ZXR10 GER General Excellent Router

User Manual (Volume I)

Version 2.6.03

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Contents

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About This Manual

Purpose

This manual provides procedures and guidelines that support the user operation on ZXRGER 02/04/08 Router.

Intended Audience

This document is intended for engineers and technicians who perform operation activities on ZXRGER 02/04/08 Router.

Prerequisite Skill and Knowledge

To use this document effectively, users should have a general understanding of OSI Model; Familiarity with the following is helpful:

- Protocols
- Routing Concepts, Data Communication Terminologies

What Is in This Manual

This manual contains the following chapters:

TABLE 1 CHAPTER SUMMARY

Chapter	Summary
Chapter 1,Safety Instructions	This chapter introduces the safety instructions and sign descriptions.
Chapter 2, System Overview	This chapter describes ZXR10 GER software and hardware functions
Chapter 3,Structure and Principles	This chapter describes ZXR10 GER working procedures. This also describes system modules in details.
Chapter 4,Usage and Operations	This chapter describes common configuration methods, command

Chapter	Summary
	modes and the use of command lines of ZXR10 GER routers. configurations
Chapter 5,System Management	This chapter introduces system management of ZXR10 GER routers, details the file system and its operations of routers, and also gives a detailed description of version upgrading.
Chapter 6,Interface Configuration	This chapter describes different types of interfaces on ZXR10 GER and their configuration examples for further illustration.
Chapter 7,V_Switch Configuration	This chapter introduces relevant configurations of the V_Switch on the ZXR10 GER router.
Chapter 8,Smart Group Configuration	This chapter introduces SMARTGROUP and relevant configurations on the ZXR10 GER.
Chapter 9,Link Protocol Configuration	This chapter introduces the link protocol PPP and related configurations on the ZXR10 GER.
Chapter 10,Bridge Configuration	This chapter introduces the bridging of the POS and ATM interfaces, and relevant configurations on the ZXR10 GER.
Chapter 11,Network Protocol Configuration	This chapter describes the IP address and ARP configuration.
Chapter 12,Static Route Configuration	This chapter describes the static route configuration.
Chapter 13, RIP Configuration	This chapter describes the Routing Information Protocol (RIP) configuration.
Chapter 14,OSPF Configuration	This chapter describes the configuration of the Open Shortest Path First (OSPF).
Chapter 15, IS-IS Configuration	This chapter describes the Intermedia System - Intermedia System (IS-IS) protocol configuration.
Chapter 16, BGP Configuration	This chapter describes Border Gateway Protocol (BGP) that is a main inter-domain routing protocol. BGP-4 is being widely applied to the Internet, used to exchange network reachability information among ASs.
Chapter 17,Policy Routing Configuration	This chapter describes policy routing and relevant configurations on ZXR10 GER.

Chapter	Summary
Chapter 18, GRE Configuration	This chapter describes several common VPN technologies and also describes the General Route Encapsulation (GRE) technology and its detailed configuration on ZXR10 GER
Chapter 19, MPLS Configuration	This chapter describes the basic concepts of Multi-Protocol Label Switching (MPLS) technology and MPLS configuration and troubleshooting on ZTE ZXR10 GER router.
Chapter 20, MPLS VPN Configuration	This chapter describes the basic concepts of L3 MPLS VPN and the configuration and troubleshooting of MPLS VPN on ZTE ZXR10 GER router.
Chapter 21,VPWS Configuration	This chapter describes the VPWS protocol and its related configuration on the ZXR10 GER.
Chapter 22,VPLS Configuration	This chapter describes VPLS. Both VPLS and VPWS are technologies for implementing MPLS VPN on Layer 2 of the network.
Chapter 23,Traffic Engineering Configuration	This chapter describes the basic concepts of layer-3 MPLS TE and the relevant configuration on the ZXR10 GER router.
Chapter 24, Multicast Routing Configuration	This chapter describes multicast routing and the relevant configuration on the ZXR10 GER router.

Related Documentation

ZXR10 General Excellent Router (GER) User Manual is applicable to ZXR10 General Excellent Router Model 02/04/08 (hereinafter called ZXR10 GER 02/04/08 for short). For difference of product they can be mentioned separately.

Related ZXR10 GER manuals are as follows:

- ZXR10 General Excellent Router (GER V2.6) Installation Manual
- ZXR10 General Excellent Router (GER V2.6) User Manual
- ZXR10 Router/Ethernet Switch Command Manual - Command Index
- ZXR10 Router/Ethernet Switch Command Manual - System Management
- ZXR10 Router/Ethernet Switch Command Manual - Functional System I

- ZXR10 Router/Ethernet Switch Command Manual - Functional System II
- ZXR10 Router/Ethernet Switch Command Manual - Functional System III
- ZXR10 Router/Ethernet Switch Command Manual - Functional System IV
- ZXR10 Router/Ethernet Switch Command Manual - Protocol Stack I
- ZXR10 Router/Ethernet Switch Command Manual - Protocol Stack II
- ZXR10 Router/Ethernet Switch Command Manual - Protocol Stack III
- ZXR10 Router/Ethernet Switch Information Manual

Commands supported by the ZXR10 GER (V2.6) routers are based on the uniform platform ZXROS V4.6.02.

Conventions

Typographical Conventions

ZTE documents employ the following typographical conventions.

TABLE 2 TYPOGRAPHICAL CONVENTIONS

Typeface	Meaning
Italics	References to other Manuals and documents.
"Quotes"	Links on screens.
Bold	Menus, menu options, functions names, input fields, radio button names, check boxes, drop-down lists, dialog box names, window names.
CAPS	Keys on the keyboard and buttons on screens and company name.
`Constant width`	Text that you type, program code, files and directory names, and functions names.

Mouse Operation Conventions

TABLE 3 MOUSE OPERATION CONVENTIONS

Typeface	Meaning
Click	Refers to clicking the primary mouse button (usually the left mouse button) once.
Double-click	Refers to quickly clicking the primary mouse button (usually the left mouse button) twice.
Right-click	Refers to clicking the secondary mouse button (usually the right mouse button) once.
Drag	Refers to pressing and holding a mouse button and

Typeface	Meaning
	moving the mouse.

How to Get in Touch

The following sections provide information on how to obtain support for the documentation and the software.

Customer Support

If you have problems, questions, comments, or suggestions regarding your product, contact us by e-mail at support@zte.com.cn. You can also call our customer support center at (86) 755 26771900 and (86) 800-9830-9830.

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Declaration of RoHS Compliance

To minimize the environmental impact and take more responsibility to the earth we live, this document shall serve as formal declaration that ZXR10-GER, manufactured by ZTE CORPORATION is in compliance with the Directive 2002/95/EC of the European Parliament - RoHS (Restriction of Hazardous Substances) with respect to the following substances:

- Lead (Pb)
- Mercury (Hg)
- Cadmium (Cd)
- Hexavalent Chromium (Cr (VI))
- PolyBrominated Biphenyls (PBB's)
- PolyBrominated Diphenyl Ethers (PBDE's)

...

(Compliance is evidenced by written declaration from our suppliers, assuring that any potential trace contamination levels of the substances listed above are below the maximum level set by EU 2002/95/EC, or are exempt due to their application.) (Optional, used when our suppliers declare their compliance with RoHS)

ZXR10-GER, manufactured by ZTE CORPORATION meet the requirements of EU 2002/95/EC; however, some assemblies are customized to client specifications. Addition of specialized, customer-specified materials or processes which do not meet the requirements of EU 2002/95/EC may negate RoHS compliance of the assembly. To guarantee compliance of the assembly, the need for compliant product must be communicated to ZTE CORPORATION in written form. (Optional, used when necessary.)

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Chapter 1

Safety Instructions

Introduction

This chapter describes the frequently use safety signs and related precautionary measures used in handling of high-voltage equipment.

Safety Instruction

Local Safety Specifications

This equipment contains high-temperature and high–voltage hardware equipment, so only skillful and highly practiced personnel are recommended for the installation, operational and maintenance activities.

To avoid personal injury and equipment damages safety precautions introduced in this manual must be followed.

Note: ZTE Corporation assumes no responsibility for consequences resulting from violation of general specifications for safety operations, safety rules for design, production and use of equipment.

Chapter 2

System Overview

Overview

Introduction

This chapter describes ZXR10 GER software and hardware functions.

Product Overview

With the explosive growth of the Internet, IP services on the Internet is no more restricted to pure data services, multiple value-added services, such as voice and video services, are also in rapid development. These demands have brought higher requirements on the traditional routers.

Enterprise Requirements

High speed carriers are looking for having more router line interface rates and more powerful data processing capabilities to keep in step with the growth of broadband services. Routers are required to act as the expansible infrastructure for running value-added services over the Internet so as to satisfy the carriers' practical requirements for continuously launching new network services to get business operation profits. For all these requirements, routers must be operable, manageable, customizable and expansible.

ZXR10 GER Description

On the basis of rich experience in R&D and carrier-class communication products manufacturing, ZTE has designed and manufactured ZXR10 GER. The router, in modular structure, can provide various service interfaces. Key module of the system adopts the 1:1 redundancy design, improving the safety and reliability of the system. High-speed network processor technology, in combination with the effective software technology, implements the fast routing policy.

This is the priority product for establishing the convergence, access for enterprise networks, and acts for them as the basic platform for the ISP to provide integrated services.

ZXR10 GER is classified into different models according to their modular structure, performance, interface cards, processing capabilities. A detail of each model is given below.

Product Models

ZXR10 is divided into to three models. This is described in below table.

ZXR10 GER02/GER04

Figure 1 shows ZXR10 GER02 back panel view.

FIGURE 1 ZXR10 GER02 BACK PANEL VIEW

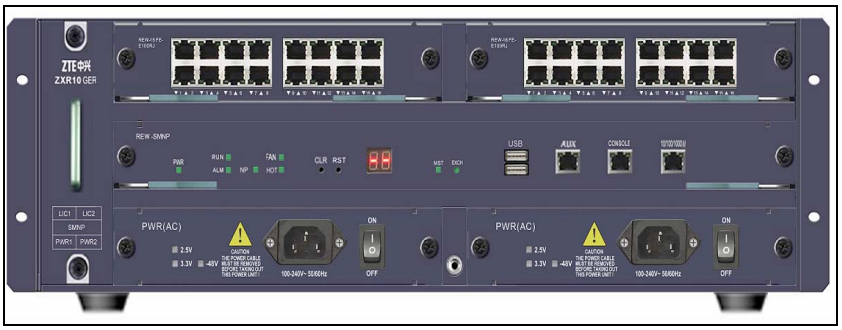
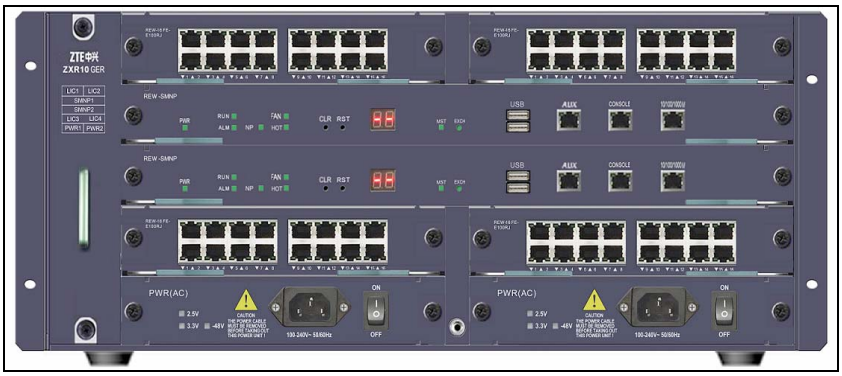


Figure 2 shows ZXR10 GER04 back panel view.

FIGURE 2 ZXR10 GER04 BACK PANEL VIEW



ZXR10 GER 08

Figure 3 shows ZXR10 GER back panel view.

FIGURE 3 ZXR10 GER08 BACK PANEL VIEW

Physical Interfaces

ZXR10 GER is designed to meet the enterprise access layer requirements and able to deliver services for carrier network. Due to modular design architecture, different modules perform different functions. System adopts the 1:1 redundancy design, improving the safety and reliability of the system.

ZXR10 GER shelf supports abundant interface types. It supports the following interface boards:

Physical Interfaces
1-port POS 2.5G interface board
2-port POS 622M interface board
8-port POS 155M interface board
4-port POS 155M interface board
1-port ATM 155M interface board
2-port gigabit Ethernet optical interface board
2-port gigabit Ethernet optical-electrical self-adaptive interface board
2-port GBIC gigabit Ethernet interface board
8-port 10/100Base-TX interface board
16-port 10/100Base-TX interface board
16-port channelized E1 interface board
1-port channelized CP3 interface board
2-port channelized CE3 interface board

Router Operating System

Background

ZTE has developed Router Operating System (ZXROS) for its carrier class routers. ZTE completely owns the self-proprietary rights of ZXROS. ZXROS is used in ZXR10 GER.

Supporting Protocols

ZXR10 GER supports industry standard protocols. These protocols are given below:

Industry Standard Protocols
Link-layer protocol: PPP, MPPP , VLAN TRUNK, HDLC and FR
Network-layer protocol: IP, ICMP, ARP, V-SWITCH and SMARTGROUP
Transmission-layer protocol: TCP and UDP
Routing protocol: RIP v1/v2, OSPF v2, BGP4 , integrated IS-IS, RIPng，OSPFv3，ISISv6 and BGP4+
MPLS/VPN, VPWS, QOS, TE, policy routing and load sharing
Tunnel protocol: GRE 6in4 tunnel,6to4 tunnel,4in6 tunnel
Application-layer protocol: Telnet, FTP and TFTP
Network-layer control application: NAT, ACL and URPF
NM protocol: SNMP v1/v2/v3, RMON v1 and NTP

Technical Features and Parameters

Standard

ZXR10 GER follows IEEE standard:

Q/SZX 122-2002 ZXR10 middle/low-end router

Features

Table 4 shows ZXR10 GER technical features and parameters.

TABLE 4 TECHNICAL FEATURES AND PARAMETERS

Item	Specification
Processor specification	Dedicated network processor
SDRAM configuration	256M~512M, 512M by default
SRAM configuration	8 M
FLASH configuration	64 M
Number of available slots	8
Basic configurations	1COM and 1FE
Bus bandwidth	32 Gbps
Message processing capability	24Mpps
Number of routing entries	200K
Routing protocols supported	RIP v1/v2, OSPF, BGP4 and integrated IS-IS

Item	Specification
Media interface protocols supported	802.3 (10Base-T) 802.3u (100Base-TX) 802.3x (1000Base-SX and 1000Base-LX) 802.3z (1000Base-SX and 1000Base-LX) E1 (WAN Multi-rate)
RMON	In accordance with RFC1757, supporting four groups: statistics, history, alarm and events.
Management	SNMP and CLI (Command line Interface)
Access control list (ACL)	Implements the standard quintuple ACL, supporting 100,000 user rules
Network Address Translation (NAT)	Implements source IP address translation of a network, supporting 256K user rules
Hot backup and redundancy components	Main processing card: 1: 1 hot backup; Power module: 1+1 redundancy design
Mean Time Between Failure (MTBF)	≥200000 hours
Mean Time To Repair (MTTR)	<0.5 hours
Electromagnetic compatibility	In light of the GJB 367.1-87 requirement
Dimensions (H x W x D)	222mm×483mm×340mm
Power supply and power consumption	220VAC/50Hz or -48V/500W
Ambient temperature	-5°C ~45°C
Environment humidity	20%~90% (without condensation)

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Chapter 3

Structure and Principles

Overview

Introduction This chapter describes ZXR10 GER working procedures and system modules in detail.

Contents This chapter covers the following topics.

TABLE 5 TOPICS IN CHAPTER 3

Working Principles

Working principles depend on ZXR10 GER product models. These models are described in the following table.

ZXR10 GER 02/04 Working Principles

ZXR10 GER02/04 modules are connected to one another in three modes.

Forwarding Channel

Forwarding channel (FOCUS) buses are used for connection between the line interface module and the network processor module. Packets are transmitted between modules by means of information elements, with the transmission throughput of each channel up to 1.6 Gbps.

Local Channel

Local channel (MIPS) buses are used for connection between the control processor module and the network processor module. System protocol process is managed by the control processor. Local channel manages the information exchange between the control processor module and the network processor module, with the transmission throughput of 6.4Gbps.

Control Channel

Control channel administrates the operation and initialization configuration for all other modules, using RISC-CPU processor.

Figure 4 shows ZXR10 GER02 system architecture.

FIGURE 4 ZXR10 GER02 SYSTEM ARCHITECTURE

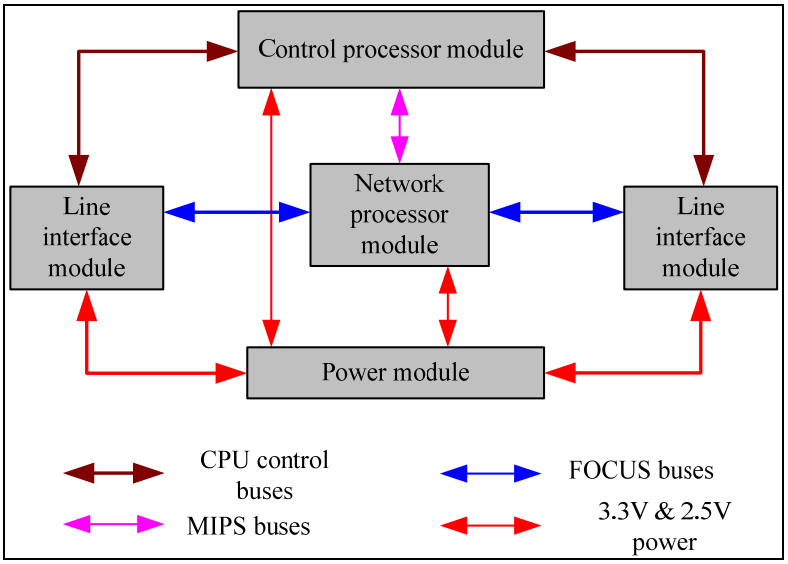
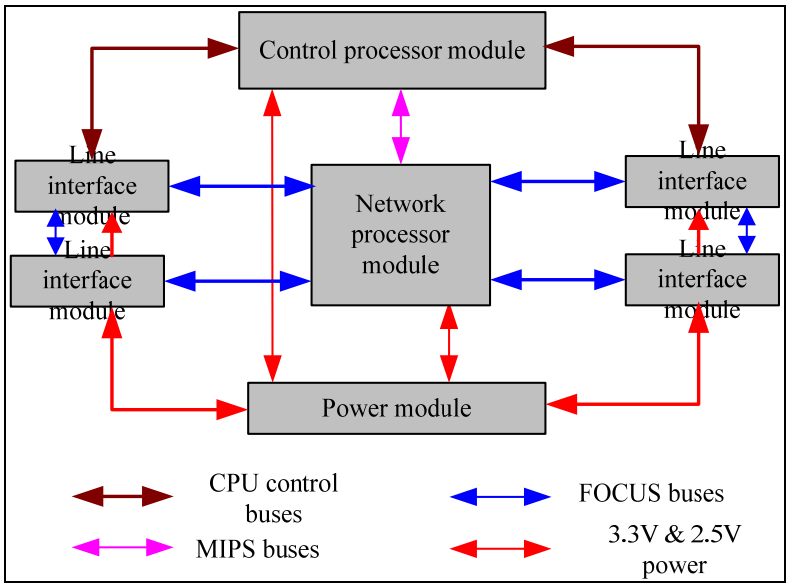


Figure 5 shows ZXR10 GER04 system architecture.

FIGURE 5 ZXR10 GER04 SYSTEM ARCHITECTURE



ZXR10 GER08 Working Principles

ZXR10 GER08 modules are connected to one another in three modes.

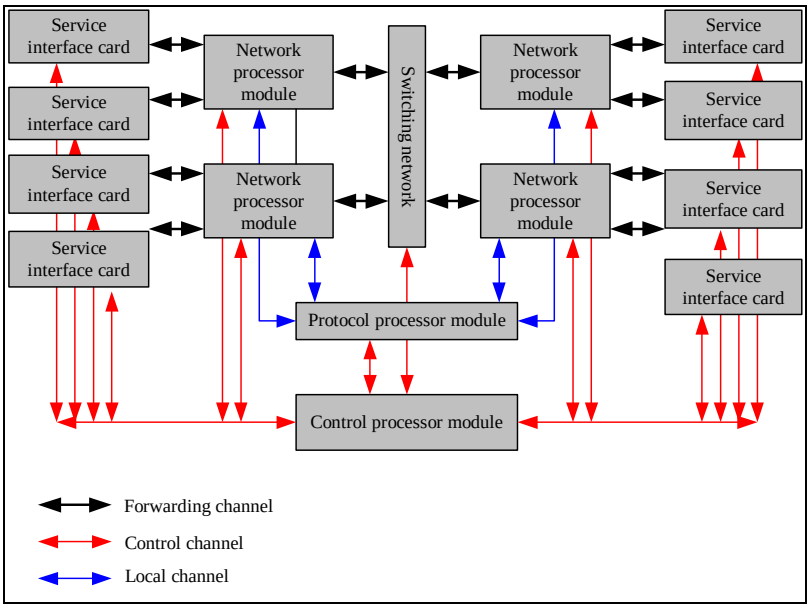
Forwarding Channel Standard buses are used for connection between the line interface module and the network processor module. Network processor module and switching module also uses these buses to communicate with each other. Packets are transmitted between modules by means of information elements, with the transmission throughput of each channel up to 1.6 Gbps

Local Channel Control processor module and network processor module connects by means of a standard bus. In the system, two high-performance RISC processors use to form a symmetrical dual CPU processing system. Each processor bus connects with two network processor modules. System is configured with a maximum of four network processor modules.

Control Channel Control channel administrates the operation and initialization configuration for all other modules by using RISC-CPU processor.

Figure 6 shows ZXR10 GER08 system architecture.

FIGURE 6 ZXR10 GER08 SYSTEM ARCHITECTURE



Data Packet Sending

Definition ZTE ZXR10 GER protocol processor module is responsible for the data packet transmission.

Process Packet transmission process is as follows:

- Protocol processor module prepares data packets for transmission by means of the data link layer, corresponding to the transmission interface type.
- Protocol processor module sends the encapsulated data packets to the corresponding network processor module through local channel. This is realized by the standard MIPS bus interface. This indicates the transmission interface properties.
- Network processor module forwards the receiving packets to the corresponding interface through fast-forwarding channel.
- Interface module outputs the received data link layer packets through the designated interface by means of packet encapsulation on the physical layer.

Data Packet Receiving

Definition ZXR10 GER receives the packet through the line interface, sent to the protocol processor module for processing. Such packet reaches the protocol processor module through the following processes:

- Interface module de-capsulate packets on physical layer and then encapsulates on data link layer. Data link layer sends them together with the receiving interface information to the network processor module.
- Network processor module performs route search and receive packets for policy processing. This module sends data link layer packet and receiving interface information to protocol processor module through local channel over the CPU.
- Protocol processor module performs protocol processing on the received packets.

