined statistics.
- See baseline interface.

Using Ethernet show Commands

Use the **show** commands described in this section to display information about your Ethernet configuration and to monitor Ethernet interfaces.

show interfaces fastEthernet

- Use to display the status of Fast Ethernet interfaces.
- You can specify the following keywords:
 - **delta**—Specifies that baselined statistics are to be shown
 - **brief**—Displays the operational status of all configured interfaces
- Field descriptions
 - FastEthernet *interfaceSpecifier*—Status of the hardware on this interface
 - up—Hardware is operational
 - down—Hardware is not operational
 - Administrative status—Operational state that you configured for this interface
 - up—Interface is enabled
 - down—Interface is disabled

- Hardware—Type of MAC device on this interface
- Address—MAC address of the processor on this interface
- MAU—Type of medium attachment unit (MAU) on the physical port:
 - 10BASE-T (10 Mbps)
 - 100BASE-TX (100 Mbps)
 - 100BASE-FX-MM (100 Mbps) with the distance appearing after the type
 - 100BASE-LX-SM (100 Mbps)
 - SFP (Empty)—SFPs that are empty
 - SFP (Non-compliant Juniper Part)—SFPs that are installed in the FE-8 I/O module and do not have a Juniper Networks part number programmed
- MTU—Size of the MTU for this interface
 - Operational—Size of the largest packet processed
 - Administrative—Setting for MTU size that you specified
- Duplex Mode—Duplex option for this interface
 - Operational—Duplex option currently used
 - Administrative—Setting for duplex that you specified
- Speed—Line speed for this interface
 - Operational—Current rate at which packets are processed
 - Administrative—Setting for line speed
 - 5 minute input rate—Data rates based on traffic received in the last 5 minutes
 - 5 minute output rate—Data rates based on traffic sent in the last 5 minutes
- De-bounce—Debounce configuration for this interface
 - State is—Enabled, Disabled
 - Interval is—Number of seconds that this interface maintains a given state before the state change is reported to the upper-layer links
- In—Analysis of inbound traffic on this interface
 - Bytes—Number of bytes received in error-free packets
 - Unicast—Number of unicast packets received
 - Multicast—Number of multicast packets received
 - Broadcast—Number of broadcast packets received

- Errors—Total number of errors in all received packets; some packets might contain more than one error
- Discards—Total number of discarded incoming packets
- Mac Errors—Number of incoming packets discarded because of MAC sublayer failures
- Alignment—Number of incomplete octets received
- CRC—Number of packets discarded because the checksum the router computed from the data does not match the checksum generated by the originating devices
- Too Long—Number of packets discarded because the size exceeded the MTU
- Symbol Errors—Number of symbols received that the router did not correctly decode
- Out—Analysis of outbound traffic on this interface
 - Bytes—Number of bytes sent
 - Unicast—Number of unicast packets sent
 - Multicast—Number of multicast packets sent
 - Broadcast—Number of broadcast packets sent
 - Errors—Total number of errors in all transmitted packets; some packets might contain more than one error
 - Discards—Total number of discarded outgoing packets
 - Mac Errors—Number of outgoing packets discarded because of MAC sublayer failures
 - Deferred—Number of packets that the router delayed sending because the line was busy. In half duplex mode, a high number of deferrals means the link is very busy with traffic from other stations. In full duplex mode, when the link is always available for transmission, this number is zero.
 - No Carrier—Number of packets sent when carrier sense was unavailable
- Collisions—Analysis of the collisions that occurred
 - Single—Number of packets sent after one collision
 - Multiple—Number of packets sent after multiple collisions
 - Late—Number of packets aborted during sending because of collisions after 64 bytes
 - Excessive—Number of packets not sent because of too many collisions

- ARP Statistics—Analysis of ARP traffic on this interface; In fields are for traffic received on the interface and Out fields are for traffic sent on the interface
 - ARP requests—Number of ARP requests
 - ARP responses—Number of ARP responses
 - Errors—Total number of errors in all ARP packets
 - Discards—Total number of discarded ARP packets
- queue—Hardware packet queue associated with the specified traffic class and interface
 - Queue length—Length of the queue, in bytes
 - Forwarded packets, bytes—Number of packets and bytes that were forwarded on this queue
 - Dropped committed packets, bytes—Number of committed packets and bytes that were dropped
 - Dropped conformed packets, bytes—Number of conformed packets and bytes that were dropped
 - Dropped exceeded packets, bytes—Number of exceeded packets and bytes that were dropped
- Example—Displays the status of a Fast Ethernet interface

```

host1:vr2#show interfaces fastEthernet 2/0
FastEthernet2/0 is Up, Administrative status is Up
  Hardware is Intel 21440, address is 0090.1a10.0552
  MAU is 10BASE-T
  MTU: Operational 1518, Administrative 1518
  Duplex Mode: Operational Full Duplex, Administrative Auto Negotiate
  Speed: Operational 100 Mbps, Administrative Auto Negotiate
  De-bounce: State is Enabled, interval is 2 seconds

  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec

  In: Bytes 39256, Unicast 612
    Multicast 0, Broadcast 0
    Errors 0, Discards 0, Mac Errors 0, Alignment 0
    CRC 0, Too Longs 0, Symbol Errors 0
  Out: Bytes 4579036, Unicast 610
    Multicast 0, Broadcast 70932
    Errors 0, Discards 0, Mac Errors 0, Deferred 0, No Carrier 3
    Collisions: Single 0, Multiple 0, Late 0, Excessive 0
  ARP Statistics:
    In: ARP requests 0, ARP responses 0
      Errors 0, Discards 0
    Out: ARP requests 0, ARP responses 0
      Errors 0, Discards 0
  Administrative qos-shaping-mode: none
  Operational qos-shaping-mode: none

```

```

queue 0: traffic class control, bound to FastEthernet2/0
  Queue length 0 bytes
  Forwarded packets 1, bytes 46
  Dropped committed packets 0, bytes 0
  Dropped conformed packets 0, bytes 0
  Dropped exceeded packets 0, bytes 0

```

- See show interfaces.

show interfaces *gigabitEthernet*

show interfaces *tenGigabitEthernet*

- Use to display the status of Gigabit Ethernet interfaces and 10-Gigabit Ethernet interfaces.
- You can specify the following keywords:
 - **delta**—Specifies that baselined statistics are to be shown
 - **brief**—Displays the operational status of all configured interfaces
- Field descriptions
 - GigabitEthernet or tenGigabitEthernet *interfaceSpecifier*—Status of the hardware on this interface
 - up—Hardware is operational
 - down—Hardware is not operational
 - Administrative status—Operational state that you configured for this interface
 - up—Interface is enabled
 - down—Interface is disabled
 - Hardware—Type of MAC device on this interface
 - Address—MAC address of the processor on this interface
 - MAU—Type of medium attachment unit (MAU) on the primary and secondary physical ports:
 - SFP—1000BASE-LH, 1000BASE-SX, 1000BASE-ZX; for SFPs that are empty, SFP (Empty) appears in this field; for SFPs that are installed in the OC3-2 GE APS I/O module and do not have a Juniper Networks part number programmed, SFP (GE Compliant) appears in this field
 - XFP—10GBASE-SR (10 Gbps), 10GBASE-LR (10 Gbps), 10GBASE-ER (10 Gbps); for XFPs that are empty, XFP (Empty) appears in this field
 - MTU—Size of the MTU for this interface
 - Operational—Size of the largest packet processed
 - Administrative—Setting for MTU size that you specified
 - Duplex Mode—Duplex option for this interface
 - Operational—Duplex option currently used

- Administrative—Setting for duplex that you specified
- Speed—Line speed for this interface
 - Operational—Current rate at which packets are processed
 - Administrative—Setting for line speed that you specified
- De-bounce—Debounce configuration for this interface
 - State is—Enabled, Disabled
 - Interval is—Number of seconds that this interface maintains a given state before the state change is reported to the upper-layer links
- Link —Link information for this interface
 - Operational Link Selected—Port that the I/O module is currently using: primary or secondary
 - Administrative link selected—Port that the I/O module is configured to use:
 - primary—Only primary port is configured to operate
 - secondary—Only redundant port is configured to operate
 - automatically—Software controls port redundancy automatically
- Primary link selected x times—Number of times that the I/O has used the primary port since the module was last rebooted
- Secondary link selected x times—Number of times that the I/O has used the secondary port since the module was last rebooted
- Primary/Secondary link signal detected, Primary/Secondary link signal not detected—Specifies the port (primary or secondary) on which the router detects a signal (not displayed on GE I/O modules that do not support SFPs)
- 5 minute input rate—Data rates based on the traffic received in the last 5 minutes
- 5 minute output rate—Data rates based on the traffic sent in the last 5 minutes
- In—Analysis of inbound traffic on this interface
 - Bytes—Number of bytes received in error-free packets
 - Unicast—Number of unicast packets received
 - Multicast—Number of multicast packets received
 - Broadcast—Number of broadcast packets received
 - Errors—Total number of errors in all received packets; some packets might contain more than one error
 - Discards—Total number of discarded incoming packets

- Mac Errors—Number of incoming packets discarded because of MAC sublayer failures
- Alignment—Number of incomplete octets received
- CRC—Number of packets discarded because the checksum that the router computed from the data does not match the checksum generated by the originating devices
- Too Longs—Number of packets discarded because the size exceeded the MTU
- Symbol Errors—Number of symbols received that the router did not correctly decode
- Out—Analysis of outbound traffic on this interface
 - Bytes—Number of bytes sent
 - Unicast—Number of unicast packets sent
 - Multicast—Number of multicast packets sent
 - Broadcast—Number of broadcast packets sent
 - Errors—Total number of errors in all transmitted packets; note that some packets might contain more than one error
 - Discards—Total number of discarded outgoing packets
 - Mac Errors—Number of outgoing packets discarded because of MAC sublayer failures
 - Deferred—Number of packets that the router delayed sending because the line was busy. In half duplex mode, a high number of deferrals means the link is very busy with traffic from other stations. In full duplex mode, when the link is always available for transmission, this number is zero.
 - No Carrier—Number of packets sent when carrier sense was unavailable
- Collisions—Analysis of the collisions that occurred
 - Single—Number of packets sent after one collision
 - Multiple—Number of packets sent after multiple collisions
 - Late—Number of packets aborted during sending because of collisions after 64 bytes
 - Excessive—Number of packets not sent because of too many collisions
- ARP Statistics—Analysis of ARP traffic on this interface; In fields are for traffic received on the interface and Out fields are for traffic sent on the interface
 - ARP requests—Number of ARP requests
 - ARP responses—Number of ARP responses

- Errors—Total number of errors in all ARP packets
- Discards—Total number of discarded ARP packets
- queue—Hardware packet queue associated with the specified traffic class and interface
 - Queue length—Length of the queue, in bytes
 - Forwarded packets, bytes—Number of packets and bytes that were forwarded on this queue
 - Dropped committed packets, bytes—Number of committed packets and bytes that were dropped
 - Dropped conformed packets, bytes—Number of conformed packets and bytes that were dropped
 - Dropped exceeded packets, bytes—Number of exceeded packets and bytes that were dropped
- Example—Displays the status of a Gigabit Ethernet interface

```

host1:vr2#show interfaces gigabitEthernet 10/2
ERX-40-20-43#show int gigabitEthernet 10/2
GigabitEthernet10/2 is Down, Administrative status is Up
  Hardware is SEEQ 8101, address is 0090.1a01.0cc8
  Primary MAU is 1000BASE-SX, secondary MAU is SFP (Empty)
  MTU: Operational 1518, Administrative 1518
  Duplex Mode: Operational Full Duplex, Administrative Auto Negotiate
  Speed: Operational 1000 Mbps, Administrative Auto Negotiate
  De-bounce: State is Enabled, interval is 2 seconds
  Link: Operational Secondary Link Selected,
        Administrative Link Selected Automatically
  Link Failover Timeout: Operational 652 ms, Administrative default
  Primary link selected 6302 times, Secondary link selected 6302 times
  Primary link signal detected, Secondary link signal detected

  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec

  In: Bytes 0, Unicast 0
      Multicast 0, Broadcast 0
      Errors 0, Discards 0, Mac Errors 0, Alignment 0
      CRC 0, Too Longs 0, Symbol Errors 0
  Out: Bytes 0, Unicast 0
      Multicast 0, Broadcast 0
      Errors 0, Discards 0, Mac Errors 0, Deferred 0, No Carrier 0
      Collisions: Single 0, Multiple 0, Late 0, Excessive 0
  ARP Statistics:
    In: ARP requests 0, ARP responses 0
        Errors 0, Discards 0
    Out: ARP requests 0, ARP responses 0
        Errors 0, Discards 0
  Administrative qos-shaping-mode: none
  Operational qos-shaping-mode: none

queue 0: traffic class control, bound to GigabitEthernet10/2
  Queue length 0 bytes

```

```

Forwarded packets 0, bytes 0
Dropped committed packets 0, bytes 0
Dropped conformed packets 0, bytes 0
Dropped exceeded packets 0, bytes 0

```

- See show interfaces.

show ip mac-validate interface

- Use to display the status of the MAC address validation on the physical interface.
- Field descriptions
 - FastEthernet *interfaceSpecifier*—On the ERX-14xx models, ERX-7xx models, and ERX-310 router, the Fast Ethernet or Gigabit Ethernet interface *slot/port*; on the E120 and E320 routers, the Gigabit Ethernet or 10-Gigabit Ethernet interface *slot/adaptor/port*
 - Keyword assigned to interface—Options: Strict or Loose
 - Address—IP address of the entry
 - Hardware Addr—Physical (MAC) address of the entry
- Example

```

host1:boston#show ip mac-validate interface fastEthernet 11/0
FastEthernet11/0: Strict

      Address      Hardware Addr
      3.3.3.3      0090.1a30.3365
      4.4.4.4      0090.1a30.3368

```

- See show ip mac-validate interface.

Chapter 6

Managing Tunnel-Service and IPSec-Service Interfaces

This chapter describes how to configure tunnel-server ports, tunnel-service interfaces, and IPSec-service interfaces on E-series routers.

This chapter contains the following sections:

- Tunnel-Service and IPSec-Service Overview on page 215
- Tunnel-Service Interface Platform Considerations on page 217
- Redundancy and Interface Distribution of Tunnel-Service Interfaces on page 221
- Tunnel-Service Interface Considerations on page 223
- Configuring Tunnel-Server Ports and Tunnel-Service Interfaces on page 225
- Monitoring Tunnel-Service Interfaces on page 228

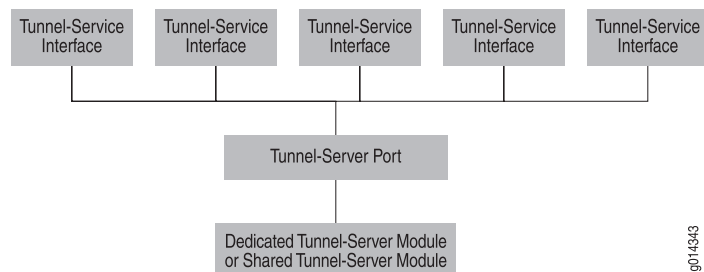
Tunnel-Service and IPSec-Service Overview

Tunnels provide a way of transporting datagrams between routers that do not support the same protocols. Often, these routers are separated by networks.

To configure tunneling, you must identify the tunnel-server ports that reside on modules that support tunnel services. You can then assign the tunnel-service interfaces that encapsulate protocols and enable them to be tunneled across the network.

Figure 13 on page 215 displays the interface stacking for tunnel-service interfaces on a tunnel-server module.

Figure 13: Interface Stacking for Tunnel-Service Interfaces



9014343

This section describes the types of tunnel-server ports that you can configure on tunnel-server modules and the types of tunnel-service interfaces that you can run on these ports.

Types of Tunnel-Server Ports

E-series routers support two types of tunnel-server ports: *dedicated* tunnel-server ports and *shared* tunnel-server ports.

Dedicated Tunnel-Server Ports

Dedicated tunnel-server ports are virtual ports that are always present on dedicated tunnel-server modules. These modules offer only tunnel services; they do not offer access services.