Data Packet Forwarding

Process Packet forwarding process is as follows

- Interface module de-capsulate the received packets on physical layer to form packets encapsulated on data link layer, and then sends them together with the receiving interface information to the network processor module.
- Network processor module performs route search and receive packets for policy processing. As a result the packets are forwarded from local router multiple interfaces.
- It encapsulates layer-3 packets through switching header, and then sends the switching packets to the switching network via fast switching channel.
- Switching network switches the packets that are inserted to one or more switching channels according to the switching header information, and outputs them to target network processor module.
- Target network processor module receives the encapsulated packets that are sent by the switching network through fast switching channel. Corresponding output interface sends them in layer-2 encapsulation format towards one or more interface modules for processing according to the switching header information of the packets.
- Interface module outputs the received layer-2 encapsulated packets through the corresponding physical interface.

Packet Discarding

Theory Interface module de-capsulate the received packets on physical layer to form data link layer packets, and then sends them together with the receiving interface information to the network processor module.

Network processor module performs route search and receive packets for policy processing. It discards the packet directly if information available is to discard this packet.

Hardware Structure

Definition

ZXR10 GER system consists of chassis, power supply, boards, fan plug-in boxes and backplanes. System adopts the international standard 19-inch plug-in box series with the dimensions (height × width × depth) being 221.5mm×442mm×380mm. Installed side ear dimensions is 221.5mm×483mm×380mm. ZXR10 GER installs in outside or fixed standard cabinet.

ZXR10 GER Hardware structure is described according to product models. These models are described in the following table.

ZXR10 GER02/04 Hardware Structure

Figure 7 shows ZXR10 GER02 hardware structure.

FIGURE 7 ZXR10 GER02 HARDWARE STRUCTURE

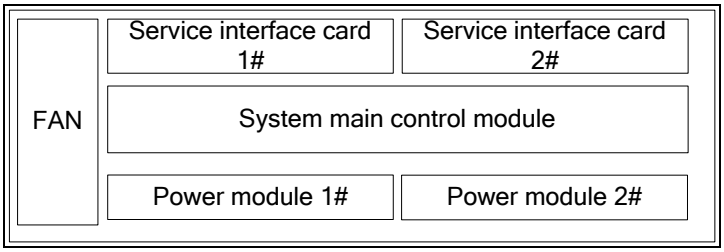
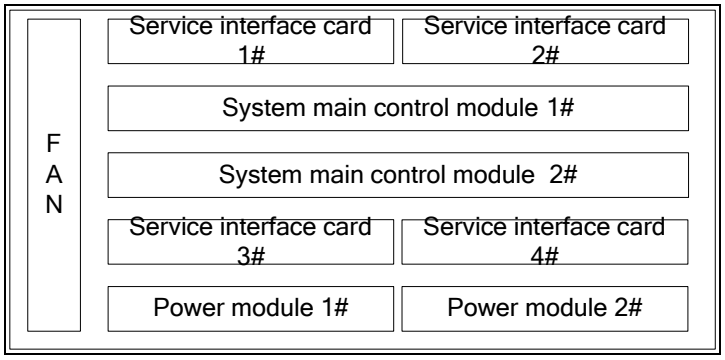


Figure 8 shows ZXR10 GER04 hardware structure.

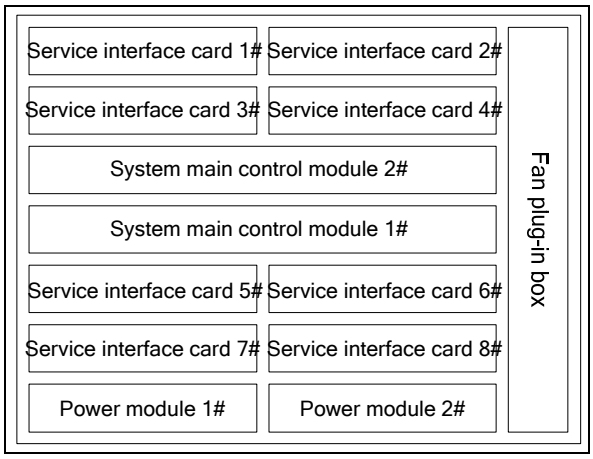
FIGURE 8 ZXR10 GER04 HARDWARE STRUCTURE



ZXR10 GER08 Hardware Structure

Figure 9 shows ZXR10 GER08 hardware structure.

FIGURE 9 ZXR10 GER08 HARDWARE STRUCTURE



ZXR10 GER System Architecture

ZXR10 GER system architecture topics are described in below table.

Topic	Page No
ZXR10 GER02/04 SMNP	16
ZXR10 GER02/04 SMNP Panel	15
ZXR10 GER08 SMP	19
ZXR10 GER08 SMP Panel	20

ZXR10 GER02/04 SMNP

Definition

ZXR10 GER02/04 core part is SMNP. This consist of central processor module (include protocol processor module and control processor module) and network processor module. This enhances level of integration and saves users money.

Central Processor Module

Central processor module implements functions of protocol processing and control processing. This is implemented by the high-speed MIPS processor. This consists of symmetric processing system, Host Bridge, CACHE system, memory system and BOOTROM.

Central processor module provides standard MIPS buses interface and control buses interface for the outside.

MIPS buses uses corresponding network processor module through the local channel.

The protocol processor module sends and receives data through local channel. Control buses connect the control channels of other modules.

Network Processor Module

Network processor module consists of network processor, RD memory and SRAM memory. Each network processor module supports four interface cards and one MIPS buses interface to connect with the central processor module. With MIPS bus, central processor module initializes the network processor configuration, manages tables in the network processor memory and sends/receives packets.

ZXR10 GER02/04 SMNP Panel

SMNP panel identifies as REW-SMP. Figure 10 shows the SMNP panel.

FIGURE 10 ZXR10 GER02/04 SMNP PANEL

Console Part

ZXR10 GER02/04 manages through console part by using terminal emulation software like HyperTerminal. CONSOLE port is a RS-232 DB9 TO RJ45, which is connected with background administration terminal through serial cable. Connection cable contains two ends, one with DB-9 and another is RJ45. Cable sequence is shown in Table 6.

TABLE 6 CABLE SEQUENCE

RJ-45 End	Signal	DB9 End
1		7
2		6
3	TXD	2
4	GND	5
5	GND	5
6	RXD	3
7		4
8		8
		1，9

AUX Port

AUX port enables to monitor the equipment remotely. AUX port is a DB9 male port (pin). Therefore, it needs to be matched with the DB9 female port (interpolation). Table 7 shows AUX port configuration.

TABLE 7 AUX PORT CONFIGURATIONS

SMP AUX	Signal	DB9-End	Signal
1	T232DCD	7	RTS
2	T232RX	3	TX
3	T232TX	2	RX
4	T232DTR	6	DSR
5	GND	5	GND
6	T232DSR	4	DTR
7	T232RTS	1	DCD
8	Not connected	8	Not connected
9	T232RI	9	RI

10/100/1000 Base-T Ethernet Interface

10/100/1000Base-T Ethernet interfaces are available on SMNP front panel. This port is a management port connecting the system to the background. This interface can serve as an out-band router NM-port. The features of 10/100/1000Base-T Ethernet interface are listed in Table 8.

TABLE 8 ETHERNET PORT SPECIFICATIONS

Port Type	Specifications
100Base-T	In compliance with IEEE 802.3; RJ45 connector

Port Type	Specifications
	Category-3, 4 and 5 Unshielded Twisted Pairs (UTP) Maximum transmission distance: 185m
100/1000Base-T	In compliance with IEEE 802.3; RJ45 connector Category-5 Unshielded Twisted Pairs (UTP) Maximum transmission distance: 100 m
Note: When the interface is connected with a host, straight-through network cable is used; when it is connected with a hub, switch or router, a crossover cable is used.	

USB Interface

ZXR10 GER02/04 has a USB interface port for flash transferring. ZXR10 GER08 has no USB interface.

Indicators

SMP panel has multiple indicators whose functions are listed in Table 9.

TABLE 9 SMP PANEL INDICATORS

Indicators	Function Description
PWR indicator (green)	Power indicator. When it is on, it indicates that the equipment has been powered on and the power supply normally.
RUN indicator (green)	Running indicator. When it is on, it indicates that the system runs normally.
ALM indicator (red)	Alarm indicator: Indicates a system fault when it is on.
NP	This indicates working status of the network processor: This is constantly on when the processor is working normally; This flashes if the processor fails; This is off if the processor initializes unsuccessfully.
FAN	This indicates working status of the fan: This is constantly on when the fan is working normally; This flashes if the fan fails.
HOT	This indicates equipment inside temperature: This is off when the equipment is working normally; this flashes if the equipment fails.
MST	This indicates SMNP master/slave status: This is constantly on in the master mode; this is off in slave working status.
Dual-8 digitron	This indicates SMNP CPU working status; This is displayed when the equipment works normally.

Buttons SMNP board contains two buttons. Their functions are listed in Table 10.

TABLE 10 SMNP BUTTONS FUNCTIONS

Buttons	Function Description
RST	If SMNP master board reset button is pressed in the presence of SMNP slave, master/slave SMNP switchover will occur. If there is no slave SMNP, then equipment will be reset. If SMNP slave has RST button, SMNP slave will be reset.
EXCH	Using EXCH button, SMNP board master/slave switches over master/slave function. There is no response if this button presses on SMNP slave.

ZXR10 GER08 SMP

Definition ZXR10 GER02/04 core part is SMP. This consists of central processor module, switching module and network processor module. Central processor module and switching module are fixed on the SMP, while the (SNP) is designed in the stackable mode, so that it can be configured and adjusted in position on actual requirements.

Central processor module Central processor module implements functions of protocol processing and control processing. This is implemented by the high-speed MIPS processor. This consists of symmetric processing system, Host Bridge, CACHE system, memory system and BOOTROM. Symmetric processing system consists of two high-performance RISC processors. Standard PCI bus connects these two processors and the communication bandwidth between them is up to 1Gbps.

Standard MIPS Bus Central processor module provides a standard MIPS bus interface and a control bus interface externally. Network processor module uses MIPS bus interface to connect the local channel through protocol processor module that sends and receive data packets. Each MIPS bus interface can connect maximum of two network processor modules. Control buses connect the control channels of other modules to realize the initialization configuration and operation administration for all the modules of the whole system.

Switching module Forwarding core of entire ZXR10 GER system is switching network. ZXR10 GER switching network chip provides eight completely independent switching channels, with the switching bandwidth of full duplex 1.6Gbps for each channel. Single switching network chip contains the capacity of full duplex 12.8Gbps. Unified bus connects network processor and switching channels through unified bus. CROSSBAR structure completes free exchange of packets, which is composed of switching channels.

Network processor module

Network processor module consists of network processor, RD memory and SRAM memory. Each network processor module supports four interface cards and one MIPS buses interface to connect with the Central processor module. With MIPS bus, central processor module initializes the network processor configuration, manages tables in the network processor memory and sends/receives packets.

ZXR10 GER08 SMP Panel

Definition

SMP provides active/standby switching and 1+1 redundancy configuration.

Panel

SMP panel identifies as RE-SMP. Figure 11 shows SMP panel.

FIGURE 11 ZXR10 GER SMP PANEL

Console Part

ZXR10 GER02/04 manages through console part by using terminal emulation software like HyperTerminal. CONSOLE port is a RS-232 DB9 TO RJ45, which is connected with background administration terminal through serial cable. Connection cable contains two ends, one with DB-9 and another is RJ45. Cable sequence is shown in Table 11.

TABLE 11 CABLE SEQUENCE

RJ-45 End	Signal	DB9 End
1		7
2		6
3	TXD	2
4	GND	5
5	GND	5
6	RXD	3
7		4
8		8
		1，9

AUX Port

AUX port enables to monitor the equipment remotely. AUX port is a DB9 male port (pin). Therefore, it needs to be matched with the DB9 female port (interpolation). Table 12 shows AUX port configuration.

TABLE 12 AUX PORT CONFIGURATIONS

SMP AUX	Signal	DB9-End	Signal
1	T232DCD	7	RTS
2	T232RX	3	TX
3	T232TX	2	RX
4	T232DTR	6	DSR
5	GND	5	GND
6	T232DSR	4	DTR
7	T232RTS	1	DCD
8	Not connected	8	Not connected
9	T232RI	9	RI

10/100/1000 Base-T Ethernet Interface

10/100/1000Base-T Ethernet interfaces are available on SMNP front panel. This port is a management port connecting the system to the background. This interface can serve as an out-band router NM-port. The features of 10/100/1000Base-T Ethernet interface are listed in Table 13.

TABLE 13 ETHERNET PORT SPECIFICATIONS

Port Type	Specifications
100Base-T	In compliance with IEEE 802.3; RJ45 connector Category-3, 4 and 5 Unshielded Twisted Pairs (UTP) Maximum transmission distance: 185m
100/1000Base-T	In compliance with IEEE 802.3; RJ45 connector Category-5 Unshielded Twisted Pairs (UTP) Maximum transmission distance: 100 m
Note: When the interface is connected with a host, straight-through network cable is used; when it is connected with a hub, switch or router, a crossover cable is used.	

USB Interface ZXR10 GER02/04 has a USB interface port for flash transferring.

Indicators SMP panel has multiple indicators whose functions are listed in Table 14.

TABLE 14 SMP PANEL INDICATORS

Indicators	Function Description
PWR indicator (green)	Power indicator. When it is on, it indicates that the equipment has been powered on and the power supply normally.
RUN indicator (green)	Running indicator. When it is on, it indicates that the system runs normally.
ALM indicator (red)	Alarm indicator: Indicates a system fault when it is on.
NP	This indicates working status of the network processor: This is constantly on when the processor is working normally; This flashes if the processor fails; This is off if the processor initializes unsuccessfully.
FAN	This indicates working status of the fan: This is constantly on when the fan is working normally; This flashes if the fan fails.
HOT	This indicates equipment inside temperature: This is off when the equipment is working normally; this flashes if the equipment fails.
MST	This indicates SMNP master/slave status: This is constantly on in the master mode; this is off in slave working status.
Dual-8 digitron	This indicates SMNP CPU working status; This is displayed when the equipment works normally.

Buttons SMNP board contains two buttons. Their functions are listed in Table 15.

TABLE 15 SMNP BUTTONS FUNCTIONS

Buttons	Function Description
RST	If SMNP master board reset button is pressed in the presence of SMNP slave, master/slave SMNP switchover will occur. If there is no slave SMNP, then equipment will be reset. If SMNP slave has RST button, SMNP slave will be reset.
EXCH	Using EXCH button, SMNP board master/slave switches over master/slave function. There is no response if this button presses on SMNP slave.

Line Interface Cards (LIC)

ZXR10 GER LICs

ZXR10 GER has external interfaces, which are called Line Interface Cards (LIC). ZXR10 GER contains high-speed network interfaces that have different interface services with different rates.

ZXR10 GER LICs are shown in Table 16

TABLE 16 LINE INTERFACE CARDS

Card ID	Description
RE-01A3-SFP	1-port ATM3 interface (SFP optical module)
RE-01CP3-SFP	1-port channelized POS3 (SFP optical module)
RE-01GP48-S02KLC	1-port POS48 single-channel single-mode two kilometers
RE-01GP48-S15KLC	1-port POS48 single-channel single-mode 15 kilometers
RE-01P48-S02KLC	1-port POS48 multi-channel single-mode two kilometers
RE-01P48-S15KLC	1-port POS48 multi-channel single-mode 15 kilometers
RE-02CE3-75	2-port channelized/non-channelized E3 interface (CC-4 interface)
RE-02GE	2-port GE electrical /optical interface (RJ45 electrical interface/SFP optical interface)
RE-02GE-E100RJ	2-port GE electrical interface (RJ45)
RE-02GE-GBIC	2-port GE optical interface (GBIC optical module)
RE-02P12-SFP	2-port POS12 (SFP optical module)
RE-04P3-SFP	4-port POS3 (SFP optical module)
RE-08FE-E100RJ	8-port 100M Ethernet electrical interface
RE-08FE-SFP	8-port 100M Ethernet optical interface (SFP optical module)
RE-16FE-RJDB44	16-port 120 ohm channelized/non-channelized E1 interface
RE-16CE1-75DB44	16-port 75 ohm channelized/non-channelized E1 interface
RE-16FE-RJDB44	16-port 100M Ethernet electrical interface

RE-01A3-SFP

Definition This is a one-port ATM3 optical interface board, providing one-channel standard OC-3c/STM-1c ATM optical interface.

Function This card does the physical processing. This card provides conversion of ATM, SAR and AAL5 adaptation signals to optical/electrical signals and serial/parallel conversion of 155.52Mb/s signals. In addition, this card implements communication between Interface cards and SMP through the bus in LLC encapsulation form.

Panel Figure 12 shows the RE-01A3-SFP card.

FIGURE 12 RE-01A3-SFP CARD

RE-01A3-SFP card provides one-channel optical interface of different transmission distances with different port types. Different port has different specifications.

TABLE 17 RE-01A3-SFP CARD INTERFACE FEATURES

Port Type	Specifications
SFP-2KM	LC connector, multi-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km
SFP-15KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 15km
SFP-40KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 40km
SFP-80KM	LC connector, single-mode fiber. Wavelength: 1550 nm. Max. transmission distance: 80 km

Indicators RE-01A3-SFP card has three indicators on the card and their functions are shown in Table 18.

TABLE 18 2 RE-01A3-SFP CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and it goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving, and this is off in the case of failure.
LINK	This is constantly on in the case of successful PPP link setup, and this is off in the case of PPP link setup failure.

RE-01CP3-SFP

Definition This is a one-port channelized POS3 interface card (SCP3), which provides single-port channelized OC3 interfaces. The channel granular is 2.048MHz.

Panel Figure 13 shows the RE-01CP3-SFP card.

FIGURE 13 RE-01CP3-SFP CARD

Interfaces RE-01CP3-SFP card adopts the SFP optical module and the supported port types are not identified on the panel. Table 19 shows the relationship between the port types and features.

TABLE 19 RE-01CP3-SFP INTERFACE FEATURES

SFP Optical Module	Feature
SFP-2KM	LC connector, multi-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km
SFP-15KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 15km
SFP-40KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 40km
SFP-80KM	LC connector, single-mode fiber. Wavelength: 1550 nm. Max. transmission distance: 80 km

Indicators RE-01CP3-SFP card has three LED indicators. Table 20 describes their functions.

TABLE 20 RE-01CP3-SFP CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally and this goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
LINK	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure.

RE-01GP48-S02KLC

Definition This is a one-port POS48 single-channel optical interface card, providing one-channel standard OC-48c/STM-16c POS optical interface.

Functions In the receiving direction, this cad extracts payload from 2.5 Gbps optical signals and provides PPP packets for the packet processing card through the bus. In the transmitting direction, this card receives PPP packets from the packet processing card through the bus. This card maps the packets into SONET/SDH virtual containe281rs VC-4-16c and sends the packets through the 2.5 Gbps optical interface.

Panel Figure 14 shows the RE-01GP48-S02KLC card.

FIGURE 14 RE-01GP48-S02KLC CARD

Interfaces RE-01GP48-S02KLC card specifications are as follows:

- LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km; and single channel

Indicators RE-01GP48-S02KLC card contains four LED indicators. Table 21 describes their functions.

TABLE 21 RE-01GP48-S02KLC CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
SD	This is constantly on if optical signals are available; and this goes off if optical signals are not available.
LINK	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure

RE-01GP48-S15KLC

Definition This is a one-port POS48 single-channel optical interface card, providing one-channel standard OC-48c/STM-16c POS optical interface.

Function In the receiving direction, this card extracts payload from 2.5 Gbps optical signals and provides PPP packets for the packet processing card through the bus. In the transmitting direction, this card receives PPP packets from the packet processing card through the bus. This card maps the packets into SONET/SDH virtual containers VC-4-16c, and then sends the packets through the 2.5 Gbps optical interface.

Panel Figure 15 shows the RE-01GP48-S15KLC card.

FIGURE 15 RE-01GP48-S15KLC CARD

Interfaces RE-01GP48-S15KLC card specifications are as follows:

- SC connector, single-mode fiber, with the wavelength of 1310nm and the maximum transmission distance of 15km, single channel

Indicators RE-01GP48-S15KLC card has four LED indicators. Table 22 shows their functions.

TABLE 22 RE-01GP48-S15KLC CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
SD	This is constantly on if optical signals are available; and this goes off if optical signals are not available.
LINK	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure

RE-01P48-S02KLC

Definition This is a one-port POS48 binary channel optical interface card, providing one-channel standard OC-48c/STM-16c POS optical interface.

Function In the receiving direction, this cad extracts payload from 2.5 Gbps optical signals and provides PPP packets for the packet processing card through the bus. In the transmitting direction, the card receives PPP packets from the packet processing card through the bus. This card maps the packets into SONET/SDH virtual containers VC-4-16c, and then sends the packets through the 2.5 Gbps optical interface.

Note: Binary channel POS48 interface card installs only on slot 5 or 6, though its port performance is two times greater than single-channel POS48 interface card. When this is installed on slot 5, no other modules can be installed on slot 7. When this is installed on slot 6, no other modules installs on slot 8.

Panel Figure 16 shows the RE-01P48-S02KLC card.

FIGURE 16 RE-01P48-S02KLC CARD

Interfaces RE-01P48-S02KLC card specifications are as follows:

- LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km, and binary channel

Indicators RE-01P48-S02KLC card panel has six LED indicators. Each port has a LINK indicator and a DATA indicator.

Table 23 describes their functions.

TABLE 23 RE-01P48-S02KLC CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
SD	This is constantly on if optical signals are available; and this goes off if optical signals are not available.
LINK	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure

RE-01P48-S15KLC

Definition This is a one-port POS48 binary channel optical interface, providing one-channel standard OC-48c/STM-16c POS optical interface.

Function In the receiving direction, this card extracts payload from 2.5 Gbps optical signals and provides PPP packets for the packet processing card through the bus. In the transmitting direction, the card receives PPP packets from the packet processing card through the bus. This card maps the packets into SONET/SDH virtual containers VC-4-16c, and then sends the packets through the 2.5 Gbps optical interface.

Note: Binary channel POS48 interface card installs only on slot 5 or 6, though its port performance is two times greater than single-channel POS48 interface card. When this is installed on slot 5, no other modules can be installed on slot 7. When this is installed on slot 6, no other modules installs on slot 8.

Panel Figure 17 shows the RE-01P48-S15KLC card.

FIGURE 17 RE-01P48-S15KLC CARD

Interfaces RE-01P48-S15KLC card specifications are as follows:

- LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 15km, and binary channel

Indicators There are four LED indicators on the RE-01P48-S15KLC card. Table 24 shows their functions.

TABLE 24 RE-01P48-S15KLC CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
SD	This is constantly on if optical signals are available; and this goes off if optical signals are not available.
LINK	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure.

RE-02CE3-75

Definition ZXR10 GER system has two port channelized E3 interface card which can be inserted in any one of eight slots. This connects with the SMP board through the backplane.

Panel Figure 18 shows the RE-02CE3-75 card.

FIGURE 18 RE-02CE3-75 CARD

Interfaces RE-02CE3-75 card provides two E3/T3 interfaces. This adopts the CC-4 connectors and provides 75 ohm coaxial cable interfaces for users.

Indicators There are three LED indicators. Table 25 shows their functions.

TABLE 25 RE-02CE3-75 CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA per port	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails.
LINK per port	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure.

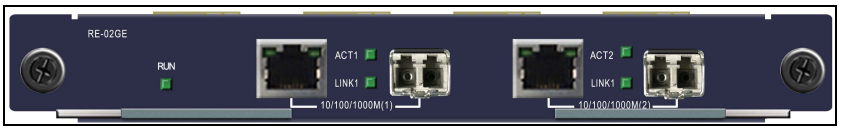
RE-02GE

Definition This is a two-port GE electrical/ optical interface board, providing two 10/100/1000BASE-T Ethernet electrical interfaces of RJ45 or providing two 1000BASE-X Ethernet optical interfaces of SFP.

Specification Maximum transmission of the optical interface is 120km; board compliances with IEEE802.3. This board only supports two GE Ethernet interfaces, so choose either of port (electrical or optical).

PanelPanel Figure 19 shows the RE-02GE card.

FIGURE 19 RE-02GE CARD



Interfaces Table 26 shows the RE-02GE card specifications.

TABLE 26 RE-02GE-E100RJ CARD SPECIFICATIONS

Port Type	Description
GE Gigabit Ethernet electrical interface (RJ45)	In compliance with IEEE 802.3; RJ45 connector; Category-5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 10BASE-T：185m；100BASE-T：100m；1000BASE-T：100m
GE Ethernet optical interface (SFP)	In compliance with IEEE 802.3; SFP optical module LC connector transmission distance 500m～80km，support multi-mode fiber and single-mode fiber

Indicators RE-02GE card has one LED indicator. Table 27 describes their functions.

TABLE 27 ON THE RE-02GE CARD INDICATORS

Indicators	Function Description
ACT each port	This is constantly on when the fan is working normally. This flashes if the fan fails.
LINK each port	This is constantly on in the case of data sending and receiving and this becomes off in the case of data failure.

RE-02GE-E100RJ

Definition This is a two-port GE electrical interface board, providing two 100Base-T GE electrical interfaces.

Panel Figure 20 shows RE-02GE-E100RJ card.

FIGURE 20 RE-02GE-E100RJ CARD

Interfaces Table 28 shows the RE-02GE-E100RJ card specifications.

TABLE 28 RE-02GE-E100RJ CARD SPECIFICATIONS

Port Type	Description
100Base-T	In compliance with IEEE 802.3u; RJ45 connector; Category-5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 80m
Note: When 100Base-T port connects with a hub, switch or router, a crossover cable must be used; when it connects with a host, a straight-through cable must be used.	

Indicators RE-02GE-E100RJ card has only one run indicator. In addition, each port has two indicators. Table 29 describes their functions.

TABLE 29 RE-02GE-E100RJ CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
ACTIVE per port	This indicates the transmission state of the current link. When this is on, data transmission occurs.
LINK per port	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure.

RE-02GE-GBIC

Definition This is a two-port GBIC GE interface card, providing two GE optical interfaces.

Panel Figure 21 shows the RE-02GE-GBIC card.

FIGURE 21 RE-02GE-GBIC CARD

Interfaces RE-02GE-GBIC card can provide two-channel Gigabit optical interface of different transmission distances by configuring GBIC parts of different specifications. Interface features are shown in Table 30.

TABLE 30 RE-02GE-GBIC CARD SPECIFICATIONS

Port Type	Specifications
SX (GBIC-M500)	SC connector, multi-mode fiber, with the wavelength of 850nm and maximum transmission distance of 500m
LX (GBIC-S10K)	SC connector, single-mode fiber, with the wavelength of 1310nm and maximum transmission distance of 10km
LH (GBIC-S70K)	SC connector, single-mode fiber, with the wavelength of 1550nm and the maximum transmission distance of 70km

Indicators RE-02GE-GBIC card contains seven indicators Table 31 sows their functions.

TABLE 31 RE-02GE-GBIC CARD INDICATORS

Indicators	Function Description
RUN	This is constantly on if the interface card is working normally, and this goes off if the interface card fails.
DATA per port	This is constantly on in the case of data sending and receiving and this is off in the case if data sending or receiving fails. (Note 1)
SD per port	This is constantly on if optical signals are available; and this becomes off if there are no optical signals available. (Note 2)
LINK per port	This is constantly on in the case of successful PPP link setup, and This is off in the case of PPP link setup failure (Note 3)

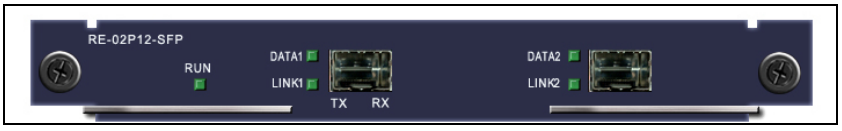
Indicators	Function Description
Notes: ■ DATA indicator is sensitive to traffic in the port regarding flash frequency. When the small volumes of data send/receives by a port, DATA indicator becomes on for a few times if the local port sends/receives a large volume of data, DATA indicator becomes on for a certain time. If the traffic is above a certain threshold, the indicator becomes normally on. ■ SD indicator becomes on if the optical transmitting/receiving devices detect any optical signals, which belongs to the scope of the physical layer in L7 protocol. ■ Two cases are involved when the Link indicator becomes on: ▸ When the port works in the non-auto negotiation mode, LINK indicator is on if optical signals are detected, just like the SD indicator. (Actually, this link set-up mode is not reliable.)) ▸ When the port works in auto negotiation mode, the link must be set up according to the specified negotiation of the Ethernet, that is, in the scope of the data link layer. (Part of the network equipment requests link setup by means of ARP, which belongs to the network layer category).	

RE-02P12-SFP

Definition This is a two-port POS12 optical interface card, providing two-channel standard OC-12c/STM-4c POS optical interface. This card mainly implements optical/electrical signal conversion, clock and data recovery of the line, POS frame mapping of the OC-12c, and data width conversion.

Panel Figure 22 shows the RE-02P12-SFP card.

FIGURE 22 RE-02P12-SFP CARD



Interfaces RE-02P12-SFP card can provide two-channel optical interface with different transmission distances by configuring SFP parts of different specifications. Interface features are shown in Table 32.

TABLE 32 RE-02P12-SFP CARD INTERFACE FEATURES

Port Type	Description
SFP-2KM	LC connector, multi-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km
SFP-15KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 15km
SFP-40KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 40km

Indicators There is one RUN indicator on the RE-02P12-SFP card panel. In addition, each port has two indicators. Table 33 shows their functions.

TABLE 33 RE-02P12-SFP CARD INDICATORS

Indicators	Function Description
RUN	It is constantly on if the interface card works normally, and it goes off if the interface card fails.
DATA per port	Interface data indicator: It is constantly on in the case of data sending and receiving, and it is off in the case of no data sending or receiving.
LINK per port	Link indicator: It is constantly on in the case of successful PPP link setup, and it is off in the case of PPP link setup failure.

RE-04P3-SFP

Definition This is a four-port POS3 optical interface card, providing four-channel standard OC-3c/STM-1c POS optical interface. It mainly implements optical/electrical signal conversion, clock and data recovery of the line, and POS Mapper function of the OC-3c.

Panel Figure 23 shows RE-04P3-SFP Card.

FIGURE 23 RE-04P3-SFP CARD

Interfaces RE-04P3-SFP card can provide four-channel optical interface with different transmission distances by configuring SFP parts of different specifications. Interface features are shown in Table 34.

TABLE 34 RE-04P3-SFP CARD INTERFACE FEATURES

Port Type	Description
SFP-2KM	LC connector, multi-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 2km
SFP-15KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 15km
SFP-40KM	LC connector, single-mode fiber. Wavelength: 1310 nm. Max. transmission distance: 40km
SFP-80KM	LC connector, single-mode fiber. Wavelength: 1550 nm. Max. transmission distance: 80 km

Indicators There is one RUN indicator on the RE-04P3-SFP card panel. In addition, each port has two indicators. Table 35 shows their functions.

TABLE 35 RE-04P3-SFP CARD INDICATORS

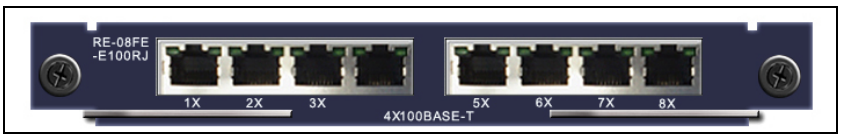
Indicators	Function Description
RUN	It is constantly on if the interface card works normally, and it goes off if the interface card fails.
DATA per port	Interface data indicator: It is constantly on in the case of data sending and receiving, and it is off in the case of no data sending or receiving.
LINK per port	Link indicator: It is constantly on in the case of successful PPP link setup, and it is off in the case of PPP link setup failure.

RE-08FE-E100RJ

Definition It is an eight-port fast Ethernet interface card and provides eight 10/100Base-TX adaptive electrical interfaces.

Panel Figure 24 shows RE-08FE-E100RJ card.

FIGURE 24 RE-08FE-E1000RJ CARD



Interfaces Table 36 shows RE-08FE-E100RJ card interface features.

TABLE 36 RE-08FE-E100RJ CARD INTERFACE FEATURES

Port Type	Description
10Base-T	In compliance with IEEE 802.3; RJ45 connector; Category-3, 4 and 5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 185m
100Base-TX	In compliance with IEEE 802.3u; RJ45 connector; Category-5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 100 m
Note: When the10/100Base-TX port is interconnected with a hub, switch or router, a crossover cable should be used; when it is interconnected with a host, a straight-through cable should be used.	

Indicators There are two indicators on the higher part of each interface on the E-08FE-E100RJ card (one is on the left and the other is on the right). Table 37 shows their functions.

TABLE 37 RE-08FE-E100RJ CARD INDICATORS

Indicators	Function Description
Upper left indicator on each port (yellow)	Indicates the connection status of the current link. When it is on, it indicates the connection has been established.
Upper right indicator on each port (green)	Indicates the wire speed of the current link. When it is on, it indicates the wire speed of 100M, when it is off, it indicates the wire speed of 10M

RE-08FE-SFP

Definition It is an eight-port fast Ethernet optical interface card and provides eight 100Base-FX optical ports. In addition, it can select SFX optical modules for its own use.

Panel Figure 25 shows RE-08FE-SFP card.

FIGURE 25 RE-08FE-SFP CARD

Interfaces RE-08FE-SFP card adopts 100Base-FX as its interface.

Indicators On the E-08FE-SFP card panel, each port corresponds to one L indicator and one D indicator. Their functions are given in Table 38.

TABLE 38 RE-08FE-SFP CARD INDICATORS

Indicators	Function Description
D per port	Interface data indicator: It is constantly on in the case of data sending and receiving, and it is off in the case of no data sending or receiving.
L per port	Link indicator: It is constantly on in the case of successful PHY link setup, and it is off in the case of PHY link setup failure.

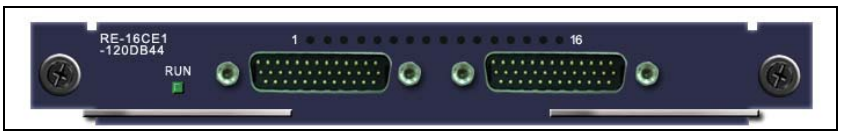
RE-16CE1-120DB44

Definition It is a 16-port channelized E1 interface board that provides 16 E1 interfaces in compliance with ITU-T G.703 and G.704 standards.

Functions Each port supports the sending and receiving functions. The receiving end implements the function of data receiving, framing and HDLC link control. The sending end is to organize the data into HDB3 codes and send them to lines.

Panel Figure 26 shows RE-16CE1-120DB44 card.

FIGURE 26 RE-16CE1-120DB44 CARD



Interfaces Table 39 shows the interface features of RE-16CE1-120DB44 card.

TABLE 39 RE-16CE1-120DB44 CARD INTERFACE FEATURES

Port Type	Description
Channelized E1	In compliance with ITU G.703 and G.704; Supporting G.704 framing; Adopting 120Ω balanceable twisted pair cable; Adopting line code of HDB3; A channelized E1controller has 31 valid timeslots

Indicators On RE-16CE1-120DB44 card, each interface has one corresponding indicator. Their functions are shown in Table 40.

TABLE 40 RE-16CE1-120DB44 CARD INDICATORS

Indicators	Function Description
Indicator of each port	It is constantly on, when the link is normal. It is off when the link is disconnected.

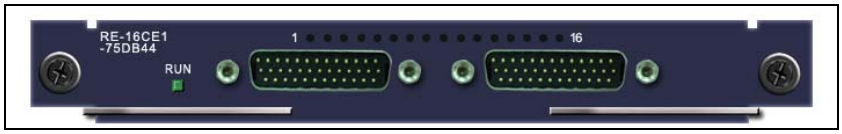
RE-16CE1-75DB44

Definition It is a 16-port channelized E1 interface and provides 16 E1 interfaces in compliance with ITU-T G.703 and G.704 standards.

Function Each port supports the sending and receiving functions. The receiving end implements the function of data receiving, framing and HDLC link control. Sending end organizes the data into HDB3 codes and sends them to lines.

Panel Figure 27 shows RE-16CE1-75DB44 Card.

FIGURE 27 RE-16CE1-75DB44 CARD



Interfaces Table 41 shows RE-16CE1-75DB44 card interface features.

TABLE 41 INTERFACE FEATURES OF THE RE-16CE1-75DB44 CARD

Port Type	Description
Channelized E1	In compliance with ITU G.703 and G.704; Supporting G.704 framing; Adopting 75Ω micro-coaxial cable; Adopting line code of HDB3; A channelized E1controller has 31 valid timeslots

Indicators On the RE-16CE1-75DB44 card, each interface has one corresponding indicator. Their functions are shown in Table 42

TABLE 42 RE-16CE1-75DB44 CARD INDICATORS

Indicators	Function Description
Indicator of each port	Link state indicator: It is on when the link is normal. It is off when the link is disconnected.

RE-16FE-RJDB44

Definition This is sixteen-port 100M Ethernet electrical interface providing sixteen 10/100/1000BASE-T Ethernet electrical interfaces of RJ45 , the cable(H-ETH-008) is special that GER can use it.

Panel Figure 28 shows RE-16FE-RJDB44 card

FIGURE 28 PANEL VIEW OF THE RE-16FE-RJDB44

Interfaces Table 43 shows interface features of RE-16FE-RJDB44 card.

TABLE 43 INTERFACE FEATURES OF THE RE-16FE-RJDB44 CARD

Port Type	Description
10Base-T	In compliance with IEEE 802.3; From DB44 to RJ45 connector; Category-3,4,5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 185m
100Base-T	In compliance with IEEE 802.3u; From DB44 to RJ45 connector; Category 5 Unshielded Twisted Pairs (UTP) are used; Maximum transmission distance: 100m

Indicators RE-16FE-RJDB44 card panel has one LED indicators each port, Table 44 describes their functions.

TABLE 44 DESCRIPTION OF INDICATORS ON THE RE-02GE CARD PANEL

Indicators	Function Description
Port Indicators	Link state indicator: It is on when the link is normal and there is no data to send or receive. It flashes when sending or receiving data. It is off when the link is disconnected.

Power Supply Module

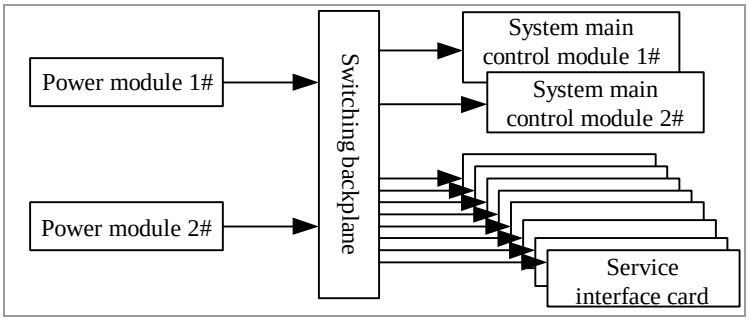
Power Supply Units Application requirements for general routers are fully considered in the design of ZXR10 GER system. To satisfy the strict requirements on equipment reliability for telecommunications,

the power part must be designed in hot backup mode, and two power supply modes of -48V DC and 220V AC are designed.

Load Sharing

Load sharing is adopted for the master/slave power supply module working in normal state. When a power supply becomes faulty, the other module will supply the system with the power for normal operation. Figure 29 shows the power supply of ZXR10 GER.

FIGURE 29 ZXR10 GER POWER SUPPLY



Power supply module is divided according to the GER models. These are described below.

Topic	Page No
ZXR10 GER02/04 Power Supply	41
ZXR10 GER08 Power Supply	43

ZXR10 GER02/04 Power Supply

GPWA

GPWA panel is shown in Figure 30.

FIGURE 30 PANEL VIEW OF THE GPWA

GPWA technical parameters are given below:

Technical Parameters
Input voltage: mono-phase 110/220VAC±10%
Input current: (110V)3.0A/(220V)1.5A
Frequency: 65/50±5%
Maximum power consumption (W): 300W

Technical Parameters
Voltage waveform distortion: <5%

GPWA panel has three power supply indicators, whose functions are given in Table 45.

TABLE 45 FUNCTIONS OF GPWA PANEL INDICATORS

Indicators	Function Description
3.3V indicator (green)	Indicates the working condition of 3.3V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
2.5V indicator (green)	Indicates the working condition of 2.5V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
-48V indicator (green)	Indicates the working condition of -48V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.

GPWD GPWD panel is shown in Figure 31.

FIGURE 31 GPWD PANEL

GPWD technical parameters are given below:

Technical Parameters
Rated voltage: -48V
Allowed voltage range: -57V~-40V
Input current: 6A
Maximum power consumption (W): 300W

GPWD has three connection terminals. They are -48V, -48V GND, PE (protection ground). GPWD panel has three power supply indicators, whose functions are shown in Table 46.

TABLE 46 GPWD PANEL INDICATORS

Indicators	Function Description
3.3V indicator (green)	Indicates the working condition of 3.3V output of the power supply board. It is constantly on in the

Indicators	Function Description
	case of normal working condition, and it goes off in the case of over-/under-voltage.
2.5V indicator (green)	Indicates the working condition of 2.5V output of the power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
5V indicator (green)	Indicates the working condition of 5V output of the power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.

ZXR10 GER08 Power Supply

SPWA

SPWA panel is shown in Figure 32.

FIGURE 32 SPWA PANEL VIEW

SPWA technical parameters are given below:

Technical Parameters
Input voltage: mono-phase 220VAC±10%
Input current: 3A
Frequency: 50±5%
Maximum power consumption (W): 500W
Voltage waveform distortion: <5%

SPWA panel has three power supply indicators, whose functions are listed in Table 47.

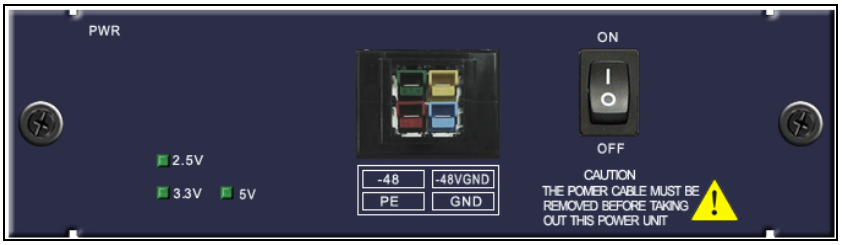
TABLE 47 SPWA CARD INDICATORS

Indicators	Function Description
3.3V indicator (green)	Indicates the working condition of 3.3V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
2.5V indicator (green)	Indicates the working condition of 2.5V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case

Indicators	Function Description
	of over-/under-voltage.
-48V indicator (green)	Indicates the working condition of -48V output of power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.

SPWD SPWD panel is shown in Figure 33.

FIGURE 33 SPWD PANEL



SPWD technical parameters are shown below:

Technical Parameters
Rated voltage: -48V
Allowed voltage range: -57V~-40V
Input current: 10A
Maximum power consumption (W): 500W

SPWD has four connection terminals. They are -48V, -48V GND, PE (protection ground) and GND (work ground). SPWD panel has three power supply indicators, whose functions are shown in Table 48.

TABLE 48 FUNCTIONS OF SPWD PANEL INDICATORS

Indicators	Function Description
3.3V indicator (green)	Indicates the working condition of 3.3V output of the power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
2.5V indicator (green)	Indicates the working condition of 2.5V output of the power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.
5V indicator (green)	Indicates the working condition of 5V output of the power supply board. It is constantly on in the case of normal working condition, and it goes off in the case of over-/under-voltage.

Fan Plug-in Box

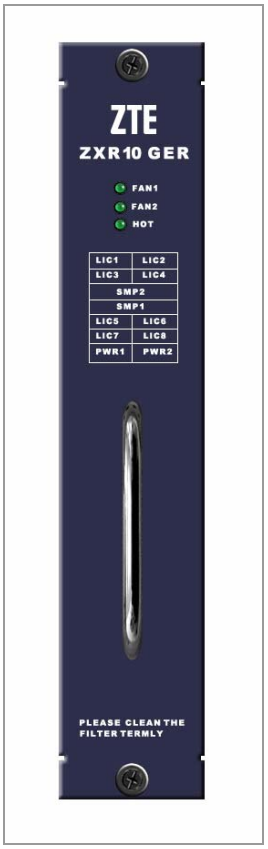
Dissipation Mode

ZXR10 GER heat dissipation mode is left dissipation mode. Two parallel fans from the left side of the chassis (view from the front) are there to blow air into the chassis. These fans make an air exhaust vent, at the right side to form a left-to-right air duct. Cool air-flow generated by the fan exchanges with the hot air-flow, generated by the board assembly and power supply board.

Modular Structure

Main chips generated heat are cooled by means of an aluminum radiator. Both the air filter of the fan and that of the air intake vent are installed in the fan plug-in box. Fan plug-in box is designed with the modular structure, which facilitates disassembling for maintenance and cleaning. Panel of the fan plug-in box of ZXR10 GER is shown in Figure 34.

FIGURE 34 FAN PLUG-IN BOX



Fan plug-in box panel has three indicators, whose functions are given in Table 49.