Shared Tunnel-Server Ports

Shared tunnel-server ports are virtual ports that are always present on certain E-series line modules that provide tunnel services in addition to regular access services. You can configure the shared tunnel-server port to use a portion of the module's bandwidth to provide tunnel services.

Shared tunnel-server ports offer the following benefits:

- Greater flexibility in deploying tunnel servers

You can use a shared tunnel-server module to provide tunnel services as an alternative to using a dedicated tunnel-server module.

- Cost savings

If you have limited tunnel-server processing needs, you can provide tunnel services on a single available port of a shared tunnel-server module instead of having to allocate the entire bandwidth of a dedicated tunnel-server module for this purpose.

Types of Tunnel-Service Interfaces

You can configure the following types of tunnel-service interfaces using dedicated tunnel-server ports and shared tunnel-server ports:

- Static IP interfaces that you configure and delete

Static IP interfaces include DVMRP and GRE tunnels. You must assign interfaces on other line modules to act as source endpoints for these tunnels. For information about configuring these tunnels, see *Configuring IP Tunnels* in *JUNOS IP Services Configuration Guide*.

- Dynamic interfaces associated with an L2TP LNS session

The router establishes dynamic interfaces when required and removes the interfaces when they are not required. For information about applications that

use these dynamic interfaces, see *L2TP Overview* in *JUNOS Broadband Access Configuration Guide* .

- Secure IP tunnels

IPSec-service modules are associated with secure IP tunnels. You must 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 adds and removes tunnels when required. For information about configuring secure IP tunnels, see *Configuring IPSec* in *JUNOS IP Services Configuration Guide* .

Tunnel-Service Interface Platform Considerations

You can configure tunnel-service interfaces on the following E-series routers:

- E120 router
- E320 router
- ERX-1440 router
- ERX-1410 router
- ERX-710 router
- ERX-705 router
- ERX-310 router

This section describes the line modules, I/O modules, and I/O adapters (IOAs) that support tunnel-service interfaces.

For detailed information about the modules that support tunnel-service interfaces on the ERX-14xx models, ERX-7xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed specifications of these modules.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the protocols and applications that tunnel-service modules support.

For detailed information about the modules that support tunnel-service interfaces on the E120 router and the E320 router:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed specifications of these modules.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the protocols and applications that tunnel-service modules support.

Supported Modules for Dedicated Tunnel-Server Ports

All E-series routers support dedicated tunnel-server ports; however, the supported modules depend on the type of E-series router that you have.

ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router

ERX-7xx models, ERX-14xx models, and the ERX-310 router all support Service Modules (SMs) and IPSec Service Modules (ISMs).

Unlike other line modules, SMs and ISMs do not pair with corresponding I/O modules that provide ingress and egress ports. Instead, they receive data from and transmit data to other line modules with ingress and egress ports.

See *JUNOS Release Notes, Appendix A, System Maximums* for information about the number of tunnels and sessions that each module supports.

E120 Router and E320 Router

The E120 router and the E320 router support the ES2-S1 Service IOA and ES2 4G line module (LM) combination.

Unlike SMs and ISMs, you must install the ES2-S1 Service IOA with the ES2 4G LM to use dedicated tunnel-server ports. The ES2-S1 Service IOA does not have ingress and egress ports, but it conditions the ES2 4G LM to receive and transmit data to other line modules.

See *JUNOS Release Notes, Appendix A, System Maximums* for information about the number of tunnels and sessions that the ES2-S1 Service IOA supports.

Supported Modules for Shared Tunnel-Server Ports

Most E-series routers support shared tunnel-server ports; however, the supported modules depend on the type of E-series router that you have.

See *JUNOS Release Notes, Appendix A, System Maximums* for information about the number of tunnels and sessions that each module supports.

ERX-14xx Models and the ERX-310 Router

The ERX-1440 router and the ERX-310 router support line modules on which you can use shared tunnel-server ports. The following module combinations offer tunnel services in addition to regular access services:

- GE-2 line module with the GE-2 APS I/O module installed
- GE-HDE line module with the GE-2 SFP I/O module installed
- GE-HDE line module with the GE-8 I/O module installed

E120 Router and E320 Router

The E120 router and the E320 router support shared tunnel-server ports on the following line module and IOA combinations:

- ES2 4G LM with the ES2-S1 GE-4 IOA
- ES2 4G LM with the ES2-S1 GE-8 IOA
- ES2 4G LM with the ES2-S1 10GE IOA
- ES2 4G LM with OCx/STMx ATM IOAs
- ES2 4G LM with OCx/STMx POS IOAs

Numbering Scheme

When configuring or managing tunnel-server ports, you must know the numbering scheme for identifying the physical location of the port in the E-series router. The numbering scheme depends on the type of E-series router that you have.

ERX-7xx Models, ERX-14xx Models, and the ERX-310 Router

Use the *slot/port* format to identify dedicated and shared tunnel-server ports.

- *slot*—Number of the slot in which the tunnel-server module resides in the chassis

In ERX-7xx models, line module slots are numbered 2-6; slots 0 and 1 are reserved for SRP modules. In ERX-14xx models, line module slots are numbered 0-5 and 8-13; slots 6 and 7 are reserved for SRP modules. In an ERX-310 router, line module slots are numbered 1-2; slot 0 is reserved for the SRP module.

- *port*—Number of the port on the tunnel-server module

For more information about identifying the port number on a tunnel-server port, see “Configuring Tunnel-Server Ports and Tunnel-Service Interfaces” on page 225.

For information about installing tunnel-server modules in ERX routers, see *ERX Hardware Guide, Chapter 4, Installing Modules*.

E120 Router and E320 Router

Use the *slot/adaptor/port* format to identify dedicated and shared tunnel-server ports.

- *slot*—Number of the slot in which the line module resides in the chassis

In the E120 router, line module slots are numbered 0-5. In the E320 router, line module slots are numbered 0-5 and 11-16. For both routers, slots 6 and 7 are reserved for SRP modules; slots 8-10 are reserved for switch fabric modules (SFMs).

- *adapter*—Number of the bay in which the I/O adapter (IOA) resides

This identifier applies to the E120 and E320 routers only. Dedicated tunnel-server ports are supported on the ES2-S1 Service IOA, which is a full-height IOA and is identified in the software as adapter 0. Shared tunnel-server ports reside on a virtual adapter that is identified in the software as adapter 2.

- *port*—Number of the port on the IOA

For more information about identifying the port number on a tunnel-server port, see “Configuring Tunnel-Server Ports and Tunnel-Service Interfaces” on page 225.

For information about installing tunnel-server modules in the E120 and E320 routers, see *E120 and E320 Hardware Guide, Chapter 4, Installing Modules*.

Interface Specifier

The configuration task examples in this chapter use the format for ERX-7xx models, ERX-14xx models, and the ERX-310 router to specify a tunnel-server port. (The format is described in “Numbering Scheme” on page 219.)

For example, the following command specifies a dedicated tunnel-server port on port 0 of a tunnel-server module in slot 4.

```
host1(config)#tunnel-server 4/0
```

When you configure a tunnel-server port on an E120 router or an E320 router, you must include the adapter identifier as part of the interface specifier. For example, the following command specifies a dedicated tunnel-server port on port 0 of an ES2-S1 Service IOA installed in both the upper and lower bays of slot 3. (When a full-height IOA is installed in the E120 router or the E320 router, it is identified in the software by the upper adapter bay 0.)

```
host1(config)#tunnel-server 3/0/0
```

For more information about interface types and specifiers on E-series models, see Interface Types and Specifiers in *JUNOS Command Reference Guide*.

Supported Applications for Dedicated and Shared Tunnel-Server Ports

Dedicated and shared tunnel-server ports provide support for some or all of the following applications and services, depending on the capabilities of the tunnel-server module on which the port resides:

- Distance Vector Multicast Routing Protocol (DVMRP) tunnels, also known as IP-in-IP tunnels
- Generic routing encapsulation (GRE) tunnels
- IPSec (on ISMs only)
- Layer 2 Tunneling Protocol (L2TP) network server (LNS) support
- IP packet reassembly for tunnels
- Network Address Translation (NAT)



NOTE: Support for IP reassembly and NAT services on shared tunnel-server ports depends on the capabilities of the module on which the shared tunnel-server port resides.