TABLE 49 FAN PLUG-IN BOX INDICATORS

Indicators	Function Description
FAN1	Fan 1 fault indicator: It is off when fan 1 works normally, and is constantly on when fan 1 fails
FAN2	Fan 2 fault indicator: It is off when fan 2 works normally, and is constantly on when fan 2 fails
HOT	Equipment temperature alarm indicator: It is off when the internal temperature of the equipment is normal and the fan works normally. It is constantly on when the internal temperature of the equipment exceeds 70°C.

ZXR10 GER slot assignment is also indicated on the fan plug-in box.

Chapter 4

Usage and Operations

Overview

Introduction This chapter describes common configuration methods, command modes and the use of command lines of ZXR10 GER routers.

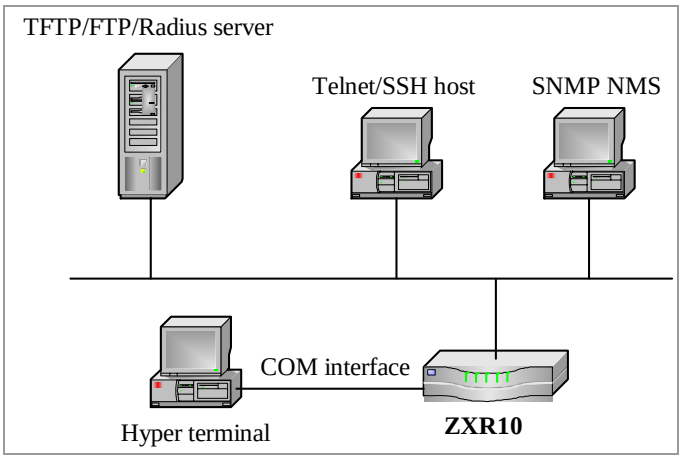
Contents This chapter covers the following topics.

TABLE 50 TOPICS IN CHAPTER 4

Basic Configuration Modes

Modes In order to make it flexible to operate as much as possible, multiple configuration modes are available for the ZXR10 GER. A user can select a suitable one according to the connected network. Figure 35 shows ZXR10 GER configuration. Detailed configuration is provided in the following content.

FIGURE 35 ZXR10 GER CONFIGURATION MODE



Configuring COM Port

Purpose This topic describes how to configure ZXR10 GER using COM port.

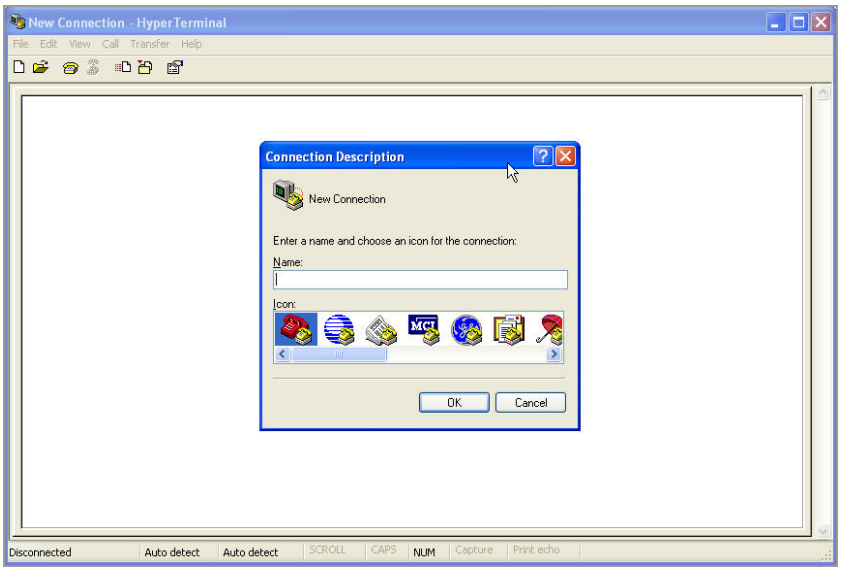
Prerequisite Command Line Interface (CLI) is accessed.

Note: CLI is a text-based interface that can be accessed through a direct serial connection to device and through telnet connections. For serial connection, there must be a DB-9 serial cable connected between Computer System and Router.

Steps Proceed with the following steps.

1. Click on **Start>Programs>Accessories>Communications > HyperTerminal**
2. Click on **HyperTerminal** and then, type ZTE as connection name and then click**> OK** button, as shown in Figure 36.

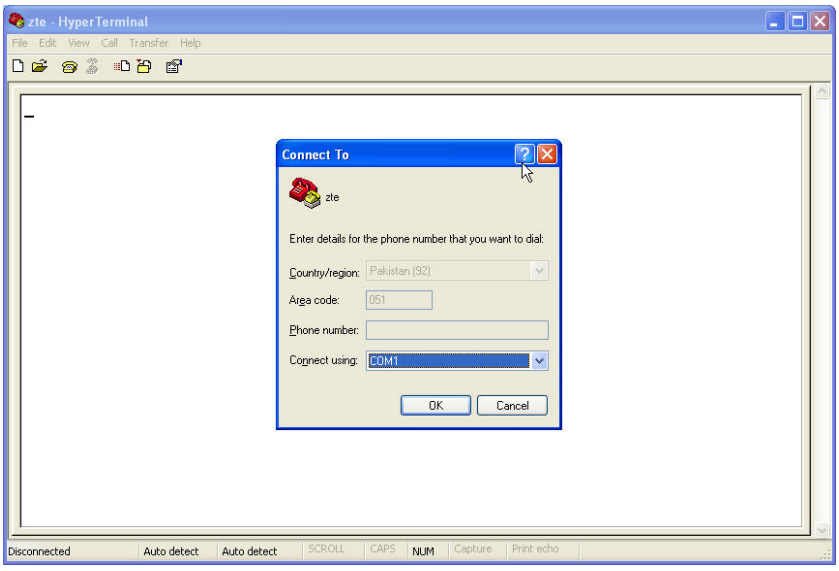
FIGURE 36 CONNECTION WINDOW



3. Select **COM** port that is in use to connect the router, click **>OK** button as shown in Figure 37

   Important! Be sure that **COM** port is selected.

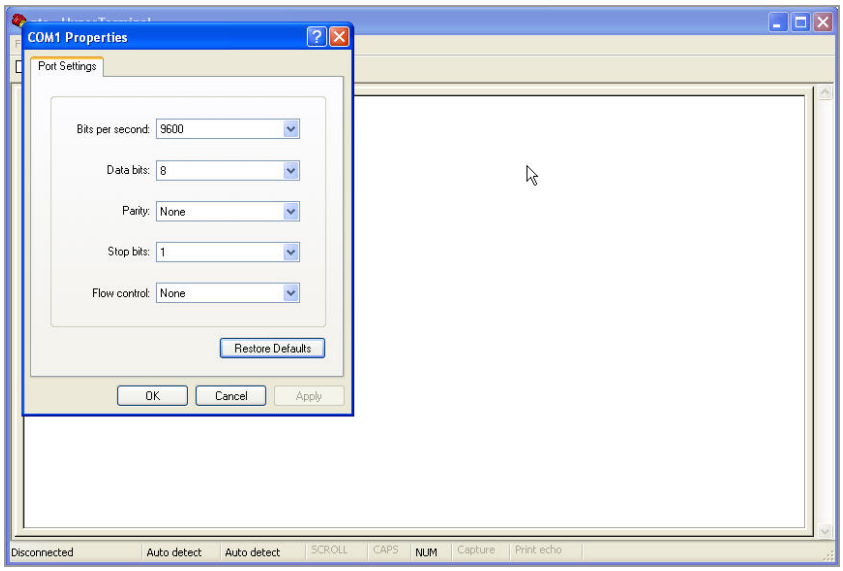
FIGURE 37 CONNECT TO WINDOW



4. Click **Restore Defaults** in order to select Bits Per Second →9600, Data bits →8, Parity →None, Stop bits→1, Flow control →None, Click → OK, then Press> Enter button as shown in Figure 38.

   Important! These options can be manually selected or by dropping down the radio buttons.

FIGURE 38 COM PROPERTIES WINDOW



END OF STEPS

Configuring Telnet Connection

Purpose This topic describes how to configure telnet connection on ZXR10 GER.

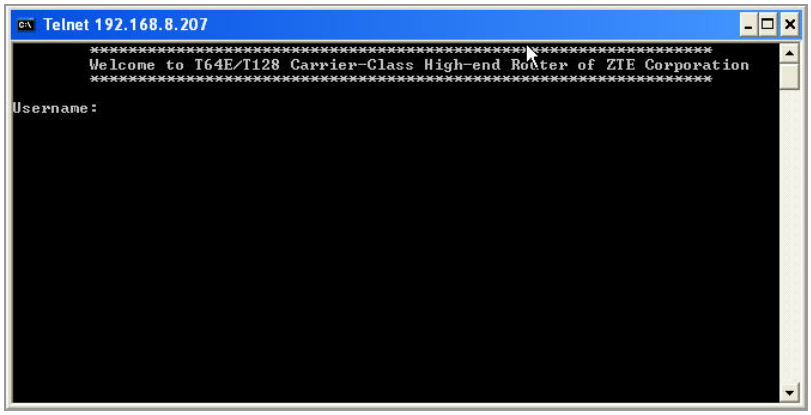
Prerequisite For telnet connection, ip address is configured on any interface of router.

Steps

1. Enter into command prompt and type telnet <ipaddress> of router interface

   - **Result:** A CLI window appears, as shown in Figure 39.

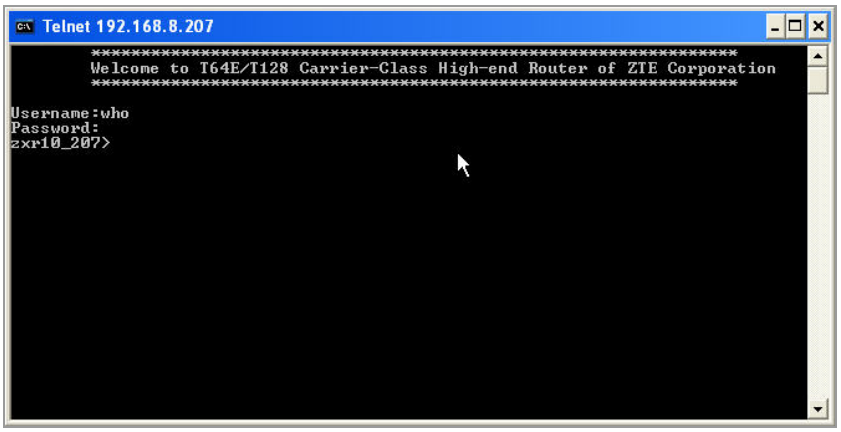
FIGURE 39 CLI WINDOW



2. Enter username and password of router to access router CLI as shown in Figure 40.

- **Result:** a **>** sign appears.

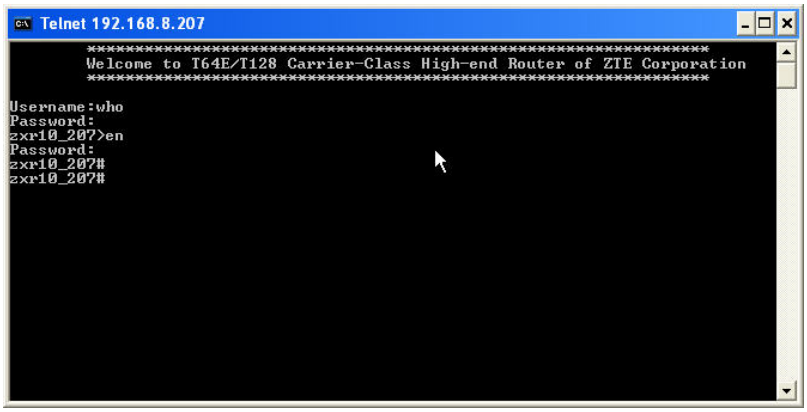
FIGURE 40 EXPRESSION CLI WINDOW



3. Write **enable** command, if there is password to access the router privileged mode, then write password as shown in Figure 41.

   Result: a **#** sign appears that shows enabled mode or privileged mode.

FIGURE 41 ENABLED MODE CLI WINDOW



4. To prevent an unauthorized access to router in Telnet mode, user name and password for Telnet access must be configured on router. To log on to router, the configured user name and password must be input. Use the following command to configure the user name and password for remote login as shown in Table 51.

TABLE 51 USERNAME COMMAND

Command Format	Command Mode	Command Function
username	Global	Configures user name and

Command Format	Command Mode	Command Function
<username> **password** <password>		password for Telnet login

Result: This prevents an unauthorized access to router in Telnet mode.

END OF STEPS

Configuring SSH

Background SSH is short for Secure Shell. All transmitted data can be encrypted through the SSH to avoid interception of the data or password and DNS and IP address spoofing. In addition, the transmitted data is compressed, thereby speeding up the transmission. With the SSH function, a user can log in to the remote router in the secure mode instead of the Telnet mode for configuration. Three parts are need to be configured for the SSH: Radius Server, remote router and SSH client. Computer where the Radius Server is installed can ping the remote router and the SSH client of the local host can ping the remote router.

Purpose This topic describes how to configure SSH.

Prerequisites To configure SSH, meet the following requirements.

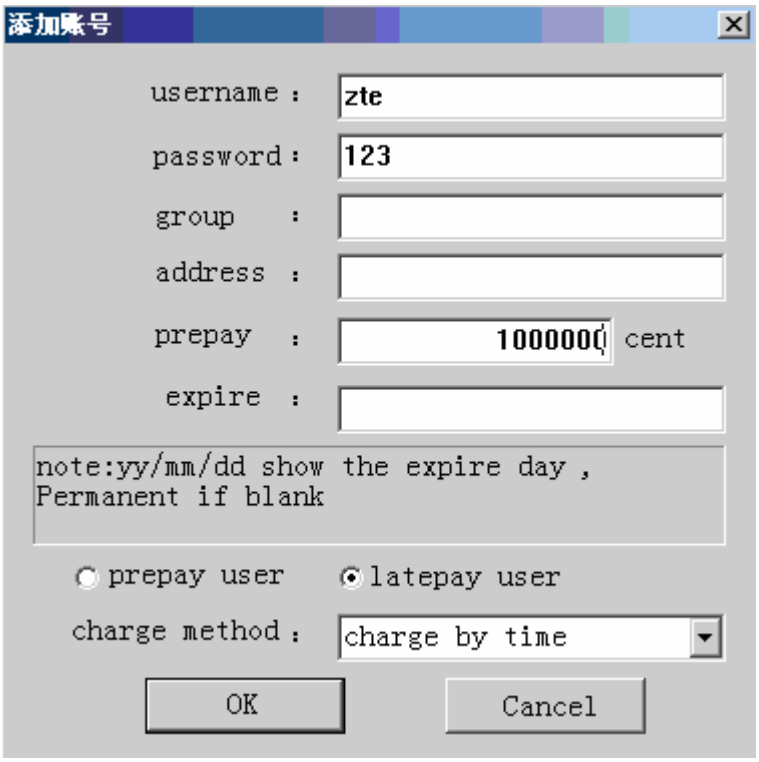
- IP address of the remote router has been configured as **192.168.3.1.**
- IP address of Radius Server is already configured **192.168.2.1.**
- Both the Radius Server and the SSH client of the local host communication is already been checked with the remote router successfully.
- Router command Line Interface has been accessed.

Steps

1. Open the **WinRadius.exe**. Select the **Add an Account** menu to add an account with the username being **zte** and password being **123**. Click **OK**. Figure 42 show the details.

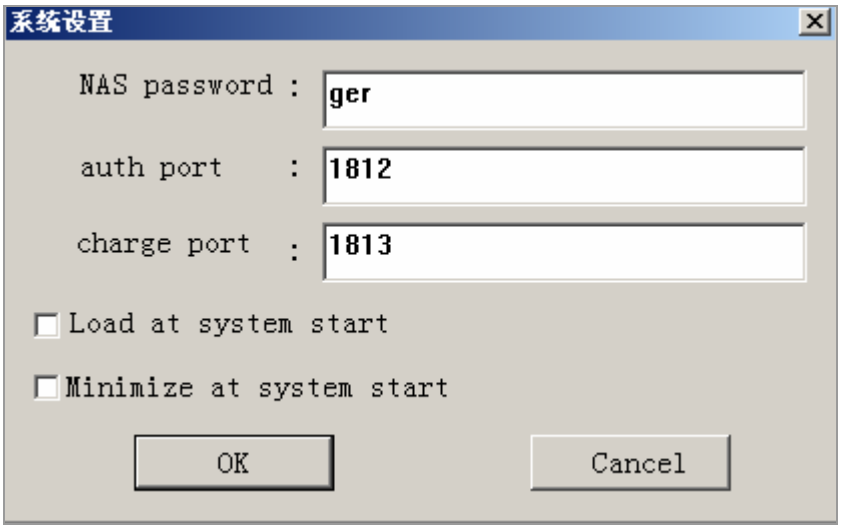
   Result: System setting menu appears.

FIGURE 42 RADIUS SERVER ACCOUNT CONFIGURATIONS



2. Select the **System Setting** menu. Set the **NAS password** to **GER** and **auth port** to **1812**, and then click **OK**, as shown in Figure 43.

FIGURE 43 RADIUS SERVER SYSTEM CONFIGURATION



Result: Radius Server has been configured.

END OF STEPS

Configuring SSH in Router

Purpose This topic describes how to configure SSH in router.

Prerequisites Router command Line Interface has been accessed.

Steps

1. To enable the SSH function; use **ssh server enable** command in global configuration mode as shown below.

```
ZXR10(config)#ssh server enable
```

Result: This enables the SSH function.

2. To configure the SSH authentication radius mode, use **ssh server authentication mode radius**, as shown below**.**

```
ZXR10(config)#ssh server authentication mode
radius
```

Note: If the Local authentication mode is configured, it is unnecessary to configure the Radius Server.

Result: This configures the SSH authentication radius mode.

3. To configure the SSH authentication type, as there are two types of SSH authentication modes: **pap** and **chap,** use **ssh server authentication type chap** command, as shown below.

```
ZXR10(config)#ssh server authentication type
chap
```

Result: This configures SSH authentication type.

4. To configure the SSH version 2, as two SSH versions are available: version 1 and version 2, use **ssh server version 2** command as shown below.

```
ZXR10(config)#ssh server version 2
```

Result: This configures SSH version 2.

5. To generate SSH key, use **ssh server generate-key** command as shown below.

```
ZXR10(config)#ssh server generate-key
```

Note: No key is needed if SSH version 2 is selected. They are only for version 1.

Result: This generates a SSH key.

6. To configure the ISP group number of SSH authentication, use **ssh server authentication ispgroup** command, as shown below.

```
ZXR10(config)#ssh server authentication
ispgroup 1
```

Note: If **Local** is selected in step 2, this step is unnecessary.

7. To configure the Radius Server parameters, **use radius server 1 authen master 192.168.2.1 1812 ger** command, as shown below.

```
ZXR10(config)#radius server 1 authen master
192.168.2.1 1812 ger
```

Result: This configures the radius server parameters.

Note: Group Number is set to the **ispgroup** in step 6; the server IP address is set to the IP address of Radius Server; the key is set to the NAS key on the Radius Server. Note: If **Local** is selected in step 2, this step is unnecessary.

Configuring SSH Client

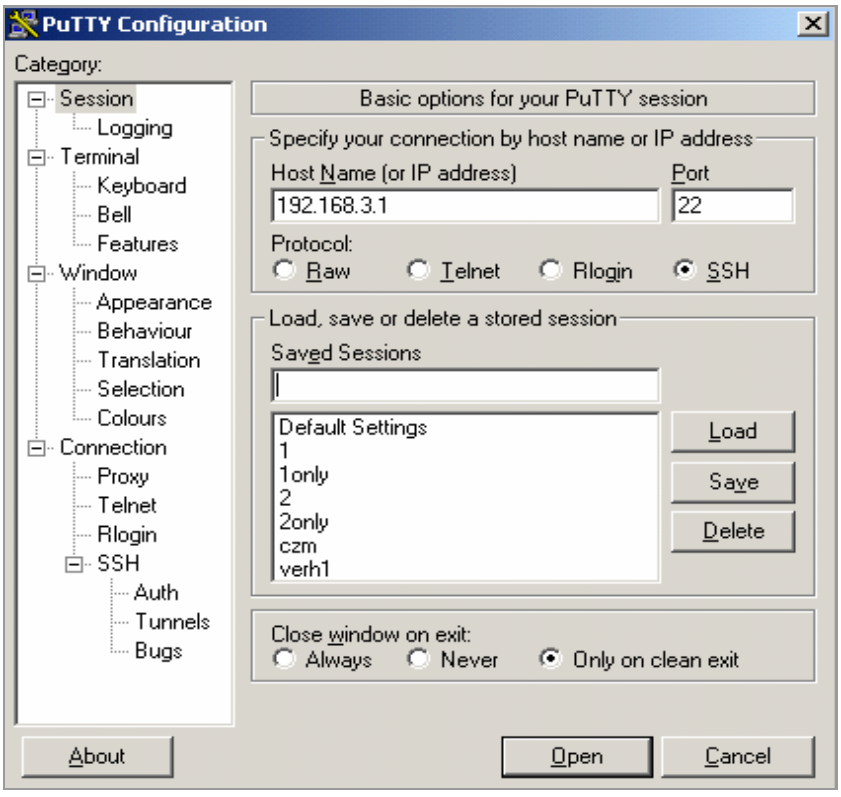
Purpose This topic describes how to configure SSH client.

Prerequisite Putty (SSH Client) has already been installed in the computer.

Steps

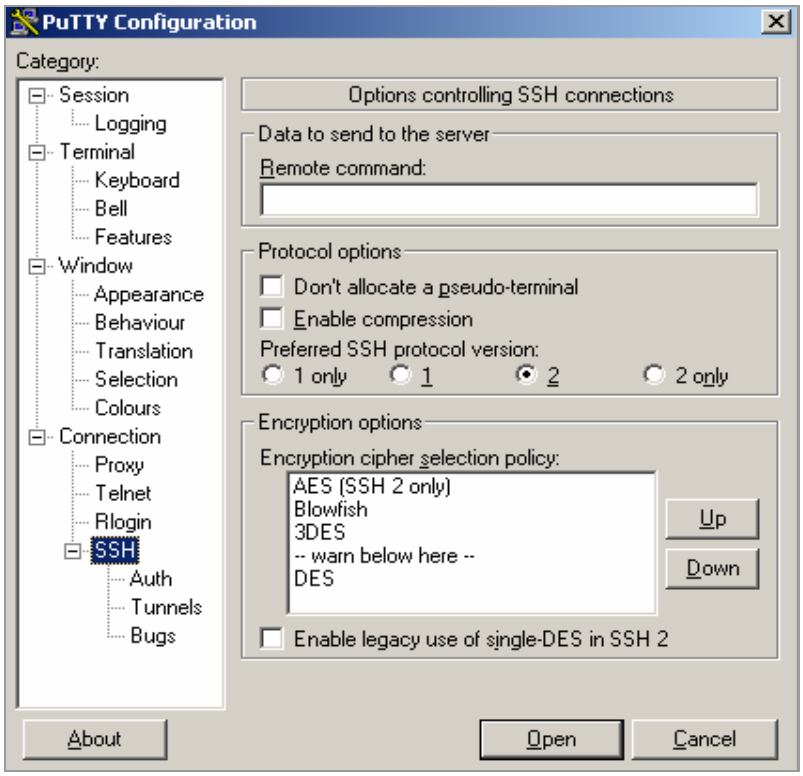
1. Enable **Putty.exe** at the SSH client. Enter the IP address of the remote router **192.168.3.1** in **hostname**. The interface is shown in Figure 44.

FIGURE 44 SSH CLIENT LOGIN CONFIGURATION



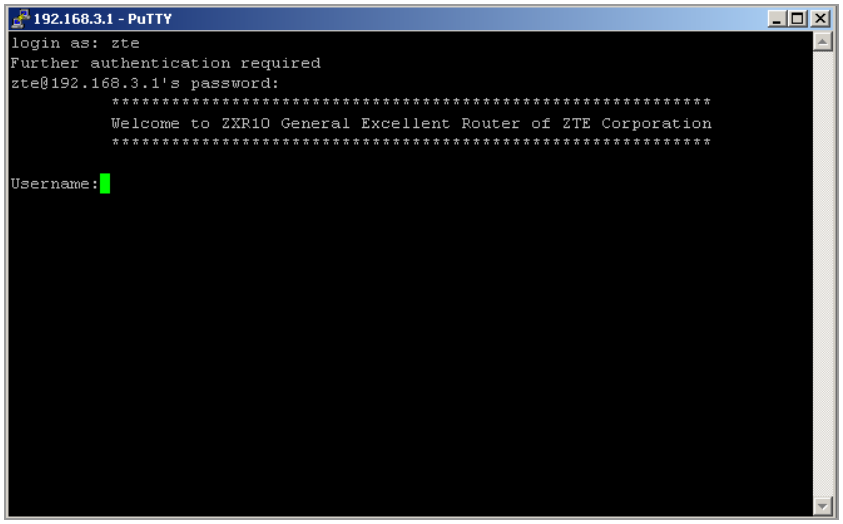
2. Select **version 2** from the protocol options and select the SSH version, as shown in Figure 45.

FIGURE 45 SSH CLIENT LOGIN CONFIGURATION 2



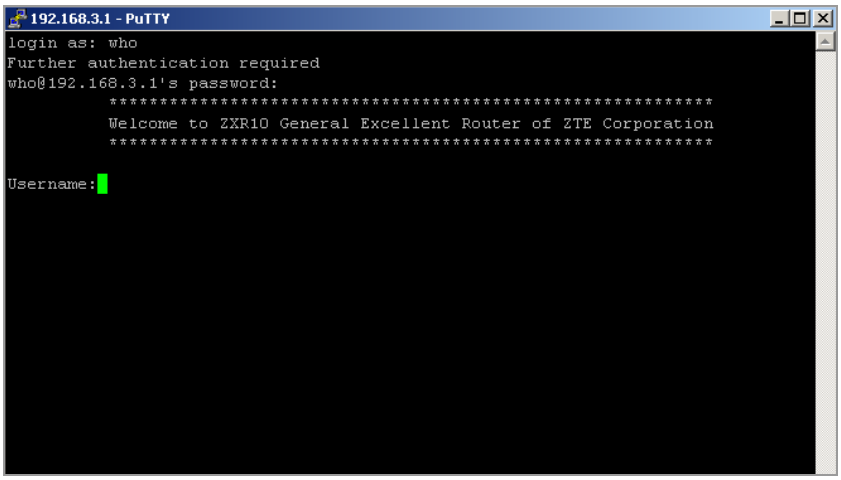
3. Click **open**. The login interface appears, as shown Figure 46. Enter the user name **zte** and password **123** to log in to the router. Then configure the router as in the Telnet mode.

FIGURE 46 SSH LOGIN INTERFACE 1



4. Select the **Local** for SSH authentication and then enter the user name and password of the Telnet in the interface, as shown in Figure 47 to log in to the router successfully.

FIGURE 47 SSH LOGIN INTERFACE 2



Command Mode

Command Usage

For users to configure and manage routers conveniently, ZXR10 GER routers assign commands to different modes according to different functions and rights. A command can only be carried out in a special mode. In any command mode, just enter a question mark "**?**", and the commands that can be used in the mode can be viewed. The command modes of ZXR10 GER routers are as follows

User Mode

Login

When the HyperTerminal mode is used to log on to the system, system enters into the user mode automatically. If using the

Telnet mode to log on, a user needs to enter the user mode after inputting the user name and password. The prompt of the user mode is the host name of the router followed by a ">", as shown in the following example (the default host name is ZXR10):

```
ZXR10>
```

In the user mode, a user can run commands, such as **ping** and **telnet,** and also can view some system information.

Privileged Mode

In the user mode, input the **enable** command and the corresponding password to enter the privileged mode, as shown in the following example:

```
ZXR10>enable
Password:(The entered password is not displayed on the screen)
ZXR10#
```

Detailed Information

In the privileged mode, a user can view more detailed configuration information and also can enter the configuration mode to configure the entire router. Therefore, a password should be used to prevent illegal use of unauthorized users. To return from the privileged mode to the user mode, execute the **disable** command.

Global Configuration Mode

Config Terminal

In the privileged mode, input the **config terminal** command to enter the global configuration mode, as shown in the following example:

```
ZXR10#configure terminal
Enter configuration commands,one per line,End with Ctrl/Z.
ZXR10(config)#
```

Commands in the global configuration mode act on the entire system, not merely on a protocol or an interface.

To return from the global configuration mode to the privileged mode, input the **exit** or **end** command or press **CTRL + Z**.

Interface Configuration Mode

Interface Parameters

In the global configuration mode, execute the **interface** command to enter the interface configuration mode, as shown in the following example:

```
ZXR10(config)#interface fei_2/1   (fei_2/1 is the
interface name, indicating the first interface of
the Ethernet interface module in slot 2)
ZXR10(config-if)#
```

A user can modify interface parameters in the interface configuration mode. For details, refer to Chapter 6 Chapter 6

Interface Configuration.

To return from the interface configuration mode to the global configuration mode, input the **exit** command; and to return from the interface configuration mode to the privileged mode directly, input the **end** command or press **CTRL + Z**.

Channelized Configuration Mode

Control Command

In the global configuration mode, execute the **control** command to enter the channelized configuration mode, as shown in the following example:

```
ZXR10(config)# controller ce1_1/1     /* ce1_1/1
is the interface name, indicating the first
interface of the E1 interface module in slot */
ZXR10(config-control)#
```

The interface cards requiring channelized configuration include ce1, ce3 and cp3. In the above example, ce1 is to be configured.

To return from the channelized configuration mode to the global configuration mode, input the **exit** command; and to return from the channelized configuration mode to the privileged mode directly, input the **end** command or press **CTRL + Z**.

Route Configuration Mode

Routing Protocols

In the global configuration mode, execute the **router** command to enter the route configuration mode, as shown in the following example:

```
ZXR10 (config) #router ospf 1
ZXR10 (config-router) #
```

Routing protocols used include RIP, OSPF, IS-IS and BGP. In the above example, the routing protocol OSPF will be configured.

To return from the route configuration mode to the global configuration mode, input the **exit** command; and to return from the route configuration mode to the privileged mode directly, input the **end** command or press **CTRL + Z**.

Diagnosis Mode

Diagnose Command

In the privileged mode, execute the **diagnose** command to enter the diagnosis mode, as shown in the following example:

```
ZXR10#diagnose
Test commands:
ZXR10(diag)#
```

Diagnosis test commands are provided in the diagnosis mode. These commands can be used to test cards used in a router, including bus and connectivity tests. In a diagnosis test, it is much better not to conduct router configuration.

To return from the diagnosis mode to the privileged mode, input the **exit** or **end** command or press **CTRL + Z**.

Online Help

Available Commands

Background

In any command mode, enter a question mark (?) after the prompt of the system, and a list of available commands in the command mode is displayed. With the context-sensitive help function, the keywords and parameter lists of any command can be obtained.

Purpose

Refer to below procedure for taking online help regarding the router CLI commands.

Prerequisite

Router command Line Interface has been accessed.

Steps

1. To take help in any command mode, enter a question mark "?" after the prompt of the system as shown below

```
ZXR10>?
Exec commands:
  enable  Turn on privileged commands
  exit    Exit from the EXEC
  login   Login as a particular user
  logout  Exit from the EXEC
  ping    Send echo messages
  quit    Quit from the EXEC
  show    Show running system information
  telnet  Open a telnet connection
  trace   Trace route to destination
  who     List users who is logining on
ZXR10>
```

Result: A list of all commands in the mode and the brief description of the commands are displayed.

2. To view the list of commands or keywords beginning with character or character string, Input the question mark behind a character or character string as shown below.

```
ZXR10#co?
configure copy
ZXR10#co
```

Note: There is no space between the character (string) and the question mark.

3. To view the command or keyword beginning with a unique character string, use **TAB** key behind the character string as shown below.

Note: There is no space between the character string and the TAB. For example:

```
ZXR10#con<Tab>
ZXR10#configure (There is a space between configure and the cursor.)
```

4. Input a question mark after a command, a keyword or a parameter, the next keyword or parameter to be input is listed, and also a brief explanation is given. There is a space in front of the question mark. For example:

```
ZXR10#configure ?
 terminal  Enter configuration mode
ZXR10#configure
```

5. If incorrect command, keyword or parameter is input, the error isolation is offered with the sign "^" in the user interface after you press **ENTER**. The sign "^" is below the first character of the input incorrect command, keyword or parameter. For example:

```
ZXR10#von ter
      ^
% Invalid input detected at '^' marker.
ZXR10#
```

END OF STEPS

Example

In the following example, suppose that a clock is to be set and the context-sensitive help is used to check the syntax for setting the clock.

```
ZXR10#cl?
clear  clock
ZXR10#clock ?
 set  Set the time and date
ZXR10#clock set ?
 hh:mm:ss  Current Time
ZXR10#clock set 13:32:00
% Incomplete command.
ZXR10#
```

At the end of the above example, the system prompts that the command is not complete and other keyword or parameter should be input.

ZXR10 GER also allows the command or keyword to be abbreviated into a character or character string that uniquely identifies this command or keyword. For example, the **show** command can be abbreviated to **sh** or **sho**.

Command History

Input Commands

User interface supports the function of recording input commands. A maximum of ten history commands can be recorded. The function is very useful in re-invocation of a long or complicated command or ingress.

Execute one of the following operations to re-invoke a command from the record buffer.

Commands	Function
Press **Ctrl-P** or the upward arrow key	Re-invokes the latest command in the record buffer. Repeat these keys to invoke old commands upwards
Press **Ctrl-N** or the downward arrow key	Roll the commands downwards. When the last command line is reached, one more operation will roll the commands from the begging of the buffer cyclically.

Use the **show history** command in any mode, and the latest several commands in the mode are listed.

Chapter 5

System Management

Introduction This chapter introduces system management of ZXR10 GER routers, details the file system and its operations of routers, and also gives a detailed description of version upgrading.

Contents This chapter covers the following topics.

TABLE 52 TOPICS IN CHAPTER 5

Introduction to File System

In ZXR10 GER, main storage device is flash. Image files and configuration files of ZTE ZXR10 GER are stored in flash. Operations, such as version upgrading and configuration saving, must be conducted in flash.

Flash consists of three directories:

- IMG
- CFG
- DATA
- **IMG:** System mapping files (that is, image files) are stored under this directory. The extended name of the image files is .zar. The image files are dedicated compression files. Version upgrading means change of corresponding image files under the directory.
- **CFG:** Configuration files are stored under this directory. File name of configuration files is startrun.dat. When a command is used to modify router configuration, information is stored

in memory. To prevent loss of configuration information, upon UAS power-off/power-on, write command must be used to write memory information into startrun.dat. To clear original configuration in UAS, upon data reconfiguration, use ***delete*** command to delete startrun.dat file and reboot UAS.

- **DATA:** This directory is used to store the log.dat file that records alarm information.

File Management

Introduction ZXR10 GER provides many commands for file operations. Command format is similar to DOS commands as present in Microsoft Windows Operating System.

Purpose This procedure describes how to do file management on ZTE ZXR10 GER.

Prerequisite Router command Line Interface has been accessed

Steps

1. To display current directory path, use **pwd** command, as shown in Table 53.

TABLE 53 PWD COMMAND

Command Format	Command Mode	Command Function
pwd	Exec	This display current directory path

Result: This shows the flash: / sign.

2. To display subdirectory information, files under a designated equipment or directory, use **dir** [<directory-name>] command, as shown in Table 54.

TABLE 54 DIR COMMAND WINDOW

Command Format	Command Mode	Command Function
dir [<directory-name>]	Exec	This display files, subdirectory information under a designated directory

This displays information about flash files including attribute, size, time and names of the same.

Result: This shows directory of flash files**.**

3. To delete a file under a designated directory of current equipment, use **delete** <*directory&filename*> command, as shown in Table 55.

TABLE 55 DELETE COMMAND WINDOW

Command Format	Command Mode	Command Function
delete <*directory&filename*>	Exec	This deletes a file under a designated directory of the current equipment

<*directory&filename*> parameter is from 1-80 characters.

Result: A Prompt appears, **Are you sure to delete files with options [Yes/No]**.

4. To enter into specific directory, use **cd** <*directory-name*> command, as shown in Table 56.

TABLE 56 CD COMMAND WINDOW

Command Format	Command Mode	Command Function
cd <*directory-name*>	Exec	This command enable to Enter into a file directory of a designated file equipment or the current equipment

<*directory-name*> represents 1-80 characters.

Result: This command sets prompt into designated directory like flash: / [directory name].

5. To return back to the root directory, use **cd ..** command, as shown in Table 57.

TABLE 57 CD.. COMMAND WINDOW

Command Format	Command Mode	Command Function
cd ..	Exec	This command makes return to root directory

Result: This permits to go back to root directory.

Important! This is to notice down that there is one space after writing **Cd** and then "**..**".

6. To make directory in flash, use **mkdir** <*directory-name*> command, as shown in Table 58.

TABLE 58 MKDIR COMMAND WINDOW

Command Format	Command Mode	Command Function
mkdir <*directory-name*>	Exec	This creates new directory in flash

<*directory-name*> represents 1-32 characters.

Result: This makes a new directory in flash.

7. To delete a directory in flash, use **rmdir** <*directory-name*> command,as shown in Table 59.

TABLE 59 RMDIR COMMAND WINDOW

Command Format	Command Mode	Command Function
rmdir <*directory-name*>	Exec	This deletes directory in flash

Result: This deletes a designated directory in flash.

8. To modify name of directory in flash, use **rename** <*oldname*> <*newname*> command, as shown in Table 60.

TABLE 60 RMDIR COMMAND WINDOW

Command Format	Command Mode	Command Function
rename <*oldname*> <*newname*>	Exec	This modifies the name of a designated file or directory in flash

<*oldname*> <*newname*> represents 1-80 characters.

Result: This renames designated file or directory in flash.

END OF STEPS

Example View of current file information.

```
ZXR10#dir
Directory of flash:/
     attribute    size      date        time  name
  1    drwx      512     MAY-17-2004  14:22:10 IMG
  2    drwx      512     MAY-17-2004  14:38:22 CFG
  3    drwx      512     MAY-17-2004  14:38:22 DATA
65007616 bytes total (48863232 bytes free)
ZXR10#cd img  (Enter the directory img)
ZXR10#dir     (Show the current directory information)
Directory of flash:/img
     attribute    size      date        time  name
  1    drwx      512     MAY-17-2004  14:22:10 .
  2    drwx      512     MAY-17-2004  14:22:10 ..
  3    -rwx  15922273    MAY-17-2004  14:29:18 ZXUAS.ZAR
65007616 bytes total (48863232 bytes free)
ZXR10#
```

Create directory and then removing.

```
ZXR10#mkdir ABC (Add a subdirectory ABC under the current directory)
ZXR10#dir (View the current directory information and find that the directory ABC has been added successfully)
Directory of flash:/
    attribute  size    date       time  name
1   drwx       2048    MAY-17-2004 14:22:10 IMG(所有 512 的 size，在 GER v2.6.03B 上都该为 2048)
2   drwx       512     MAY-17-2004 14:38:22 CFG
3   drwx       512     MAY-17-2004 14:38:22 DATA
4   drwx       512     MAY-17-2004 15:40:24 ABC
65007616 bytes total (48861184 bytes free)
ZXR10#rmdir ABC (Delete the subdirectory ABC)
ZXR10#dir (View the current directory information and find that the directory ABC has been deleted successfully)
Directory of flash:/
    attribute  size    date       time  name
1   drwx       512     MAY-17-2004 14:22:10 IMG
2   drwx       512     MAY-17-2004 14:38:22 CFG
3   drwx       512     MAY-17-2004 14:38:22 DATA
65007616 bytes total (48863232 bytes free)
ZXR10#
```

Note: System Management is described in detail in the following content.

TFTP Configuration

Background

By use of FTP or TFTP, image files and configuration files of router can be backed up and recovered. ZXR10 GER supports FTP and TFTP modes. ZXR10 GER can serve as FTP/TFTP client.

TFTP (Trivial file transfer protocol) sets as an example for description.

Purpose

This procedure describes how to do TFTP configuration in ZTE ZXR10GER.

Prerequisites

- There must be TFTP software installed in computer system, so it behaves as a TFTP server for transferring files between router and System.

- Router Command Line Interface has been accessed.

Steps In these steps, Solarwinds TFTP is used for TFTP software part, a free TFTP server software program, which is installed on Microsoft Windows XP (SP2).

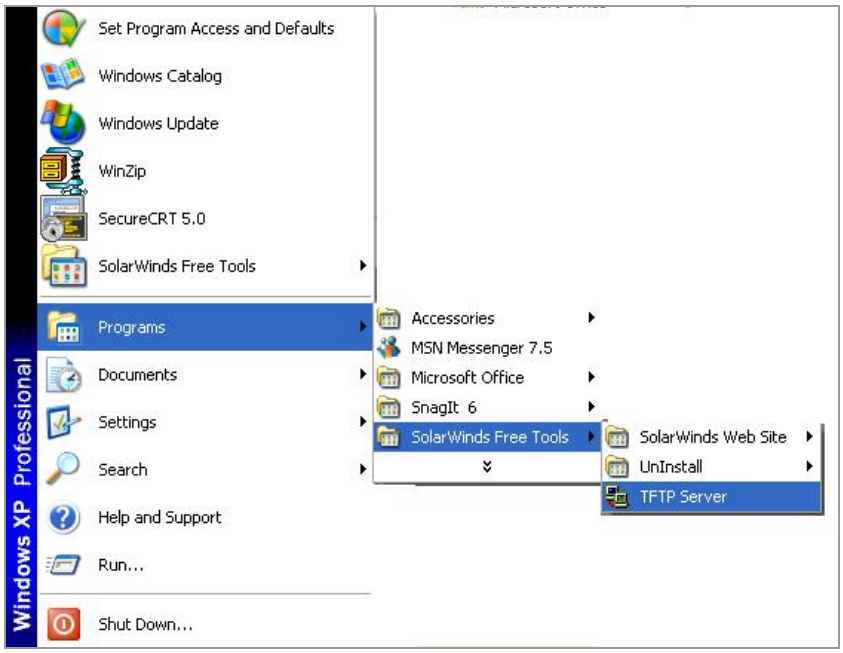
Note: In these steps, CLI configuration of router occurs through Hyper Terminal emulation software, present in Windows Operating System.

SolarWinds TFTP is downloaded from http://www.solarwinds.net/Download-Tools.htm. When downloading is completed, run SolarWinds-TFTP-Server.exe from downloaded location.

After installation follow these steps to configure TFTP.

1. Select SolarWinds TFTP server from start menu and then Click**>TFTP Server**, as shown in Figure 48.

FIGURE 48 TFTP SERVER SELECTION WINDOW



Result: A Windows XP Firewall prompt appears that SolarWinds TFTP wants to run.

Note: This occurs only if Windows XP firewall is enabled. For other firewall configurations, refer to their documentation.

Important! This is to be in notice that TFTP uses communication port# 69.

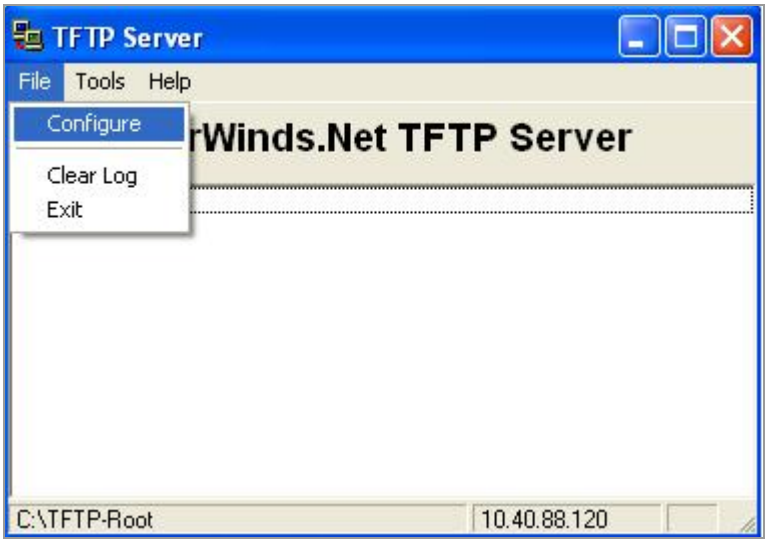
2. **Click>Unblock** for permanently allowing TFTP server to run as shown in Figure 49.

FIGURE 49 WINDOWS FIREWALL ALERT

Result: SolarWinds TFTP window is displayed, showing an ip address configured on Ethernet interface of computer system on left side and TFTP directory on right side of taskbar.