For a list of applications and services that dedicated and shared tunnel-server modules support on ERX-7xx models, ERX-14xx models, and the ERX-310 router, see *ERX Module Guide, Appendix A, Module Protocol Support*.

For a list of applications and services that dedicated tunnel-server modules support on the E120 and E320 routers, see *E120 and E320 Module Guide, Appendix A, IOA Protocol Support*.

Redundancy and Interface Distribution of Tunnel-Service Interfaces

The redundancy and distribution mechanisms supported for tunnel-service ports configured on ISMs differ from those supported for SMs, the ES2-S1 Service IOA, and shared tunnel-server ports.

This section describes the redundancy and interface distribution mechanisms for all tunnel-server ports.

SMs, ES2-S1 Service IOA, and Shared Tunnel-Server Modules

You can install multiple modules to provide redundancy. If you install multiple modules at the same time, the router automatically distributes the tunnel-service interfaces over the modules in proportion to the available tunnel-service interfaces.

Even distribution of tunnel-service interfaces is not critical to router performance. However, the number of modules that you install must be able to support the extra tunnel if one of the modules becomes unavailable.



NOTE: When both dedicated tunnel-server ports (on SMs) and shared tunnel-server ports (on shared tunnel-server modules) are configured on ERX-7xx models, ERX-14xx models, and the ERX-310 router, the router performs load balancing across all available server ports of the same type. For this purpose, dedicated tunnel-server ports (on SMs) and shared tunnel-server ports (on shared tunnel-server modules) are considered one type of server port, whereas server ports on ISMs are considered a different type.

Interface allocation depends on the types of tunnel-service interface created on the router. For more information about the types of tunnel-service interfaces, see “Types of Tunnel-Service Interfaces” on page 216 .

Static IP Tunnel-Service Interfaces

You can configure and delete static IP tunnel-service interfaces.

When you configure a static tunnel-service interface, the router automatically assigns that interface to a particular module. If that module becomes unavailable, the router attempts to reassign the interface to an available module. If no module is currently available, the router keeps track of the interface and assigns it to a module when one become available.

Consequently, if you reinstall a module that was formerly unavailable or removed, the distribution of static tunnel-service interfaces over the modules might be uneven. Because users create and remove static tunnels, the distribution might remain uneven indefinitely.

Dynamic Tunnel-Service Interfaces

The router dynamically creates and deletes dynamic tunnel-service interfaces as dictated by the operation of the relevant protocols. Currently, L2TP sessions are the only dynamic tunnel-service interfaces available.

When the router creates a dynamic tunnel-service interface, it assigns that interface to a particular module. If that module becomes unavailable, the router removes the interface. If the initiator of the dynamic interface requests its reestablishment, the router recreates the dynamic tunnel service interface and assigns it to an available module.

Going forward, if you reinstall a module that was formerly unavailable or removed, the router deletes unwanted dynamic tunnel-service interfaces and creates new ones for applications on other modules. Gradually, the distribution of dynamic tunnel-service interfaces on the modules becomes even.

Interface Allocation for Shared Tunnel-Server Modules

When determining how to distribute interfaces across tunnel-server ports, the E-series router does not perform interface policing to prevent the access services of a shared tunnel-server module from depriving the tunnel services of the requisite interface resources (and vice-versa). We recommend that when provisioning shared tunnel-server ports, you restrict the number of interfaces configured for both access and tunnel services to prevent competition between them.

For example, when paired with the ES2-S1 OC3-8/STM1 IOA or the ES2-S1 GE-4 IOA, the ES2 4G LM on the E320 router can support a maximum of 16,000 access interfaces and 8,000 shared tunnel-server interfaces, both of which must compete for the overall supported maximum of 16,000 interface columns.

For tunneling, PPP, and IP maximums, see *JUNOS Release Notes, Appendix A, System Maximums*.

ISMs

You can install multiple ISMs to provide redundancy. If you install multiple ISMs at the same time, the router automatically distributes ISM interfaces over the modules in proportion to the available ISM interfaces.

Even distribution of ISM interfaces is not critical to router performance. However, the number of ISMs that you install must be able to support the extra tunnels if one of the modules becomes unavailable.

When you configure a static IPsec interface, the router automatically assigns that interface to a particular ISM. If that ISM becomes unavailable, the interface becomes not present (operational state down).

The router then manages the interface as follows:

- If the interface's local IP address (tunnel source) is less than the remote IP address (tunnel destination), the router attempts to reassign the interface to an available ISM. If the reassignment is successful, the router immediately initiates an IPSec negotiation, also known as *rekeying* the interface.
- If the interface's local IP address is greater than the remote IP address, the router attempts to reassign the interface to an available ISM. If the reassignment is successful, the router waits 3 minutes before initiating an IPSec negotiation.

In either case, the interface becomes available (operational state up) when the rekeying operation is completed successfully. If the rekeying operation fails for reasons such as an unreachable remote end or a policy mismatch, the router waits a certain number of minutes and then tries again.

The wait time increases after each unsuccessful rekeying attempt, and follows a progressive pattern. This pattern gradually increases in intervals, starting at 1 minute and reaching a maximum interval of 60 minutes. The 60-minute interval repeats indefinitely. When the rekeying operation is completed successfully, the pattern starts again.

If no ISM is available to which the router can reassign the interface, the interface remains in the not present state until an ISM becomes available. As a result, the distribution of dedicated ISM interfaces over the modules might become uneven.

Tunnel-Service Interface Considerations

To configure a tunnel-server port, you assign the maximum number of tunnel-service interfaces to run on the specified tunnel-server port. This process is referred to as *provisioning*. Conversely, the process of reducing the maximum number of tunnel-service interfaces on a tunnel-server port to zero is referred to as *unprovisioning* the port.

This section describes the considerations for provisioning and unprovisioning tunnel-service interfaces on dedicated and shared tunnel-server ports.

For instructions on how to provision and unprovision tunnel-service interfaces, see “Configuring Tunnel-Server Ports and Tunnel-Service Interfaces” on page 225 .

Provisioning Tunnel-Service Interfaces

By default, dedicated tunnel-server ports are configured to have the maximum number of tunnel-service interfaces that the dedicated tunnel-server module supports. You can reduce the maximum number of interfaces or completely unprovision the port by issuing the **max-interfaces** command.

By default, shared tunnel-server ports are configured to have no tunnel-service interfaces. To provision tunnel-service interfaces on shared tunnel-server ports, you must provision the port by assigning a nonzero maximum number of tunnel-service interfaces to run on the port by issuing the **max-interfaces** command.

Bandwidth Limitations of Shared Tunnel-Server Ports

Bandwidth limitations for shared tunnel-server ports and tunnel-service interfaces depend on bandwidth restrictions, if any, that are in effect for the module on which the shared tunnel-server port resides.

Exchanging Tunnel-Server Modules

Tunnel-server modules are available in different hardware revisions that support varying numbers of tunnel-service interfaces. For more information about determining the hardware revision on a module, see *ERX Module Guide, Table 1, Module Combinations*, or *E120 and E320 Module Guide, Table 1, Modules and IOAs*.

When you exchange a tunnel-server module with a lower capacity for tunnel-service interfaces with a module that supports a higher capacity, the tunnel-server port maintains the original number of provisioned tunnel-service interfaces. By using the **all-available** keyword with the **max-interfaces** command, you can configure the tunnel-server port to automatically adjust the number of provisioned tunnel-service interfaces to the maximum value supported by the new module.

When you exchange a tunnel-server module that has a higher number of provisioned interfaces than the new module's capacity, the module adjusts the provisioned number of interfaces to the maximum value that the module supports.

Table 25 on page 224 displays sample capacity, configuration, and utilization values for exchanging tunnel-server modules with different capacities.

Table 25: Sample Capacity, Configuration, and Utilization Values for Tunnel-Service Interfaces

Old Capacity	Old Provisioned Interfaces (max-interfaces command)	Old Utilization	New Capacity	New Provisioned Interfaces (max-interfaces command)	New Utilization
8000	5000	5000	16,000	5000	5000
8000	8000	8000	16,000	8000	8000
8000	all-available	8000	16,000	all-available	16,000
16,000	5000	5000	8000	5000	5000
16,000	16,000	16,000	8000	8000	8000
16,000	all-available	16,000	8000	all-available	8000

Unprovisioned Tunnel-Service Interfaces

Tunnel-server ports exist whether or not they have been configured. This means that you cannot delete a tunnel-server port from a module. However, you can unprovision

all of the tunnel-service interfaces on a tunnel-server port by issuing the **no max-interfaces** command or the **no tunnel-server** command.

You can also restore the default configuration by issuing the **default max-interfaces** command. On dedicated tunnel-server ports, the default configuration is the maximum number of interfaces that the port supports. On shared tunnel-server ports, the default configuration is zero tunnel-service interfaces.



NOTE: If the module on which the tunnel-server port resides supports IP reassembly or NAT services, these services become enabled when you provision tunnel-service interfaces on the port. However, when you unprovision tunnel-service interfaces to zero, only IP reassembly is disabled and NAT remains configured in the current release.

Configuring Tunnel-Server Ports and Tunnel-Service Interfaces

This section describes the tasks associated with configuring a tunnel-server port and tunnel-service interface.

Identifying the Physical Location of the Tunnel-Server Port

To display the physical location of the dedicated tunnel-server port on your module, issue the **show tunnel-server config** command.

```
host1#show tunnel-server config
                        Server Ports
                        -----
```

Port	Type	MaximumInterfaces	Provisioned Interfaces	HwPresent
Port 2/2	shared	8000	0	yes
Port 8/0	dedicated	16000	8000	yes

Provisioning the Maximum Number of Interfaces on a Tunnel-Server Port

To provision the maximum number of interfaces on a tunnel-server port:

1. From Global Configuration mode, specify the location of the dedicated tunnel-server port that you want to configure.

On a dedicated tunnel-server port:

```
host1(config)#tunnel-server 8/0
host1(config-tunnel-server)#
```

On a shared tunnel-server port:

```
host1(config)#tunnel-server 2/2
host1(config-tunnel-server)#
```

This command accesses Tunnel Server Configuration mode.

2. Provision the maximum number of tunnel-service interfaces to be used on the dedicated tunnel-server port.

```
host1(config-tunnel-server)#max-interfaces all-available
```



NOTE: When you issue the **tunnel-server** command, ensure that you specify the same interface specifier that was displayed for this tunnel-server port in the **show tunnel-server config** command in the output described in “Identifying the Physical Location of the Tunnel-Server Port” on page 225. If you specify an incorrect location for the tunnel-server port, the router displays an error message and rejects the command as invalid.

Verifying the Tunnel-Server Interface Configuration

To verify that you properly provisioned the number of tunnel-server interfaces on the tunnel-server port:

1. From Tunnel Server Configuration Mode, return to Privileged Exec mode.

```
host1(config-tunnel-server)#exit
host1(config)#exit
host1#
```

2. Issue the **show tunnel-server config** command.

```
host1#show tunnel-server config
```

		Server Ports		

Port	Type	MaximumInterfaces	Provisioned Interfaces	HwPresent
-----	-----	-----	-----	-----
Port 2/2	shared	8000	5000	yes
Port 8/0	dedicated	16000	all-available	yes

For more information about using the **show tunnel-server** command, see “Monitoring Tunnel-Service Interfaces” on page 228.

Unprovisioning Tunnel-Service Interfaces

To unprovision the tunnel-service interfaces on a tunnel-server port, use any of the following commands, all of which have the same effect:

- Issue the **no max-interfaces** command from Tunnel Server Configuration mode.

```
host1(config-tunnel-server)#no max-interfaces
```

- Issue the **max-interfaces 0** command from Tunnel Server Configuration mode.

```
host1(config-tunnel-server)#max-interfaces 0
```

- Issue the **no tunnel-server** command from Global Configuration mode. This command unprovisions the tunnel-service interfaces on the specified tunnel-server port but does *not* delete the port itself.

```
host1(config)#no tunnel-server 2/2
```

max-interfaces

- Use from Tunnel Server Configuration mode to provision the maximum number of tunnel-service interfaces to be used on a tunnel-server port.
- Specify an integer in the range 0–16000 to provision the maximum number of tunnel-service interfaces.
- Use the **all-available** keyword to provision the maximum number of tunnel-service interfaces to match the maximum value that the tunnel-server module supports.
- Examples

```
host1(config-tunnel-server)#max-interfaces 5000
host1(config-tunnel-server)#max-interfaces all-available
```

- Use the **default** version to restore the default configuration. On dedicated tunnel-server ports, the default configuration is the maximum number of tunnel-service interfaces that the tunnel-service module supports (**all-available**). On shared tunnel-server ports, the default configuration is zero tunnel-server interfaces.
- Use the **no** version to reduce the number of provisioned tunnel-service interfaces to zero. Issuing the **no max-interfaces** command has the same effect as issuing the **max-interfaces 0** command.
- See max-interfaces.

tunnel-server

- Use from Global Configuration mode to specify the physical location of the tunnel-server port that you want to configure.
- The **tunnel-server** command accesses Tunnel Server Configuration mode, which enables you to provision the maximum number of tunnel-service interfaces to be used on the tunnel-server port.
- For ERX-7xx models, ERX-14xx models, and the ERX-310 router, use the *slot/port* format.
- For the E120 router and the E320 router, use the *slot/adaptor/port* format. On dedicated tunnel-server ports, use adaptor 0 and port 0. On shared tunnel-server ports, use adaptor 2 and port 0.
- Example

```
host1(config)#tunnel-server 12/2
```

- Use the **default** version to restore the default configuration. On dedicated tunnel-server ports, the default configuration is the maximum number of

tunnel-service interfaces that the tunnel-service module supports. On shared tunnel-server ports, the default configuration is zero tunnel-service interfaces.

- Use the **no** version to reduce the number of provisioned tunnel-service interfaces to zero.
- See tunnel-server.

Monitoring Tunnel-Service Interfaces

You can monitor tunnel-service interfaces by using the **show tunnel-server** command.



NOTE: The E120 router and E320 router output for **monitor** and **show** commands is identical to output from other E-series routers, except that the E120 and E320 router output also includes information about the adapter identifier in the interface specifier (*slot/adapter/port*).

show tunnel-server

- Use to display status and configuration information for dedicated and shared tunnel-server ports and tunnel-service interfaces configured on the router. Unconfigured tunnel-server ports are not displayed in the output.
- You can display information for a specific tunnel-server port or for all tunnel-server ports.
- Use the optional **config** keyword to display information about available and provisioned tunnel-service interfaces on each port, and to indicate whether modules that support the use of dedicated or shared tunnel-server ports are currently installed in the router.
- Field descriptions
 - Port:Appl—Identifier in *slot/port* or *slot/adapter/port* format for the module or tunneling application
 - slot—Number of the slot in the chassis where the module resides
 - adapter—Number of the bay in which the I/O adapter (IOA) resides.