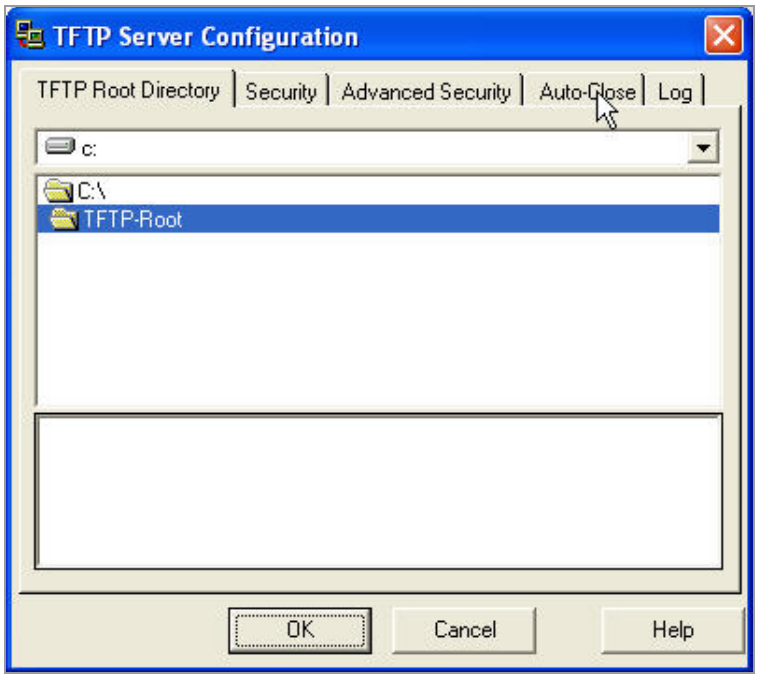
3. Select file menu and then **Click>Configure** as shown in Figure 50.

FIGURE 50 MAIN TFTP WINDOW



4. A different directory for storing image files can be selected. By default this is C:\TFTP-Root as shown in Figure 51.

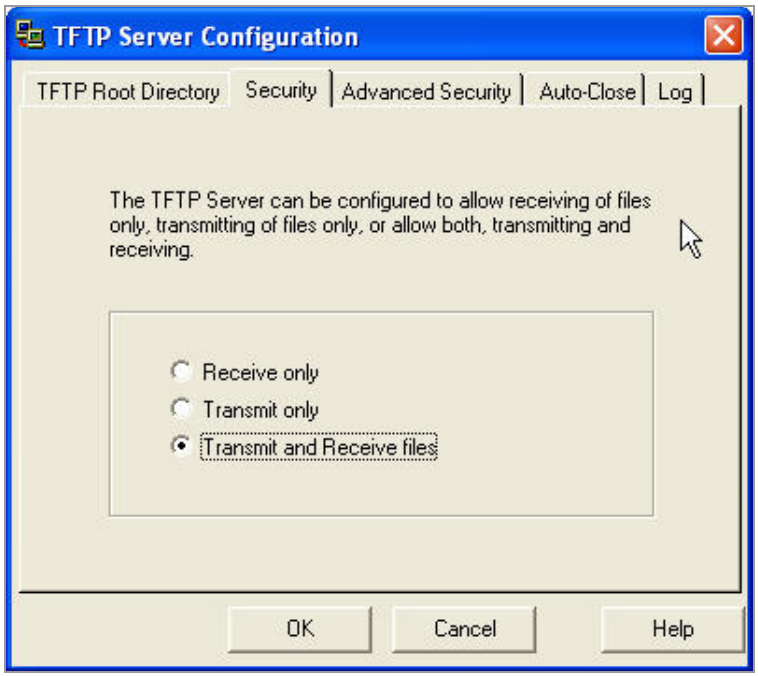
FIGURE 51 TFTP-ROOT DIRECTORY



Result: This displays current root directory for image files.

5. Select security tab from TFTP Server Configuration window, there are some options available: Transmit only, receive only, Transmit and Receive files. Select Transmit and Receive files as shown in Figure 52. By default Receive files option is selected.

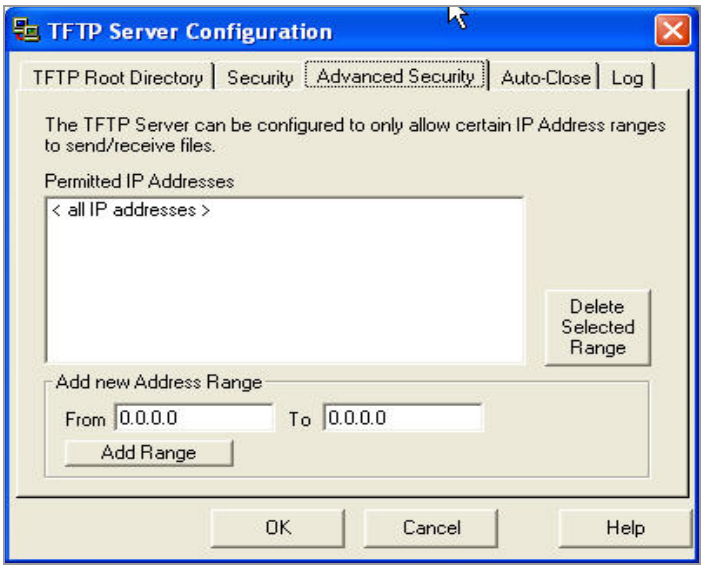
FIGURE 52 TFTP SECURITY WINDOW



Result: Transmit and Receive files option is selected for both transmitting and receiving files between TFTP server computer system and UAS.

6. **Click> Advanced Security** tab if further security is required, specify the range of permitted ip addresses as shown in Figure 53. By default all ip addresses are permitted.

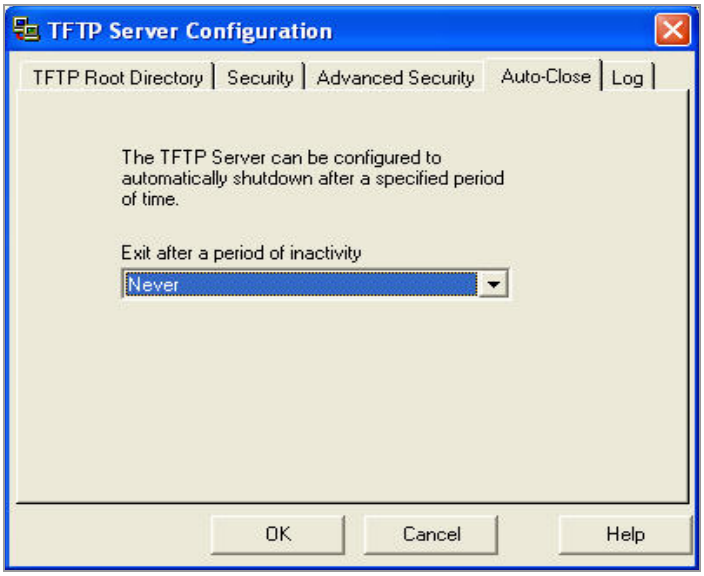
FIGURE 53 ADVANCED SECURITY WINDOW



Result: All IP addresses range is selected.

7. Select Auto-Close Tab if TFTP server require to automatically shutdown after a period of inactivity as shown in Figure 54. By default this time sets to Never.

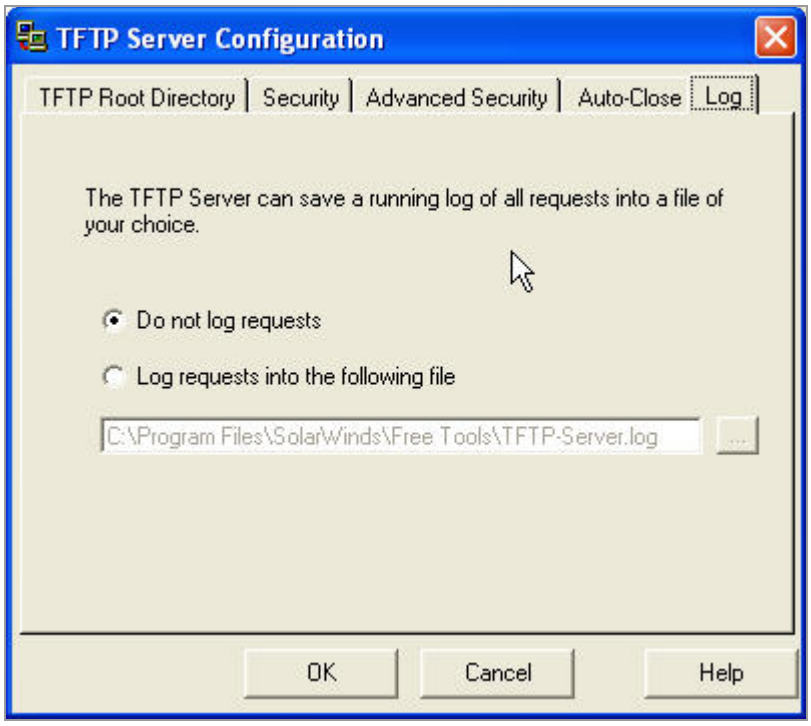
FIGURE 54 AUTO-CLOSE WINDOW



Result: Never option is selected.

8. To save log in specific path, this can be chosen from Log tab. By default do not log request option is selected as shown in Figure 55.

FIGURE 55 LOG WINDOW



Result: Do not log option is selected.

END OF STEPS

Software Version Upgrading

Background

Version upgrading is required only when original version does not support some functions or equipment cannot run normally due to some reasons. If version-upgrading operations are not performed properly, upgrading failure may occur or system may even break down.

Version upgrading must be done with complete knowledge, principles and operations of ZXR10 GER router.

Version upgrading includes two cases:

Version Upgrade in case of System Abnormality

Purpose This procedure describes how to do version upgrading in ZTE ZXR10 GER.

Prerequisites Router Command Line Interface has been accessed.

TFTP server is up and running.

Steps

1. Connect serial port of ZXR10 GER (COM port on BIC) to serial port of TFTP Server Computer System with the console cable.

   Result: TFTP server computer system and Router are ready to transfer files.

2. Connect management Ethernet port of router (10/100M Ethernet port on BIC) to network port of TFTP Server Computer System with Ethernet cable and make sure connections are correct.

   Result: Media (Ethernet cable) is ready to transfer files.

3. Configure both TFTP Server Computer System Ethernet port and router management Ethernet port of router in same network section.

   Result: Different IP addresses belonging to same network are configured.

4. Restart ZXR10 GER and press any key to enter into Boot status according to prompt on HyperTerminal as shown in Table 61.

TABLE 61 BOOT WINDOW

```
ZXR10 System Boot Version: 1.0
Creation date: Dec 31 2002, 14:01:52
...
Press any key to stop for change parameters...
 2
[ZXR10 Boot]:
```

Input "c" in the Boot status and press <ENTER> to enter into parameter modification status as shown in Table 62.

Result: Parameter modification status window is displayed

5. Change the boot mode to "**Boot from the background TFTP**"; change the address of the TFTP Server to corresponding TFTP Server Computer System IP address as shown in Table 62.

   Result: Boot mode is changed from normal boot to TFTP boot.

6. Change Client address and gateway address to address of built-in Ethernet interface and configure corresponding subnet mask as shown in Table 62.

TABLE 62 VERSION UPGRADING COMMAND WINDOW

[ZXR10 Boot]:c
'.' = clear field; '-' = go to previous field; ^D = quit Boot Location [0:Net,1:Flash] : 0 (0 indicates booting from the background TFTP, and 1 indicates booting from the FLASH)
Client IP [0:bootp]: 168.4.168.168 (Corresponding to the address of the management Ethernet port) Netmask: 255.255.0.0
Server IP [0:bootp]: 168.4.168.89 (Corresponding to the address of the background TFTP Server)
Gateway IP: 168.4.168.168 (The gateway address is the address of the management Ethernet port)
Boot Path: zxr10.zar (Use the default value)
Enable Password:(Use the default value)
Enable Password Confirm:(Use the default value)
[ZXR10 Boot]:

Result: The following prompt "[ZXR10 Boot]:" appears

7. Enter "@" and press <ENTER>, System boots with the image from the background TFTP Server automatically as shown in below table.

[ZXR10 Boot]:@
Loading... get file zxr10.zar[15922273] successfully!
file size 15922273.
...
Start ZXR10-TSR MPU
Version V1.2.m.n Built at Mar 22 2004, 11:03:18
Synchronizing ....OK!

```
****************************************
        Welcome to ZXR10 T64E
****************************************
ZXR10>
```

Result: System boots with TFTP image.

8. For normal boot, use **show version** command, as shown in Table 63.

TABLE 63 SHOW VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
show version	Exec	This indicates software version of flash and new image file present in directory

Result: This indicates new image file present in directory.

9. Use **delete** command in Exec mode to delete old image file zxr10.zar under the IMG directory in the flash only if space is not sufficient, otherwise just change its name. The command is shown in Table 64.

TABLE 64 DELETE COMMAND WINDOW

Command Format	Command Mode	Command Function
delete	Exec	This deletes file present in flash

- **Result:** This deletes old image file.

10. Copy new image file in background TFTP Server into IMG directory in FLASH. The name of the image file is zxr10.zar. Operation of copying the image file to the flash in TFTP mode is shown in Table 65.

TABLE 65 COPY COMMAND WINDOW

```
ZXR10#copy tftp: //168.4.168.89/zxr10.zar
flash: /img/zxr10.zar
Starting copying file
.....................................................................
.....................................................................
.....................................
file copying successful.
ZXR10#
```

Result: This copies new image file in flash.

11. Check whether the new image file exists in FLASH using command ***show version*** in Exec mode. If file does not exist, this indicates a copy failure.

    Important! If file does not exist, this indicates a copy failure.

TABLE 66 SHOW VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
show version	Exec	This indicates software version of flash and new image file present in directory

Result: This indicates new image file present in directory.

12. Reboot ZXR10 GER, based on method mentioned in Step 8; change boot mode to "Boot from the flash". In this case, "Boot path" will change to "/flash/img/zxr10.zar" automatically.

    Note: Boot mode can also be changed to "Boot from the FLASH" by using the command **nvram imgfile-location local** in the global configuration mode.

13. Under [ZXR10 Boot]: enter "@" and press <ENTER>, system boots with new image from FLASH.

14. After normal boot, view the image version under running and confirm whether the upgrading is successful.

Version Upgrade in Case of Normal System

Purpose

Refer to below procedure for version upgrading in case of normal system.

Prerequisite

- Router Command Line Interface has been accessed.
- TFTP server is up and running.

Steps

1. Connect serial port of ZXR10 GER (COM port on SMP Panel) to serial port of TFTP Server Computer System with console cable.

   Result: TFTP server computer system and Router are ready to transfer files.

2. Connect management Ethernet port of router (10/100M Ethernet port on BIC) to the network port of TFTP Server Computer System with an Ethernet cable, and make sure the connections are correct.

   Result: Media (Ethernet cable) is ready to transfer files.

3. Configure both TFTP Server Computer System Ethernet port and router management Ethernet port of router in the same network section.

   Result: Different IP addresses belonging to same network are configured.

4. View information about the currently running image, use **show version** command, as shown in Table 67.

TABLE 67 SHOW VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
show version	Exec	This indicates software version of flash and new image file present in directory

Result: This indicates new image file present in directory.

5. Use the ***delete*** command in Exec mode to delete the old image file zxr10.zar under the IMG directory in the FLASH only if space is not sufficient, otherwise just change its name. The command is shown in Table 68.

TABLE 68 DELETE COMMAND WINDOW

Command Format	Command Mode	Command Function
delete	Exec	This deletes file present in flash

Result: This deletes old image file.

6. Copy new image file in background TFTP Server into IMG directory in FLASH. The name of the image file is zxr10.zar. The operation of copying the image file to the FLASH in FTP mode is shown in Table 69.

TABLE 69 COPY COMMAND WINDOW

```
ZXR10#copy tftp: //168.4.168.89/zxr10.zar
flash: /img/zxr10.zar
Starting copying file
.....................................................................
.....................................................................
.....................................
file copying successful.
ZXR10#
```

Result: This copies new image file in flash.

7. Check whether the new image file exists in FLASH using command **show version** in Exec mode as shown in Table 70.

Important! If file does not exist, this indicates a copy failure.

TABLE 70 SHOW VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
show version	Exec	This indicates software version of flash and new image file present in directory

Result: This indicates new image file present in directory

Note:

- Reboot ZXR10 GER, Based on method mentioned in Step 8, change the boot mode to "Boot from the FLASH". In this case, "Boot path" will change to "/flash/img/zxr10.zar" automatically.

Note: The boot mode also can be changed to "Boot from the FLASH" by using the command ***nvram imgfile- location local*** in the global configuration mode.

- Under [ZXR10 Boot]: enter "@" and press <ENTER>, system boots with new image from FLASH.
- After normal boot, view the image version under running and confirm whether the upgrading is successful.

END OF STEPS

Example Example is given in steps.

Data Backup and Recovery

Purpose This procedure delivers information about how to make backup and recovery of image files present in flash.

Prerequisite Router Command Line Interface has been accessed.

TFTP server is up and running as described in TFTP configuration topic.

Steps

1. To save running configuration into NVRAM and flash, use **write/ write flash** command, as shown in Table 71.

TABLE 71 WRITE COMMAND WINDOW

Command Format	Command Mode	Command Function
write	Exec	This starts writing function
write flash	Exec	This writes to flash memory
write logging	Exec	This writes running system file to M&S UPC
write nvram	Exec	This writes to NVRAM memory

Note: When a command is used to modify configuration of a router, the information is running in the memory in real time. If the router reboots, all new configurations will lost.

Result: This writes running configuration into memory.

2. To backup configuration files on TFTP server or in FTP server, use **copy/copy flash** command, as shown in Table 72.

TABLE 72 COPY COMMAND WINDOW

Command Format	Command Mode	Command Function
copy	Exec	This copies image and configuration files from TFTP server or FTP server to Router and Vice versa
copy flash	Exec	This copies from flash file system
copy ftp	Exec	This copies from ftp: file system
copy tftp	Exec	This copies from tftp: file system

Result: This makes configuration backup.

Example: The following command can be used to back up a configuration file in the FLASH to the backup TFTP Server.

3. To copy the image file into TFTP server, FTP server or copy from TFTP server, FTP server into router, use **copy** command

```
ZXR10#copy flash: /cfg/db.dat tftp: //168.1.1.1/cfg/db.dat
```

as shown in Table 73.

TABLE 73 COPY COMMAND WINDOW

Command Format	Command Mode	Command Function
copy	Exec	This copies image and configuration files from TFTP server or FTP server to Router and Vice versa
copy flash	Exec	This copies from flash file system
copy ftp	Exec	This copies from ftp: file system
copy tftp	Exec	This copies from tftp: file system

Result: This copies image file from TFTP server or To TFTP server from Router.

Example: The following command can be used to copy an image file into FLASH from TFTP Server.

```
ZXR10#copy tftp: //168.1.1.1/img/zxr10.zar flash:
/img/zxr10.zar
```

Configuring System Parameters

Purpose Refer to below procedure for configuring system parameters of ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.

Steps

1. To set a hostname of system, use **hostname** command in global configuration mode as shown in Table 74.

TABLE 74 HOSTNAME COMMAND WINDOW

Command Format	Command Mode	Command Function
hostname	Global Config	This sets hostname of system

Result: This configures hostname of system.

Note: By default, the host name of the system is ZXR10. After host name is changed, log on to the router again, and the new host name appears on screen.

2. To set Welcome message upon system boot or when login on telnet, use **banner** command in global configuration mode, as shown in Table 75.

TABLE 75 BANNER INCOMING COMMAND WINDOW

Command Format	Command Mode	Command Function
banner	Global Config	This sets hostname of system

Result: This configures hostname of system.

Example

```
ZXR10(config)#banner incoming #
Enter TEXT message.  End with the character '#'.
**********************************
   Welcome to ZXR10 Router World
**********************************
#
    ZXR10(config)#
```

3. To prevent an unauthorized user from modifying the configuration, use **enable secret** {**0** *<password>*|**5** *<password>*|*<password>*} command in global configuration mode, as shown in Table 76.

TABLE 76 ENABLE SECRET COMMAND WINDOW

Command Format	Command Mode	Command Function
enable secret {**0** *<password>*|**5** *<password>*|*<password>*}	Global Config	This sets password for privileged mode

Result: This configures privileged password in order to confirm read/write action.

Note: In the privileged mode, a user can configure operation parameters and also can enter the configuration mode.

4. To set Telnet username and password, use **username** *<username>* **password** *<password>* command in global configuration mode, as shown in Table 77.

TABLE 77 TELNET USERNAME COMMAND WINDOW

Command Format	Command Mode	Command Function
username *<username>* **password** *<password>*	Global Config	This sets Telnet user and password

Result: This configures username and password for telnet session.

5. To set system time, use **clock set** *<current-time>* *<month>* *<day>* *<year>* command in privilged mode, as shown in Table 78.

TABLE 78 CLOCK SET COMMAND WINDOW

Command Format	Command Mode	Command Function
clock set *<current-time>* *<month>* *<day>* *<year>*	Exec	This sets System time

Result: This configures system time.

END OF STEPS

Related Information For more information about system management please refer to below procedure.

Viewing System Information

Purpose Refer to below procedure for viewing system information of ZTE GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To view hardware and software versions of the System, use **show version** command in global configuration mode, as shown in Table 79.

TABLE 79 SHOW VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
show version	Global Config	This displays the version information about the software and hardware of System

Result: This shows the running software and hardware System information.

END OF STEPS

Example: The following information is displayed after carried out show version command.

```
ZXR10#show version
ZXR10 Router Operating System Software, ZTE Corporation
ROS  ZXR10-T64 Software (ZXR10-T64-I-M), Version V1.2.m.n,
(EARLY DEPLOYMENT RELEASE SOFTWARE)
ROM: System Bootstrap, Version 1.0(0), RELEASE SOFTWARE
Copyright (c) 2001-2003 by ZTE Corporation
System image files are <flash:/img/*.img>
ZXR10-T64(MPC750) processor with 512M bytes of memory
Processor Board ID 15007
128K bytes of non-volatile configuration memory
64M bytes of processor board System flash (Read/Write)
ZXR10#
```

Chapter 6

Interface Configuration

Overview

Introduction This chapter describes different types of interfaces on ZXR10 GER and their configuration examples for further illustration.

Contents This chapter covers the following topics.

TABLE 80 TOPICS IN CHAPTER 6

Interfaces Types

Interfaces are divided into following types.

- Physical interfaces
- Logical interfaces

Physical Interfaces These refer to interfaces, which exist physically, such as Ethernet interface POS interfaces, ATM interfaces and E1 interfaces.

Logical Interfaces These interfaces are configured logically and are not physical they are also called virtual interfaces, such as VLAN sub-interfaces and Loopback interfaces.

Interface Naming Rules

Introduction

Interfaces of ZTE ZXR10 GER are named in the following rule <Interface type>_<Slot ID>/<Port ID>. <Sub-interface or channel ID> Follow for interface types and their descriptions.

Interface Type	Description
fei	Fast Ethernet interface
gei	Gigabit Ethernet interface
pos3	155M POS interface
pos12	622M POS interface
pos48	2.5 POS interface
atm155	155M ATM interface
ce1	CE1 interface
ce3	CE3 interface
serial	Channelized E1 interface (E3 interface in Channelized mode)
smtgrp	SmartGroup interface
multi	MultiLink interface
loopback	Loopback interface

- <Slot ID> refers to physical slots where line interface module is installed, ranging from 1 to 8 (ZXR10 GER08) or from 1 to 4 (ZXR10 GER04) or from 1to 2(ZXR10 GER02).
- <Port ID> refers to number allocated to line interface module connector. The value range and assignment of port IDs depend upon different types of line interface modules.
- <Sub-interface or channel ID> refers to sub-interface ID or channel ID of E1 or E3 interface.