This identifier applies only to dedicated and shared tunnel-server ports configured on the E120 and E320 routers. Dedicated tunnel-server ports are always adapter 0; shared tunnel-server ports are always adapter 2.
 - port—Number of the tunnel-server port on the module; for dedicated tunnel-server ports, this is a virtual port number that is always 0; for shared tunnel-server ports, this is a virtual port number dynamically assigned by the router
 - Card Type or Active Type—Type of port: dedicated or shared
 - Oper State or Max State—Physical state of the port or application
 - up—Port or application is available
 - down—Port or application is unavailable

- present—Module associated with this port is installed
- not present—Module associated with this port has been removed
- pending—Router has not yet detected all previously configured modules during a reboot or initial installation of the module
- Active Interfaces or Interfaces—Number of tunnel-service interfaces currently configured on this port
- Max Interfaces—Total number of tunnel-service interfaces available on this module
- Fill—Percentage of available interfaces used by a server port, an application on a server port, an application on all server ports, and all server ports
- Appl Totals—Statistics for each application
- Server Ports—Displays configuration information about dedicated and shared tunnel-server ports on the router; this display format appears only when the **config** keyword is specified
 - Port—Identifier in *slot/port* format (ERX-7xx models, ERX-14xx models, and ERX-310 routers) or *slot/adapter/port* format (E120 and E320 routers) for the module on which the tunnel-server port resides
 - Type—Type of tunnel-server port: dedicated or shared
 - MaximumInterfaces—Total number of tunnel-service interfaces available on this module
 - Provisioned Interfaces—Total number of tunnel-service interfaces currently provisioned on this port
 - HwPresent—Indicates whether a module that supports the specified tunnel-server port is currently installed in the router: yes or no
- Example 1—Displays information about a dedicated tunnel-server port on an SM

host1#show tunnel-server

Port:Appl	Card Type	Oper State	Active Interfaces	Max Interfaces	Fill
Port 8/0	dedicated	present	1	8000	0.0%
ipsec-tunnel		down	0	0	0.0%
ipsec-transport		down	0	0	0.0%
12tp		up	0	8000	0.0%
gre/dvmrp		up	1	4000	0.0%
Appl Totals					
ipsec-tunnel			0	0	0.0%
ipsec-transport			0	0	0.0%
12tp			0	8000	0.0%
gre/dvmrp			1	4000	0.0%
total			2	12000	0.0%

- Example 2—Displays information about a dedicated tunnel-server port on an ISM

```
host1#show tunnel-server
```

Port:App1	Card Type	Oper State	Active Interfaces	Max Interfaces	Fill
Port 2/0	dedicated	present	1	8000	0.0%
ipsec-tunnel		up	0	0	0.0%
ipsec-transport		down	0	0	0.0%
l2tp		down	0	8000	0.0%
gre/dmmp		up	1	4000	0.0%
App1 Totals					
ipsec-tunnel			0	0	0.0%
ipsec-transport			0	0	0.0%
l2tp			0	16000	0.0%
gre/dmmp			2	8000	0.0%
total			2	16000	0.0%

- Example 3—Displays information about a specific shared tunnel-server port

```
host1#show tunnel-server 2/2
```

Port:App1	Card Type	Oper State	Active Interfaces	Max Interfaces	Fill
Port 2/2	shared	present	0	4000	0.0%
ipsec-tunnel		down	0	0	0.0%
ipsec-transport		down	0	0	0.0%
l2tp		up	0	4000	0.0%
gre/dmmp		up	0	4000	0.0%

- Example 4—Displays configuration information about dedicated and shared tunnel-server ports

```
host1#show tunnel-server config
```

Server Ports				
Port	Type	MaximumInterfaces	Provisioned Interfaces	HwPresent
Port 2/2	shared	8000	4000	yes
Port 8/0	dedicated	16000	16000	yes

- See show tunnel-server.

Part 2

Index

- Index on page 233

Index

Symbols

- 10-Gigabit Ethernet interfaces
 - modules.....191
 - specifying an interface.....201
- 4xDS3 ATM I/O modules.....48

A

- Address Resolution Protocol. *See* ARP
- all option (show controllers).....29, 64
- aps commands.....89
 - aps events.....94
 - aps force.....95
 - aps group.....89
 - aps lockout.....89
 - aps manual.....96
 - aps protect.....89
 - aps revert.....93
 - aps unidirectional.....93
 - aps working.....89
- See also* show aps commands
- APS/MSP (Automatic Protect Switching/Multiplex Section Protection)
 - automatic switchover.....73
 - channel numbers.....81, 117
 - communication methods.....75
 - configuration example.....93
 - configuring.....89, 119
 - events.....94
 - K1 byte.....76
 - K2 byte.....75
 - manual switchover.....73, 95
 - monitoring.....106, 172
 - overview.....109
 - protect interface.....73, 81, 89, 117
 - reversion after switchover.....75
 - switching mechanisms.....73
 - working interface.....73, 81, 89, 117
- ARP (Address Resolution Protocol).....175
- Automatic Protect Switching. *See* APS/MSP

B

- baseline commands
 - baseline interface.....205
 - baseline interface serial
 - channelized T3 interfaces.....29
 - cOCx/STMx interfaces.....153
 - E3/T3 interfaces.....64
 - baseline line interface sonet.....98, 153
 - baseline path interface sonet.....98, 153
 - baseline section interface sonet.....98, 153
- BERT (bit error rate test) patterns
 - channelized T3 interfaces.....9, 23
 - cOCx/STMx interfaces.....117, 146
 - E3/T3 interfaces.....50, 61
- bert command
 - channelized T3 interfaces.....23
 - E3/T3 interfaces.....61
- bit error rate test patterns. *See* BERT patterns

C

- cable length
 - specifying.....11, 54
- cablelength commands
 - cablelength.....11, 54
- cell scrambling
 - E3.....54
 - T3.....54
- channel numbers, APS/MSP interfaces.....81, 117
- channel-group commands. *See* path ds1 | e1
- commands
- channelized OCx/STMx interfaces. *See* cOCx/STMx interfaces
- channelized T3 interfaces
 - bert command.....23
 - configuring.....10, 23
 - configuring HDLC channel.....20
 - equipment loopback command.....23
 - loopback command.....23
 - monitoring parameters.....29
 - numbering scheme.....7, 8
 - references.....9
 - testing.....23

clock commands	
clock source	
channelized T3 interfaces.....	13, 23
cOCx/STMx interfaces.....	119, 125
E3/T3 interfaces.....	54, 61
OCx/STMx interfaces.....	84
clock source, selecting	
channelized T3 interfaces.....	13, 14
cOCx/STMx interfaces.....	133
E1 interfaces on cOCx/STMx.....	125
E3/T3 interfaces.....	54
OCx/STMx interfaces.....	84, 119
T1 interfaces on cOCx/STMx.....	125
T3 interfaces on cOCx/STMx.....	130
COCX-F3 line modules.....	47
cOCx/STMx interfaces	
configuring HDLC channel.....	139
configuring T1/E1.....	124
loopback.....	61, 145
monitoring.....	153
numbering scheme.....	117
references.....	117
testing.....	145, 148
configuring. <i>See</i> specific feature, product, or protocol	
connectivity in SONET/SDH paths.....	97, 152
control traffic for high-density Ethernet.....	196
controller commands	
controller e3.....	51, 52
controller sonet.....	84, 120
controller t3.....	10, 14, 51, 52
conventions	
notice icons.....	xix
text and syntax.....	xx
counters	
channelized T3 interfaces.....	29
E3/T3 interfaces.....	64
CRC (cyclic redundancy check)	
channelized T3 interfaces.....	20
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
crc command	
channelized T3 interfaces.....	20
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
CT3/T3 12 I/O modules.....	48
CT3/T3 12 line modules.....	6
CT3/T3-F0 line modules.....	48
customer support.....	xxi
contacting JTAC.....	xxi
cyclic redundancy check. <i>See</i> CRC	

D

data stream inversion, enabling	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
debounce command.....	199
debounce-interval command.....	200
dedicated tunnel-server ports	
configuring.....	225
supported applications.....	219
supported modules.....	217
description command	
channelized T3 interfaces.....	13
E3/T3 interfaces.....	54
unchannelized SONET interfaces.....	84, 120
description, interface	
channelized T3 interfaces.....	13, 14
cOCx/STMx interfaces.....	124, 125, 130, 133
E3/T3 interfaces.....	54
serial interfaces.....	21, 59, 139
unchannelized SONET interfaces.....	84, 120
Distance Vector Multicast Routing Protocol. <i>See</i>	
DVMRP tunnels	
documentation set	
comments on.....	xxi
DS0 timeslots	
channelized T3 interfaces.....	16
cOCx/STMx interfaces.....	116, 125, 133
DS1. <i>See</i> T1 entries	
ds3-scramble command.....	54
DS3. <i>See</i> T3 entries	
dsu commands	
dsu bandwidth.....	56
dsu mode.....	56
duplex command.....	200
DVMRP tunnels.....	216
dynamic tunnel-server ports	
applications supported.....	220
overview.....	217
unprovisioning.....	225
dynamic tunnel-service interfaces	
monitoring.....	228
overview.....	216

E

E1 channels	
cOCx/STMx interfaces.....	124
E1 interfaces. <i>See</i> cOCx/STMx interfaces	
E120 and E320 routers	
Ethernet interfaces.....	176
tunnel-service interfaces.....	217
E120 routers.....	77, 176
E3 interfaces	
configuring controllers.....	51
configuring HDLC channel.....	57

- loopback command.....61
 - monitoring interfaces.....64
 - references.....50
- e3-scrumble command.....54
- E320 routers.....77, 176, 217
 - 100 Gbps fabric.....80, 191
 - 120 Gbps fabric.....80
 - 320 Gbps fabric.....80, 191
 - SONET/SDH interfaces.....77
- equipment loopback command
 - channelized T3 interfaces.....23
 - T3 interfaces.....61
- ES2 10G ADV line module (LM).....187
- ES2 10G line module (LM).....186, 189, 193, 194
- ES2 10G Uplink line module (LM).....192
- ES2 4G line module (LM).....80, 182, 191
- ethernet description command.....200
- Ethernet interfaces
 - commands.....205
 - ethernet description.....200
 - interface fastEthernet.....201
 - interface gigabitEthernet.....201
 - interface tenGigabitEthernet.....201
 - See also* show commands
 - configuring.....198
 - debounce, enabling.....199
 - debounce-interval, modifying.....200
 - disabling interfaces.....204
 - duplex type.....200
 - high-density.....196
 - IEEE 802.3ae.....175, 191
 - line speed.....204
 - MAC address validation.....201
 - monitoring.....205
 - numbering scheme.....177, 219
- events
 - APS/MSP.....94

F

- facilities data link. *See* FDL
- Fast Ethernet interfaces
 - modules.....178
 - specifying an interface.....201
- FDL (facilities data link)
 - cOCx/STMx interfaces.....109
 - monitoring statistics.....168
 - T1 channel over DS3, configuring.....133
 - T1 over VT, configuring.....125
 - T1 channels on channelized T3 interfaces.....3
 - configuring.....16
 - monitoring statistics.....38
- filtering
 - show displays.....29, 64, 153
- fractional T1/E1.....8
- fractional T3.....56

- framing command
 - channelized T3 interfaces.....13
 - E3/T3 interfaces.....55
 - framing format
 - channelized T3 interfaces.....13, 16
 - cOCx/STMx interfaces.....125, 130
 - E3/T3 line.....55

G

- Generic Routing Encapsulation. *See* GRE tunnels
- Gigabit Ethernet interfaces
 - modules.....179
 - redundant port.....179, 180
 - specifying an interface.....201
- GRE (Generic Routing Encapsulation) tunnels.....216

H

- HDLC channel, configuring
 - channelized T3 interfaces.....20
 - cOCx/STMx interfaces.....139
 - E3/T3 interfaces.....57
- high-density Ethernet
 - overview.....196
 - packet classifier.....196
 - supported modules.....180, 182, 191

I

- idle character
 - channelized T3 interfaces.....20
 - cOCx/STMx interfaces.....125, 139
 - E3/T3 interfaces.....58
- idle-character command
 - channelized T3 interfaces.....20
 - cOCx/STMx interfaces.....125, 139
 - E3/T3 interfaces.....58
- IEEE 802.1w.....195
- IEEE 802.3ae.....175, 191
- IEEE 802.3u.....195
- IEEE 802.3z.....195
- intelligent dropping of packets.....196
- interface commands
 - interface fastEthernet.....201
 - interface gigabitEthernet.....201
 - interface serial
 - channelized T3 interfaces.....21
 - cOCx/STMx interfaces.....139
 - E3/T3 interfaces.....58
 - interface tenGigabitEthernet.....201
- interface description
 - channelized T3 interfaces.....13, 14
 - cOCx/STMx interfaces.....124, 125, 130, 133
 - E3/T3 interfaces.....54

serial interfaces.....	21, 59, 139
unchannelized SONET interfaces.....	84, 120
interface stack	
cOCx/STMx interfaces.....	112
E3/T3 interfaces.....	47
ES2-21 OC48/STM16 POS.....	81
OCx/STMx POS interfaces.....	79
OCx/STMx/DS3-ATM interfaces.....	78
interfaces, monitoring	
channelized T3.....	29
cOCx/STMx	153
E3/T3.....	64
Ethernet.....	205
OCx/STMx	98
internal clocking.....	133
channelized T3 interfaces.....	13
cOCx/STMx interfaces.....	119, 133
E1 interfaces.....	125, 130
E3/T3 interfaces.....	54
OCx/STMx interfaces.....	84
T1 interfaces.....	125, 130
invert data command	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
ip commands	
ip mac-validate.....	201
IP tunnels	
secure.....	216, 221
ISMs (IPSec Service modules)	
monitoring.....	228
redundancy and interface distribution.....	221

K

K1 byte, APS/MSP.....	76
K2 byte, APS/MSP.....	75

L

L2TP (Layer 2 Tunneling Protocol).....	193
L2TP network server. <i>See</i> LNS	
Layer 2 Tunneling Protocol. <i>See</i> L2TP	
line clocking.....	14, 133
channelized T3 interfaces.....	13
cOCx/STMx interfaces.....	119, 133
E1 interfaces.....	125, 130
E3/T3 interfaces.....	54
OCx/STMx interfaces.....	84
T1 interfaces.....	125, 130
line modules	
changing.....	5, 81
line speed.....	204

link commands	
link failover force.....	196
link failover timeout.....	196
link selection.....	196
LNS (L2TP network server)	
termination.....	216
load-interval command	
channelized T3 interfaces.....	21
E3/T3 interfaces.....	58
Ethernet interfaces.....	201
local loopback	
channelized T3 interfaces.....	23
cOCx/STMx interfaces.....	147
E3/T3 interfaces.....	61
OCx/STMx interfaces.....	96
loopback	
channelized T3 interfaces.....	23
cOCx/STMx interfaces.....	61, 145
E3/T3 interfaces.....	61
T3 interfaces, remote.....	61
loopback command	
channelized T3 interfaces.....	23
cOCx/STMx interfaces.....	148
E3/T3 interfaces.....	61
OCx/STMx interfaces.....	96

M

MAC (media access control) addresses	
validation.....	201
MAC pause frames.....	180
maintenance data link. <i>See</i> MDL	
manual switchover, APS/MSP.....	95
manuals	
comments on.....	xxi
max-interfaces command.....	227
maximum receive unit. <i>See</i> MRU	
maximum transmission unit. <i>See</i> MTU	
MDL (maintenance data link)	
channelized T3 interfaces.....	3
configuring.....	10
monitoring statistics.....	38
T3 interfaces.....	45
configuring.....	52
monitoring statistics.....	65
T3 on cOCx/STMx interfaces.....	109
configuring.....	130
monitoring statistics.....	168
mdl commands	
mdl carrier.....	11, 52
mdl string.....	11, 52
mdl transmit.....	11, 52
monitoring. <i>See</i> specific feature, product, or protocol	
MPLS (Multiprotocol Label Switching)	
fast reroute.....	84, 119

MRU (maximum receive unit)	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
mru command	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
MSP.....	73
MSP (Multiplex Section Protection).....	73, 109
MTU (maximum transmission unit)	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	59
Ethernet interfaces.....	201
mtu command	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	59
Ethernet interfaces.....	201
Multiplex Section Protection. <i>See</i> APS/MSP	
Multiprotocol Label Switching. <i>See</i> MPLS	

N

network loopback	
channelized T3 interfaces.....	23
cOCx/STMx interfaces.....	147
E3/T3 interfaces.....	61
OCx/STMx interfaces.....	96
notice icons.....	xix
numbering scheme	
ASP/MSP.....	81, 117
slot/adaptor/port.....	81, 177, 219
slot/port.....	7, 81, 117, 177, 219

O

OC12 I/O modules.....	78
OC3-2 GE APS I/O module.....	79, 182
OC3-4 I/O modules.....	78, 79
OC3/STM1 GE/FE line module.....	79, 182
OCx/STMx interfaces	
configuring.....	84
disabling.....	84
line modules.....	73
monitoring statistics.....	98
numbering scheme.....	81
path ds3 loopback remote command.....	148
testing.....	96
OCx/STMx POS line modules.....	78, 79
OCx/STMx/DS3-ATM line modules.....	48, 78