Physical Interfaces

Physical interfaces cover the following topics.

Configuring Ethernet Interfaces

Purpose This below procedure describes how to do configuration of Ethernet interfaces on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- Ethernet Interfaces is connected and running.

Steps

1. Enter into configuration mode by writing following command as shown in Table 81.

TABLE 81 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. Enter into interface configuration mode by writing following command in global configuration mode, as shown in Table 82.

TABLE 82 INTERFACE CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
interface *<interface-*	global config	This enters into interface configuration mode

Command Format	Command Mode	Command Function
number>		

Result: This enables to enter into interface configuration mode.

3. To configure an IP address of an interface, use **ip address** *<ip-address>* *<net-mask>* [*<broadcast-address>*] command in interface configuration mode, as shown in Table 83.

TABLE 83 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address *<ip-address>* *<net-mask>* [*<broadcast-address>*]	interface config	This configures an ip address of an interface

Result: This configures an ip address of an interface.

4. For configuring duplex mode of an interface, use **full-duplex / half-duplex** command interface configuration mode, as shown in Table 84.

TABLE 84 DUPLEX COMMAND WINDOW

Command Format	Command Mode	Command Function
full-duplex	interface config	This configures duplex mode of fast Ethernet interface to full duplex
half-duplex	interface config	This configures duplex mode of fast Ethernet interface to half duplex

Result: This sets duplex mode for an interface.

5. To configure negotiation mode of an interface, use **negotiation auto** command in interface configuration mode, as shown in Table 85**.**

TABLE 85 INTERFACE AUTOCONFIG COMMAND

Command Format	Command Mode	Command Function
negotiation auto	Interface	This enables auto negotiation of gigabit Ethernet interface

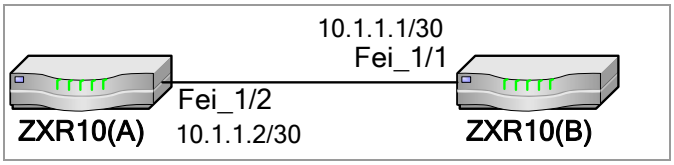
Result: This configures auto negotiation of gigabit Ethernet interface.

Note: Configuration of duplex mode is only applicable to Fast Ethernet interfaces, and negotiation is only applicable to Gigabit Ethernet interfaces.

END OF STEPS

Example: As shown in Figure 56, interface of ZTE ZXR10 GER is connected to the et.2.1 interface of ZXR10 routing switch.

FIGURE 56 ETHERNET INTERFACE CONFIGURATION



Configuration of ZXR10(A)

```
ZXR10(config)#interface fei_1/2
ZXR10(config-if)#ip address 10.1.1.2 255.255.255.252
ZXR10(config-if)#full-duplex
```

Configuration of ZXR10 (B)

```
ZXR10(config)#interface fei_1/1
ZXR10(config-if)#ip address 10.1.1.1 255.255.255.252
ZXR10(config)# full-duplex
```

Configuring E1 Interface

Introduction

Similar to the North American T-1, E1 is the European format for digital transmission. E1 interfaces have found wide application in Europe and China. E1 carries signals at 2 Mbps (32 channels at 64Kbps, with 2 channels reserved for signaling and controlling), versus the T1, which carries signals at 1.544 Mbps (24 channels at 64Kbps). E1 and T1 lines may be interconnected for international use.

There are two types of E1 working modes:

- Channelized Mode
- Non-Channelized Mode

Channelized Mode

This is physically divided into 32 timeslots (corresponding to numbers 0 through 31). Bandwidth of each timeslot is 64Kbps. Timeslot 0 is used to transmit synchronous information. Except Timeslot 0, all the other timeslots can be bound into groups. Each group of timeslots can serve as a sub-interface whose logical features are also equivalent to those of a synchronous serial port. An E1 interface can be divided into a maximum of 31 sub-interfaces.

Non-Channelized Mode

This is equivalent to an interface with a data bandwidth of 2.048Mbps without timeslot division. Logical features are similar to those of a synchronous serial port. E1 interface support data link layer protocols (such as PPP, MPPP) and network protocols (such as IP).

Purpose

This procedure describes how to do E1 Configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- E1 cable is connected and running.

Steps

1. Enter into configuration mode by writing following command as shown in Table 86.

TABLE 86 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into E1 configuration mode, use **controller ce1_<***interface-name***>** command in global configuration mode, as shown in Table 87.

TABLE 87 E1 CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
controller ce1_<*interface-name***>**	Global config	enters E1 controller configuration mode

Result: This enables to enter into E1 configuration mode.

3. To configure framing mode of an E1 interface, use **framing** {**unframe|frame**} command in controller configuration mode, as shown in Table 88.

TABLE 88 FRAMING COMMAND WINDOW

Command Format	Command Mode	Command Function
framing {**unframe|frame**}	controller	This configures framing mode of E1 interface. When non-framing mode is configured, system automatically create a sub-channel with channel ID 1

Result: This sets framing mode of an E1 interface.

4. To configure E1 channel for channelized E1, use **channel-group** <*channel-number*> **timeslots** <*timeslots*> command in controller configuration mode, as shown in Table 89.

TABLE 89 CHANNEL GROUP COMMAND

Command Format	Command Mode	Command Function
channel-group <*channel-number*> **timeslots** <*timeslots*>	controller	This configures channel number and time slots of E1 interface

Result: This configures E1 channels and timeslots for channelized E1.

5. To configure an ip address for E1 interface, use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 90.

TABLE 90 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures IP address of an interface

Result: This configures an ip address of an interface.

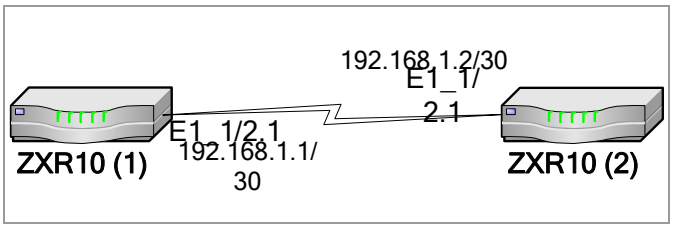
Note: In configuration of routers at both ends of an E1 interface, following parameters of E1 interface must be consistent: Timeslot, framing, linecode (HDB3 by default), CRC (32 by default), L2 encapsulation protocol (PPP by default). In addition pay attention to clock synchronization.

END OF STEPS

Example: Channelized Configuration

As shown in Figure 57, E1 interface of ZTE ZXR10 GER (1) is interconnected with E1 interface of another ZTE ZXR10 GER (2). In channelized configuration timeslots 1 through 10 are used. The default L2 WAN encapsulation protocol is PPP, linecode is hdb3, frame format is crc32 and clock mode is "internal".

FIGURE 57 CHANNELIZED E1 CONFIGURATION



Configuration of ZXR10 (1):

```
ZXR10(1)(config)#controller ce1_1/2
ZXR10(1)(config-control)#channel-group 1 timeslots 1-10
ZXR10(1)(config-control)#exit
ZXR10(1)(config)#interface e1_1/2.1
ZXR10(1)(config-if)#ip address 192.168.1.1 255.255.255.252
```

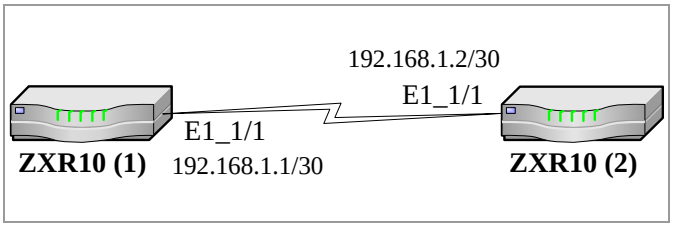
Configuration of ZXR10 (2):

```
ZXR10(2)(config)#controller ce1_1/2
ZXR10(2)(config-control)#channel-group 1 timeslots 1-10
ZXR10(2)(config-control)#exit
ZXR10(2)(config)#interface e1_1/2.1
ZXR10(2)(config-if)#ip address 192.168.1.2 255.255.255.252
```

Example: Non-Channelized Configuration

As shown in Figure 58, E1 interface of ZTE ZXR10 GER (1) is interconnected with E1 interface of another ZTE ZXR10 GER (2). Non-channelized configuration is used.

FIGURE 58 NON-CHANNELIZED CONFIGURATION



Configuration of ZTE ZXR10 GER (1):

```
ZXR10(1) (config)#controller ce1_1/1
ZXR10(1) (config-control)#framing unframe
ZXR10(1) (config-control)#exit
ZXR10(1) (config)#interface e1_1/1.1
ZXR10(1) (config-if)#ip address 192.168.1.1 255.255.255.252
```

Note: When an E1 interface is set to non-channelized mode, its interface name is e1_slot ID/port ID.1, such as e1_1/1.1.

Configuration of ZTE ZXR10 GER (2):

```
ZXR10(2) (config)#controller e1 e1_1/1
ZXR10(2) (config-control)#framing unframe
ZXR10(2) (config-control)#exit
ZXR10(2) (config)#interface e1_1/1.1
ZXR10(2) (config-if)#ip address 192.168.1.2 255.255.255.252
```

Configuring CE3 Interface

Background

Similar to North American T-3, CE3 is the European format for digital transmission. CE3 Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 34.368 Mbps. E3 lines can be leased for private use from common carriers.

There are two types of CE3 working modes.

- Channelized Mode
- Non-Channelized Mode

Channelized Mode

This is the demultiplex 16 E1 signals. Each E1 can be configured freely to channelized or non-channelized E1.

Non-Channelized Mode

When an E3 interface works in the non-channelized mode, this is equivalent to an interface with a data bandwidth of 34.368Mbps. Its logical features are similar to those of a synchronous serial port. E3 interface support data link layer protocols (such as PPP, MPPP) and network protocols (such as IP).

Purpose

This procedure describes how to do E3 Configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- E3 Cable is connected and running

Steps

1. Enter into configuration mode by writing following command as shown in Table 91.

TABLE 91 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into E3 configuration mode, use **controller ce3_<***interface-name***>** command in controller configuration mode, as shown in Table 92.

TABLE 92 E1 CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
controller ce3_<*interface-name***>**	controller	enters E1 controller configuration mode

Result: This enables to enter into E3 configuration mode.

3. To configure channelized mode of E3 interface, use **Channelized e3 <***interface-name***>** command in controller configuration mode, as shown in Table 93.

TABLE 93 CHANNELIZED COMMAND

Command Format	Command Mode	Command Function
Channelized e3 <*interface-name***>**	controller	This configures channelized mode

Result: This sets E3 interface into channelized mode.

4. To configure frame mode of an E3 interface, use **framing** {**unframe|frame**} command in controller configuration mode, as shown in Table 94.

TABLE 94 FRAMING COMMAND WINDOW

Command Format	Command Mode	Command Function
framing {**unframe|frame**}	global config	This configures framing mode of E3 interface. When non-framing mode is configured, system automatically create a sub-channel with channel ID 1

Result: This sets framing mode of an E1 interface.

5. To configure an ip address for E3 interface use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 95.

TABLE 95 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures IP address of an interface

Result: This sets an ip address of E3 interface.

Non-Channelized E3 configuration covers the following contents.

6. To enter into E3 configuration mode, use **controller e3/t3** <*interface-name*>command in global configuration mode, as shown in Table 96.

TABLE 96 E1 CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
controller e3/t3 <*interface-name*>	global config	enters E1 controller configuration mode

Result: This enables to enter into E3 configuration mode.

7. To configure non-channelize mode of E3 interface, use **No channelized** command in controller configuration mode, as shown in Table 97.

TABLE 97 CHANNELIZED COMMAND

Command Format	Command Mode	Command Function
No channelized	controller	This configures channelized mode

Result: This sets E3 interface into channelized mode.

8. To configure frame mode of an E3 interface, use **framing** {unframe|frame} command in global configuration mode, as shown in Table 98.

TABLE 98 FRAMING COMMAND WINDOW

Command Format	Command Mode	Command Function
framing {unframe|frame}	global config	This configures framing mode of E3 interface. When non-framing mode is configured, system automatically create a sub-channel with channel ID 1

Result: This sets framing mode of an E1 interface.

9. To configure an ip address for E3 interface use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 99.

TABLE 99 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures IP address of an interface

Result: This sets an ip address of E3 interface.

END OF STEPS

Example:

As shown in Figure 59, ce3_5/2 interfaces of two ZTE ZXR10 GER units are interconnected. Channelized configuration is used.

FIGURE 59 E3 EXAMPLE

Configuration of R1:

```
ZXR10_R1(config)#controller ce3_5/2
ZXR10_R1(config-control)#channelized e1
ZXR10_R1(config-control)#e1 2 framed
ZXR10_R1(config-control)#e1 3 framed
ZXR10_R1(config-control)#e1 4 framed
ZXR10_R1(config-control)#e1 5 framed
ZXR10_R1(config-control)#e1 6 framed
ZXR10_R1(config-control)#e1 7 framed
ZXR10_R1(config-control)#e1 8 framed
ZXR10_R1(config-control)#e1 9 framed
ZXR10_R1(config-control)#e1 10 framed
ZXR10_R1(config-control)#e1 11 framed
ZXR10_R1(config-control)#e1 12 framed
ZXR10_R1(config-control)#e1 13 framed
ZXR10_R1(config-control)#e1 14 framed
ZXR10_R1(config-control)#e1 15 framed
ZXR10_R1(config-control)#e1 16 framed
ZXR10_R1(config-control)#e1 17 framed

ZXR10_R1(config)#interface serial_5/2.2
ZXR10_R1(config-if)#ip address 10.1.2.1 255.255.255.0

ZXR10_R1(config)#interface serial_5/2.3
ZXR10_R1(config-if)#ip address 10.1.3.1 255.255.255.0
```

```
.....
ZXR10_R1(config)#interface serial_5/2.17
ZXR10_R1(config-if)#ip address 10.1.17.1 255.255.255.0
```

Configuration of R2:

```
ZXR10_R2(config)#controller ce3_5/2
ZXR10_R2(config-control)#channelized e1
ZXR10_R2(config-control)#e1 2 framed
ZXR10_R2(config-control)#e1 3 framed
ZXR10_R2(config-control)#e1 4 framed
ZXR10_R2(config-control)#e1 5 framed
ZXR10_R2(config-control)#e1 6 framed
ZXR10_R2(config-control)#e1 7 framed
ZXR10_R2(config-control)#e1 8 framed
ZXR10_R2(config-control)#e1 9 framed
ZXR10_R2(config-control)#e1 10 framed
ZXR10_R2(config-control)#e1 11 framed
ZXR10_R2(config-control)#e1 12 framed
ZXR10_R2(config-control)#e1 13 framed
ZXR10_R2(config-control)#e1 14 framed
ZXR10_R2(config-control)#e1 15 framed
ZXR10_R2(config-control)#e1 16 framed
ZXR10_R2(config-control)#e1 17 framed

ZXR10_R2(config)#interface serial_5/2.2
ZXR10_R2(config-if)#ip address 10.1.2.2 255.255.255.0

ZXR10_R2(config)#interface serial_5/2.3
ZXR10_R2(config-if)#ip address 10.1.3.2 255.255.255.0
.....
ZXR10_R2(config)#interface serial_5/2.17
ZXR10_R2(config-if)#ip address 10.1.17.2 255.255.255.0
```

Configuring Packet over Sonet

Background

Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) has emerged as significant technologies for building large-scale, high-speed, Internet Protocol (IP)-based networks. Even though SONET/SDH is frequently labeled as "Old World" because this is a time division-multiplexing (TDM) technology optimized for voice traffic, its capability to provide high-bandwidth capacity for transporting data is the primary reason for ubiquitous use in the Internet and large enterprise data networks.

Packet over SONET (PoS) technology, which allows efficient transport of data over SONET/SDH, has certainly been a major player in accommodating explosive growth on Internet.

Network Backbone Infrastructure

PoS provides a flexible solution to well known applications that includes network backbone infrastructures and data aggregation or distribution on network edge and in metropolitan area. Router PoS interfaces are frequently connected to Add Drop Multiplexers (ADMs), terminating point-to-point SONET/SDH links. Direct connections over dark fiber or via dense wave-division multiplexing (DWDM) systems are becoming increasingly popular.

Sonet/SDH Rates

Basic transmission rate of SONET (51.840 Mbps), referred to as Synchronous Transport Signal level 1 (STS-1), is obtained by sampling 810-byte frames at 8000 frames per second. SONET features an octet-synchronous multiplexing scheme with transmission rates in multiples of 51.840 Mbps.

ZTE POS

There are different POS interfaces in ZXR10 GER depending upon transmission rates, which are described in Figure 60 , also shown are corresponding transmission rates and terminology for SDH. SDH is SONET-equivalent specification proposed by International Telecommunications Union (ITU). SDH supports only a subset of SONET data rates, starting from 155.520 Mbps.

FIGURE 60 SONET SDH RATES

SONET	SDH	Data Rates
STS-1		51.840 Mbps
STS-3	STM-1	155.520 Mbps
STS-12	STM-4	622.080 Mbps
STS-48	STM-16	2,488.320 Mbps

Pos Framing

PoS use PPP in High-Level Data Link Control (HDLC)-like framing (as specified in RFC 1662) for data encapsulation at Layer 2 (data link) of Open System Interconnection (OSI) stack. This method provides efficient packet delineation and error control. The frame format for PPP in HDLC-like framing is shown in Figure 61.

FIGURE 61 PPP FRAME FORMAT

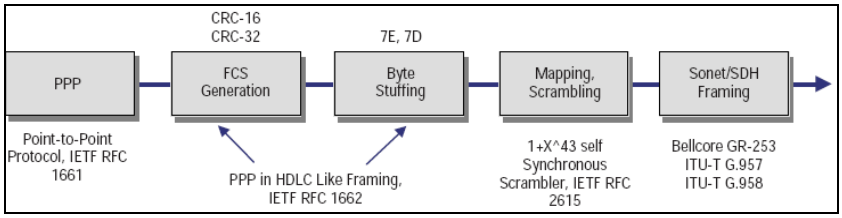
RFC2615

RFC 2615 specifies use of PPP encapsulation over SONET/SDH links. PPP was designed for use on point-to-point links and is

suitable for SONET/SDH links, which are provisioned as point-to-point circuits even in ring topologies. PoS specifies STS-3c/STM-1 (155 Mbps) as basic data rate and this has a usable data bandwidth of 149.760 Mbps. PoS frames are mapped into SONET/SDH frames and they sit in payload envelop as octet streams aligned on octet boundaries.

Figure 62 shows framing process. RFC 2615 recommends payload scrambling and a safeguard against bit sequences, which may disrupt timing. PoS payload scrambling is further discussed in the section "Synchronization."

FIGURE 62 POS FRAMING SEQUENCE



Purpose This procedure describes how to do PoS configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into configuration mode, use **config terminal** command in privilged mode, as shown in Table 100.

TABLE 100 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into packet over sonnet configuration mode, use **interface** *<interface-number>* command in global configuration mode, as shown in Table 101.

TABLE 101 INTERFACE CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
interface *<interface-number>*	global config	This enters into Packet over sonnet configuration mode

Result: This enables to enter into interface configuration mode.

3. To configure an IP address of an interface, use the **ip address** <*ip-address*> <*net-mask*> [<*broadcast-address*>] command in interface configuration mode, as shown in Table 102.

TABLE 102 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <*ip-address*> <*net-mask*> [<*broadcast-address*>]	interface config	This configures an ip address of an interface

Result: This configures an ip address of an interface.

4. To configure clock source for PoS interface, use **clock source** {external|internal|line} command in global configuration mode, as shown in Table 103.

TABLE 103 CLOCK SOURCE COMMAND

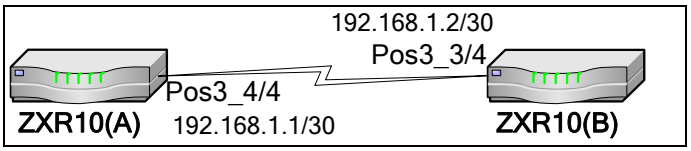
Command Format	Command Mode	Command Function
clock source {external|internal|line}	global config	This configures clock source for POS interface

Result: This sets clock source of PoS interface.

END OF STEPS

Example: As shown in Figure 63 , the pos3_4/4 interface of ZTE ZXR10 GER is connected to so.13.1 interface of ZXR10 routing switch.

FIGURE 63 PACKET OVER SONET EXAMPLE



Configuration of ZXR10 (A)

```
ZXR10(config)#interface pos3_4/4
ZXR10(config-if)#ip address 192.168.1.1 255.255.255.252
```

Configuration of ZXR10 (B)

```
ZXR10(config)#interface pos3_3/4
ZXR10(config-if)#ip address 192.168.1.2 255.255.255.252
```

Configuring ATM

Background

Asynchronous transfer mode (ATM) is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic. Networks that have been primarily focused on providing better voice services are evolving to meet new multimedia communications challenges and competitive pressures.

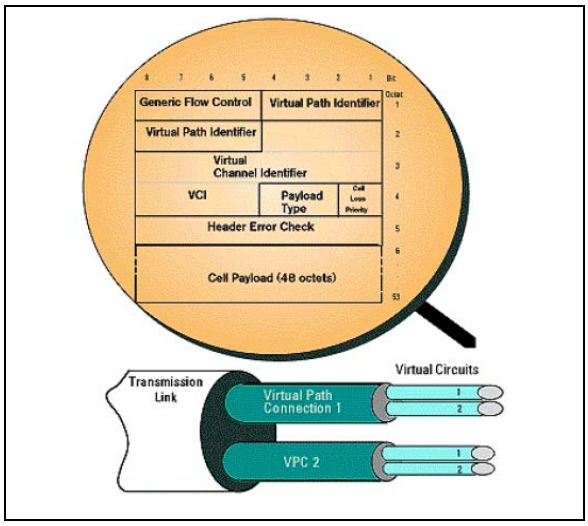
Service Based

Services based on asynchronous transfer mode (ATM) and synchronous digital hierarchy (SDH)/synchronous optical network (SONET) architectures provide flexibility essential for success in this market. The most basic service building block is ATM virtual circuit, which is an end-to-end connection that has defined end points and routes.

ATM Cells

In ATM networks, all information is formatted into fixed-length cells consisting of 48 bytes (8 bits per byte) of payload and 5 bytes of cell header. The fixed cell size ensures that time-critical information such as voice or video is not adversely affected by long data frames or packets. The header is organized for efficient switching in high-speed hardware implementations and carries payload-type information, virtual-circuit identifiers, and header error check.

FIGURE 64 ATM FIXED LENGTH CELLS



VPI / VCI

ATM standards defined two types of ATM connections: virtual path connections (VPCs), which contain virtual channel connections (VCCs). A virtual channel connection (or virtual circuit) is the basic unit, which carries a single stream of cells, in order, from user to user.