P

packet classifier.....	196
------------------------	-----

packets	
intelligently dropping.....	196
path commands	
path.....	120
path description.....	84, 120
path e1 unframed.....	125
path overhead c2.....	84, 120
path overhead j1.....	97, 148
path snmp trap link-status.....	84, 120
path trigger alarm	84, 120
path trigger delay.....	84, 120
path ds1 fdl commands	
path ds1 fdl.....	125
path ds1 fdl carrier.....	125
path ds1 fdl transmit.....	129
path ds1 remote-loopback command.....	151
path ds1 e1 commands	
path ds1 e1.....	124
path ds1 e1 bert.....	146
path ds1 e1 channel-group description.....	125
path ds1 e1 channel-group shutdown.....	125
path ds1 e1 channel-group snmp trap	
link-status.....	125
path ds1 e1 channel-group timeslots.....	125
path ds1 e1 clock source.....	125
path ds1 e1 description.....	124
path ds1 e1 framing.....	125
path ds1 e1 loopback.....	148
path ds1 e1 loopback remote.....	148
path ds1 e1 shutdown.....	130
path ds1 e1 snmp trap link-status.....	125
path ds3 commands	
path ds3.....	130
path ds3 bert.....	146
path ds3 clock source.....	130
path ds3 description.....	130
path ds3 framing.....	130
path ds3 loopback.....	148
path ds3 loopback remote.....	148
path ds3 shutdown.....	130
path ds3 snmp trap link-status.....	130
path ds3 mdl commands	
path ds3 mdl carrier.....	133
path ds3 mdl string.....	133
path ds3 mdl transmit.....	133
path ds3 t1 commands	
path ds3 t1.....	133
path ds3 t1 bert.....	147
path ds3 t1 clock source.....	133
path ds3 t1 description.....	133
path ds3 t1 framing.....	133
path ds3 t1 loopback.....	148
path ds3 t1 loopback remote.....	148
path ds3 t1 remote-loopback.....	148
path ds3 t1 shutdown.....	133

path ds3 t1 snmp trap link-status.....	133
path ds3 t1 timeslots.....	133
path ds3 t1 fdl commands	
path ds3 t1 fdl.....	133
path ds3 t1 fdl carrier.....	133
path ds3 t1 fdl transmit.....	133
pause frames.....	180
payload loopback	
channelized T3 interfaces.....	23
E3/T3 interfaces.....	61
platform considerations	
channelized T3 interfaces.....	5
cOCx/STMx interfaces.....	111
Ethernet interfaces.....	176
tunnel-service interfaces.....	217
unchannelized SONET/SDH interfaces.....	77
unchannelized T3/E3 interfaces.....	47
ports, tunnel-server	
shared.....	216
protect interface, APS/MSP.....	73, 89

R

redundant port, Gigabit Ethernet.....	179, 180
remote loopback	
channelized T3 interfaces.....	23
cOCx/STMx interfaces.....	148
T3 interfaces.....	61
reversion	
after switchover	
APS/MSP.....	75
RSTP (Rapid Spanning Tree Protocol).....	195

S

scramble command.....	57
sdh command.....	88, 123
section layer, SONET/SDH.....	113
secure IP tunnels.....	216, 221
serial description command	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	59
serial interfaces	
configuring	
channelized T3 interfaces.....	21
cOCx/STMx interfaces.....	139
E3/T3 interfaces.....	58
monitoring	
channelized T3 interfaces.....	38
cOCx/STMx.....	172
SFPs (small form-factor pluggable transceivers).....	206, 209
shared tunnel-server ports	
configuring.....	225
overview.....	216

supported applications.....	219
supported modules.....	217
show aps commands	
show aps.....	106
show aps group.....	106
show controllers commands	
show controllers e3.....	65
show controllers sonet.....	99
show controllers sonet configuration.....	153
show controllers sonet ds1 e1.....	159
show controllers sonet ds3.....	161
show controllers sonet line path section.....	99
show controllers sonet line path section tributary.....	161
show controllers t3.....	30, 65
show controllers t3 ft1.....	38
show controllers t3 remote.....	38, 65, 168
show controllers t3 serial.....	38
show displays, filtering.....	29, 64, 153
show interfaces commands	
show interfaces fastEthernet.....	205
show interfaces gigabitEthernet.....	205
show interfaces serial	
channelized T3 interfaces.....	43
cOCx/STMx interfaces.....	172
show interfaces tenGigabitEthernet.....	205
show tunnel-server command.....	228
shutdown command	
channelized T3 interfaces.....	10
E3/T3 interfaces.....	52
Ethernet interfaces.....	204
OCx/STMx interfaces.....	84
shutting down	
DS3.....	130
E3/T3 interfaces.....	52
SONET/SDH interface.....	84
T1 channel.....	16, 133
T1 subchannel.....	16, 133
T1/E1 channel.....	130
T1/E1 channel group.....	125
T3 controller.....	10
SMs (Service modules)	
monitoring.....	228
redundancy and interface distribution.....	221
SNMP (Simple Network Management Protocol) link	
status processing	
channelized T3 interfaces.....	13, 16
cOCx/STMx interfaces.....	120, 125, 130, 133
OCx/STMx interfaces.....	84
snmp trap link-status command	
channelized T3 interfaces.....	13
cOCx/STMx interfaces.....	120
OCx/STMx interfaces.....	84
SONET APS 1 + 1 redundancy. <i>See</i> APS/MSP	

SONET/SDH (synchronous optical
network/Synchronous Digital Hierarchy)
 alarms, configuring.....93
 line modules supported.....77
 MPLS fast reroute.....84, 119
source, clock
 channelized T3 interfaces.....13, 14
 E3/T3 interfaces.....54
 OCx/STMx interfaces.....84, 119
speed command.....204
static tunnel-service interfaces
 monitoring.....228
 overview.....216
subchannels
 configuring.....16
 monitoring.....38
 shutting down t1.....16
support, technical *See* technical support
switching mechanisms, APS/MSP.....73, 75
switchover
 APS/MSP.....73
Synchronous Digital Hierarchy. *See* SONET/SDH
synchronous optical network. *See* SONET/SDH

T

T1 channels
 channelized T3 interfaces.....8
 cOCx/STMx interfaces.....124
 configuring.....14
t1 commands
 t1 bert.....23
 t1 clock source.....14
 t1 description.....14
 t1 framing.....16
 t1 loopback.....23
 t1 remote-loopback.....23
 t1 shutdown.....16
 t1 snmp trap link-status.....16
 t1 timeslots.....16
 t1 yellow detect.....19
 t1 yellow generate.....19
t1 fdl commands
 t1 fdl.....16
 t1 fdl carrier.....16
 t1 fdl string.....19
 t1 fdl transmit.....19
T3 channels.....130
T3 controllers
 configuring.....10
 monitoring.....29
T3 interfaces
 configuring controllers.....51
 configuring HDLC channel.....57
 configuring MDL.....52
 equipment loopback command.....61

 loopback command.....61
 monitoring.....64
 numbering scheme.....49
 testing.....148
T3, fractional.....56
technical support
 contacting JTAC.....xxi
testing interfaces
 channelized T3.....23
 cOCx/STMx.....145, 148
 OCx/STMx.....96, 97
text and syntax conventions.....xx
threshold command.....91, 94
time intervals.....29, 64
transmit clock source, configuring
 channelized T3 interfaces.....13, 14
 cOCx/STMx interfaces.....125, 133
 E3/T3 interfaces.....54
 OCx/STMx interfaces.....84, 119
transmit powers and cable length.....11, 54
trigger delay command.....89
tunnel-server ports
 dedicated.....215
 shared.....216
tunnel-service interfaces
 configuring.....225
 considerations.....223
 E120 and E320 routers.....217
 monitoring.....228
 overview.....216
 redundancy and interface distribution.....221
tunnels
 configuring tunnel-service interfaces.....225
 dynamic tunnel-server ports.....217
 monitoring.....228
 secure IP.....216, 221

U

unframed E1.....113

V

VT (virtual tributary).....114

W

working interface, APS/MSP.....73, 89

X

XFPs (10-gigabit small form-factor pluggable
transceivers).....191, 192, 209