Virtual Connection

A collection of virtual circuits can be bundled together into a virtual path connection. A virtual path connection can be created from end-to-end across an ATM network. In this case, the ATM

network does not route cells belonging to a particular virtual circuit. All cells belonging to a particular virtual path are routed the same way through the ATM network, thus resulting in faster recovery in case of major failures.

Service Class	Quality of Service Parameters
Constant Bit Rate (CBR)	This class is used for emulating circuit switching. The cell rate is constant with time. CBR applications are quite sensitive to cell-delay variation. Examples of applications that can use CBR are telephone traffic (i.e., nx64 kbps), videoconferencing, and television.
Variable bit rate–non-real time (VBR–NRT)	This class allows users to send traffic at a rate that varies with time depending on the availability of user information. Statistical multiplexing is provided to make optimum use of network resources. Multimedia e-mail is an example of VBR–NRT.
Variable bit rate–real time (VBR–RT)	This class is similar to VBR–NRT but is designed for applications that are sensitive to cell-delay variation. Examples for real-time VBR are voice with speech activity detection (SAD) and interactive compressed video.
Available bit rate (ABR)	This class of ATM services provides rate-based flow control and is aimed at data traffic such as file transfer and e-mail. Although the standard does not require the cell transfer delay and cell-loss ratio to be guaranteed or minimized, it is desirable for switches to minimize delay and loss as much as possible. Depending upon the state of congestion in the network, the source is required to control its rate. The users are allowed to declare a minimum cell rate, which is guaranteed to the connection by the network.
Unspecified bit rate (UBR)	This class is the catch-all, other class and is widely used today for TCP/IP.

ATM Standards

ZTE ZXR10 GER provides ATM 155M and ATM 622M standard speed interfaces. They can support IP Over ATM, Encapsulation of IP Over ATM LLC/SNAP, ATM AAL5, IP routing, ATM cell processing, 256 PVCs and point-to-point connection.

Purpose

Refer to below procedure for ATM configuration on ZTE ZXR10 GER Routers.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. To enter into configuration mode, use **config terminal** command in privileged mode, as shown in Table 104.

TABLE 104 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into ATM interface configuration mode, use **interface** <interface-number> command in global configuration mode, as shown in Table 105.

TABLE 105 INTERFACE CONFIG COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	global config	This enters into interface configuration mode

Result: This enables to enter into interface configuration mode.

3. To create ATM PVC, use **atm pvc** <*vpi*> <*vci*> command in interface configuration mode, as shown in Table 106.

TABLE 106 PVC COMMAND

Command Format	Command Mode	Command Function
atm pvc <*vpi*> <*vci*>	Interface	This creates PVC

4. To configure an IP address of an interface, use **ip address** <*ip-address*> <*net-mask*> [<*broadcast-address*>] command in interface configuration mode, as shown in Table 107.

TABLE 107 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <*ip-address*> <*net-mask*> [<*broadcast-address*>]	Interface	This configures an ip address of an interface

Result: This configures an ip address of an interface.

5. To enable oam F5 management of PVCs, use **oam-pvc** manage [<*frequency*>] command in interface configuration mode, as shown in Table 108.

TABLE 108 OAM-PVC PVC MANAGEMENT

Command Format	Command Mode	Command Function
oam-pvc manage [<*frequency*>]	Interface	This enables oamF5 management of PVCs

Result: This creates oamF5 PVCs management.

6. To configure OamF5 management parameters, use **oam-pvc** manage [<*frequency*>] command in interface configuration mode, as shown in Table 109.

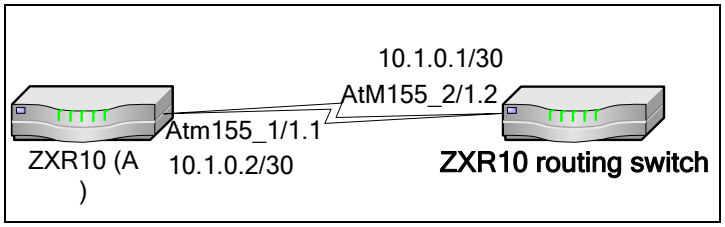
TABLE 109 OAM-RETRY

Command Format	Command Mode	Command Function
oam-pvc manage [<*frequency*>]	Interface	This enables oamF5 management of PVCs

Result: This enables oamF5 PVC management.

Example: As shown in Figure 65 , atm155_1/1.1 interface of ZTE ZXR10 GER is connected to at.5.1 interface of ZXR10 routing switch.

FIGURE 65 ATM CONFIGURATION EXAMPLE



END OF STEPS

Configuration of ZXR10 GER(A)

```
ZXR10(config)#interface atm155_1/1.1
ZXR10(config-if)#atm pvc 2 40
ZXR10(config-if)#ip address 10.10.0.2 255.255.255.252
```

Configuration of ZXR10 GER(B)

```
ZXR10(config)#interface atm155_2/1.1
ZXR10(config-if)#atm pvc 2 40
ZXR10(config-if)#ip address 10.1.0.1 255.255.255.252
```

Configuring VLAN-Sub Interface

Background

IEEE 802.1q was a project in IEEE 802 standards process to develop a mechanism to allow multiple bridged networks to transparently share same physical network link without leakage of information between networks (i.e. "trunking"). IEEE 802.1q is also name of standard issued by this process and in common usage name of encapsulation protocol used to implement this mechanism over Ethernet networks.

802.1q VLAN Trunk

ZXR10 routers can utilize 802.1q VLAN trunk and sub-interface technology to provide inter-VLAN routes in switch. To terminate different VLANs on switch, multiple logical sub-interfaces should be created on the physical interface of the router. The sub-interfaces correspond to the VLANs on the switch one by one by means of VLAN IDs.

Purpose

This procedure describes how to do VLAN-sub interface on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. To enter into configuration mode, use **config terminal** command in privilged mode, as shown in Table 110.

TABLE 110 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into interface configuration mode, use **interface** <interface-number> command in global configuration mode, as shown in Table 111.

TABLE 111 INTERFACE CONFIG COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	global config	This enters into interface configuration mode

Result: This enables to enter into interface configuration mode.

3. To encapsulate dot1q VLAN-ID, use **encapsulation** dot1Q <*vlan-id*>command in interface configuration mode, as shown in Table 112.

TABLE 112 ENCAPSULATE DOT1Q COMMAND

Command Format	Command Mode	Command Function
encapsulation dot1Q <*vlan-id*>	Interface	This encapsulates VLAN-ID for a created sub-interface

Result: This encapsulates dot1q vlan id for different VLANs.

4. To configure an IP address of an interface, use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 113 .

TABLE 113 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures an ip address of an interface

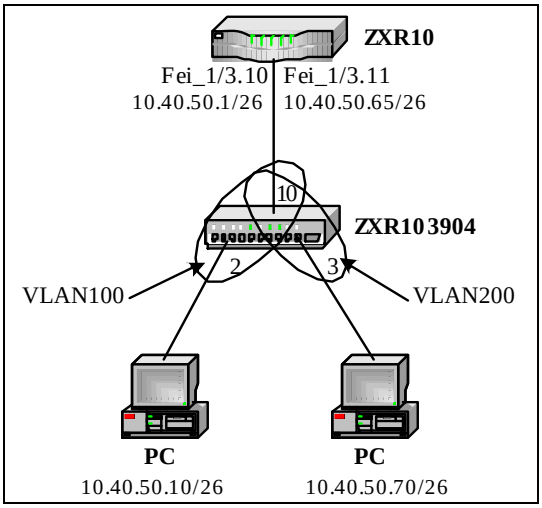
Result: This configures an ip address of an interface.

END OF STEPS

Example: In following configuration example, the VLAN sub-interface technology is applied to implement the access and routing of different VLAN users on same physical Ethernet interface.

As shown in Figure 66, fei_1/3 interface of ZXR10 GER is connected to port 10 of a ZXR10 3904 switch. Ports 2 and 3 of ZXR10 3904 switch belong to VLAN100 and VLAN200 in turn, supporting two PCs.

FIGURE 66 VLAN-SUB INTERFACE EXAMPLE



Configuration of ZTE ZXR10 GER:

```
ZXR10(config)#interface fei_1/3.10
ZXR10(config-subif)#encapsulation dot1q 100
ZXR10(config-subif)#ip address 10.40.50.1 255.255.255.192
ZXR10(config)#interface fei_1/3.11
ZXR10(config-subif)#encapsulation dot1q 200
ZXR10(config-subif)#ip address 10.40.50.65 255.255.255.192
```

Configuration of ZXR10 3904:

```
ZXR10-3904(bridge)#set vlan create br100 100
ZXR10-3904(bridge)#set vlan create br200 200
ZXR10-3904(bridge)#set vlan del br1 2-3,10
ZXR10-3904(bridge)#set vlan add br100 2 untagged
ZXR10-3904(bridge)#set vlan add br100 10 tagged
ZXR10-3904(bridge)#set vlan add br200 3 untagged
ZXR10-3904(bridge)#set vlan add br200 10 tagged
ZXR10-3904(bridge)#set vlan pvid 2 100
ZXR10-3904(bridge)#set vlan pvid 3 200
ZXR10-3904(config)#interface br100
ZXR10-3904(config-if)#no shutdown
ZXR10-3904(config)#interface br200
ZXR10-3904(config-if)#no shutdown
```

Configuring Smart-Group

Background Smart Group refers to aggregation of multiple physical interfaces into one logical interface to provide higher aggregated bandwidth, load balancing, and link redundancy. One SmartGroup interface can contain up to eight Ethernet interfaces in the same board slot. One Ethernet interface board can support up to 31 SmartGroup interfaces.

Purpose This procedure describes how to do smart group configuration on ZTE ZXR10 GER Routers.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into configuration mode, use **config terminal** command in privilged mode, as shown in Table 114.

TABLE 114 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To create a smartgroup interface and to enter into it, use **interface** <interface-number> command in global configuration mode, as shown in Table 115.

TABLE 115 SMART GROUP INTERFACE COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	global config	This creates a smartgroup interface and enters into interface configuration mode

Result: This enables to create smart-group and to enter into it.

3. To configure an IP address of an interface, use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 116.

TABLE 116 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures an ip address of an interface

Result: This configures an ip address of an interface.

4. To add Ethernet interfaces into smartgroup, use **smartgroup** <interface-number>command in interface configuration mode, as shown in Table 117.

TABLE 117 SMART-GROUP ETHERNET COMMAND

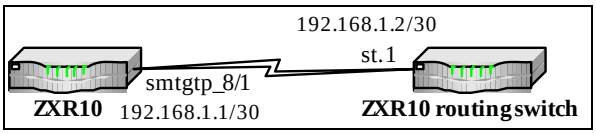
Command Format	Command Mode	Command Function
smartgroup <interface-number>	Interface	This adds Ethernet interfaces into smartgroup

Result: This sets Ethernet interfaces into smartgroup.

END OF STEPS

Example: As shown in Figure 67, the smartgroup1 interface of ZXR10 GER router is interconnected with the st.1 interface of ZXR10 routing switch.

FIGURE 67 SMART-GROUP EXAMPLE



Configuration of ZXR10 GER

```
ZXR10(config)#interface smartgroup1
ZXR10(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10(config)#interface fei_8/1
ZXR10(config-if)#smartgroup 1 mode on
ZXR10(config)#interface fei_8/2
ZXR10(config-if)#smartgroup 1 mode on
```

Configuration of ZXR10 routing switch:

```
T64C(config)#smarttrunk create st.1 protocol no-protocol
T64C(config)#smarttrunk add ports et.3.1-2 to st.1
T64C(config)#interface create ip to-zxr10 address-netmask
192.168.1.2/30 port st.1
```

Configuring Multilink

Background To increase bandwidth, multiple E1 physical links can be bound into a logical link and logical interface generated in this way is called multilink interface.

In ZXR10 GER, a multilink interface can be bound with a maximum of sixteen E1 interfaces in same slot.

Purpose This procedure describes how to do multilink on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into configuration mode, use **config terminal** command in privilged mode, as shown in Table 118.

TABLE 118 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To create multilink interface and to enter into it, use **interface** <interface-number> command in global configuration, as shown in Table 119.

TABLE 119 MULTILINK INTERFACE COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	global config	Creates a multilink interface and enters the interface configuration mode

Result: This enables to create multilink interface and to enter into it.

3. To configure an IP address of an interface, use **ip address** <ip-address> <net-mask> [<broadcast-address>] command in interface configuration mode, as shown in Table 120.

TABLE 120 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures an ip address of an interface

Result: This configures an ip address of an interface.

4. To bind physical link of multiple E1s use **multilink-group** <*multilink-number*> command in interface configuration mode, as shown in Table 121.

TABLE 121 MULTI-LINK GROUP COMMAND

Command Format	Command Mode	Command Function
multilink-group <*multilink-number*>	Interface	This binds link to multilink

Result: This sets multiple E1 links to a group.

5. To configure end point string of multilink, use **ppp multilink endpoint string** <*string*> command in interface configuration mode, as shown in Table 122.

TABLE 122 PPP MULTILINK END POINT COMMAND

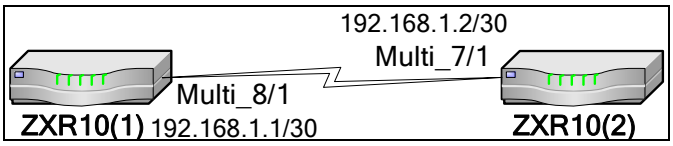
Command Format	Command Mode	Command Function
ppp multilink endpoint string <*string*>	Interface	This configures end point string of multilink

Result: This sets end point string of multilink.

END OF STEPS

Example: As shown in Figure 68 , ZXR10 GER is interconnected to non-channelized E1 interfaces of another ZXR10 GER in a binding manner. PPP serves as the L2 WAN encapsulation protocol.

FIGURE 68 MULTILINK CONFIGURATION EXAMPLE



Configuration of ZXR10 GER (A):

```
ZXR10(1)(config)#interface multilink1
ZXR10(1) (config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10(1) (config)# controller ce1_8/1
ZXR10(1) (config-control)#framing unframe
ZXR10(1) (config)#interface ce1_8/1.1
ZXR10(1) (config-if)#multilink-group multi_8/1
ZXR10(1) (config)#controller ce1_8/2
ZXR10(1) (config-control)#framing unframe
ZXR10(1) (config)#interface ce1_8/2.1
ZXR10 (1) (config-if) #multilink-group multi_8/1.....
ZXR10(1) (config)#controller ce1_8/8
ZXR10(1) (config-control)#framing unframe
ZXR10(1) (config)#interface ce1_8/8.1
ZXR10(1) (config-if)#multilink-group multi_8/1
```

Configuration of ZTE ZXR10 GER (2):

```
ZXR10(2)(config)#interface multi_7/1
ZXR10(2) (config-if)#ip address 192.168.1.2 255.255.255.252

ZXR10(2) (config)#controller ce1_7/1
ZXR10(2) (config-control)#framing unframe
ZXR10(2) (config)#interface ce1_7/1.1
ZXR10(2) (config-if)#multilink-group multi_7/1

ZXR10(2) (config)#controller ce1_7/2
ZXR10(2) (config-control)#framing unframe
ZXR10(2) (config)#interface ce1_7/2.1
ZXR10(2) (config-if)#multilink-group multi_7/1
.....
ZXR10(2) (config)#controller ce1_7/8
ZXR10(2) (config-control)#framing unframe
ZXR10(2) (config)#interface ce1_7/8.1
ZXR10(2) (config-if)#multilink-group multi_7/1
```

Note: When one device is interconnected with multiple routers through multilink, E1 interfaces corresponding to multilink interfaces of routers must have different identifiers.

Configuring CPOS Interface

Background CPOS stands for channelized POS interface. By fully utilizing SDH features, it can divide bandwidth in a refined way, lower the quantity requirement for low-speed physical ports of routers in networking, and improve the convergence ability of low-speed ports and private line access ability of routers.

Purpose Refer to below procedure for configuring CPOS on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into the CPOS channel configuration mode, use **controller** command in global configuration mode, as shown in Table 123.

TABLE 123 CONTROLLER COMMAND

Command Format	Command Mode	Command Function
controller	global config	This enables to enter into the CPOS channel configuration mode

Result: This enables to enter into the CPOS channel configuration mode.

2. To add a description for the interface, use **description** command in interface configuration mode, as shown in Table 124.

TABLE 124 DESCRIPTION COMMAND

Command Format	Command Mode	Command Function
description	Interface config	This adds a description for the interface

Result: This adds a description for the interface.

3. To configure the router interface clock extraction, use **clock source** command in interface configuration mode, as shown in Table 125.

TABLE 125 CLOCK SOURCE COMMAND

Command Format	Command Mode	Command Function
clock	Interface	This configures the router

Command Format	Command Mode	Command Function
source	config	interface clock extraction

Result: This configures the router interface clock extraction.

4. To set the threshold parameter, use **threshold** command in interface configuration mode, as shown in Table 126.

TABLE 126 THRESHOLD COMMAND

Command Format	Command Mode	Command Function
threshold	Interface config	This sets the threshold parameter

5. To set the frame type of cpos3, use **sdh** command in interface configuration mode, as shown in Table 127.

TABLE 127 FRAME TYPE

Command Format	Command Mode	Command Function
sdh	Interface config	This sets the frame type of cpos3 into sdh
sonet.	Interface config	This sets the frame type of cpos3 into sonet

END OF STEPS

Follow Up Action Refer to below procedure for configuring aug.

Aug-3 Mapping

Purpose Refer to below procedure for configuring CPOS on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To set the framing format of T1 channel, use **tug-2**<*Vtg number*> **t1**< *T1 number* > framing command in interface configuration mode, as shown in Table 128.

TABLE 128 T1 CHANNLE FRAME

Command Format	Command Mode	Command Function
tug-2<*Vtg number*> **t1**< *T1 number* > framing	Interface config	This sets the framing format of T1 channel

Result: This sets the framing format of T1 channel.

2. To create a CPOS interface in T1 encapsulation, use **format tug-2**<*Vtg number*> **t1**< *T1 number* > channel-group 1 timeslots <*1-24*>. Command in interface configuration mode, as shown in Table 129.

TABLE 129 T1 ENCAPSULATIONS CPOS INTERFACE

Command Format	Command Mode	Command Function
format tug-2<*Vtg number*> **t1**< *T1 number* > channel-group 1 timeslots <*1-24*>.	Interface config	This creates a cpos interface in the T1 encapsulation

Result: This creates a cpos interface in the T1 encapsulation.

3. To set the clock source of T1 channel, use **tug-2**<*Vtg number***> t1**< *T1 number* **>clock source** command in interface configuration mode, as shown in Table 130.

TABLE 130 T1 CLOCK SOURCE COMMAND

Command Format	Command Mode	Command Function
tug-2<*Vtg number***> t1**< *T1 number* **>clock source**	Interface config	This sets the clock source of T1 channel

Result: This sets the clock source of T1 channel.

END OF STEPS

E1 Encapsulation- AU-4

Purpose Refer to below procedure for configuring E1 encapsulation in case of AU-4 on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into the tug-3 configuration mode, use **au-4 1 tug-3** command in interface configuration mode, as shown in Table 131.

TABLE 131 TUG-3 CONFIG MODE

Command Format	Command Mode	Command Function
au-4 1 tug-3	Interface config	This enables to enter into the tug-3 configuration mode

Result: This enables to enter into the tug-3 configuration mode.

2. To set the framing format of E1 channel, use **tug-2<***Vtg number* **> e1<** *E1 number* **> framing** command in interface configuration mode, as shown in Table 132.

TABLE 132 E1 FRAMING FORMAT

Command Format	Command Mode	Command Function
tug-2<*Vtg number* **> e1<** *E1 number* **> framing**	Interface config	This sets the framing format of E1 channel

Result: This sets the framing format of E1 channel.

3. To create a CPOS interface in the E1 encapsulation format, use **tug-2<***Vtg number***> e1<** *E1 number* **> channel-group 1 timeslots <***1-31***>** command in interface configuration mode, as shown in Table 133.

TABLE 133 E1 CPOS INTERFACE

Command Format	Command Mode	Command Function
tug-2<*Vtg number***> e1<** *E1 number* **> channel-group 1 timeslots <***1-31***>**	Interface config	This creates a CPOS interface in the E1 encapsulation format

Result: This creates a CPOS interface in the E1 encapsulation format.

4. To set the clock source of E1 channel, use **tug-2<***Vtg number***> e1<** *E1 number* **> clock source** command in interface configuration mode, as shown in Table 134.

TABLE 134 E1 CLOCK SOURCE

Command Format	Command Mode	Command Function
tug-2<*Vtg number***>**	Interface config	This sets the clock source of E1 channel

Command Format	Command Mode	Command Function
e1 < *E1 number* **> clock source**		

Result: This sets the clock source of E1 channel.

5. To set frame as a sonet, use **sonet** command in interface configuration mode, as shown in Table 135.

TABLE 135 SONET FRAMING

Command Format	Command Mode	Command Function
sonet	Interface config	This sets the framing as a sonet

Result: This sets the framing as a sonnet.

6. To enter into the sts-1 configuration mode, use **sts-1** command in global configuration mode, as shown in Table 136.

TABLE 136 STS-1 COMMAND

Command Format	Command Mode	Command Function
sts-1	global config	This enter into the sts-1 configuration mode

Result: This enters into the sts-1 configuration mode.

7. To select the mapping mode of sts-1, vt-15 or vt-2, use **mode** command in interface configuration mode, as shown in Table 137.

TABLE 137 MODE COMMAND

Command Format	Command Mode	Command Function
mode	Interface config	This select the mapping mode of sts-1, vt-15 or vt-2

Result: This select the mapping mode of sts-1, vt-15 or vt-2.

END OF STEPS

E1 Encapsulation-VT-2

Purpose Refer to below procedure for configuring E1 encapsulation in case of VT-2 ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enter into the vt-2 configuration mode, use **vt-2 1** command in global configuration mode, as shown in Table 138.

TABLE 138 VT-2.1 COMMAND

Command Format	Command Mode	Command Function
vt-2 1	global config	This enables to enter into the vt-2 configuration mode

Result: This enables to enter into the vt-2 configuration mode.

2. To set the framing format of E1 channel in VTG, use **vtg<***Vtg number* **> e1<** *E1 number* **> framing** command in interface configuration mode, as shown in Table 139.

TABLE 139 E1 CHANNLE FRAME FORMAT

Command Format	Command Mode	Command Function
vtg<*Vtg number* **> e1<** *E1 number* **> framing**	Interface config	This sets the framing format of E1 channel in VTG

Result: This sets the framing format of E1 channel in VTG.

3. To create a CPOS interface in the E1 encapsulation format, use **vtg**<*Vtg number*> **e1**< *E1 number* > **channel-group 1 timeslots** <*1-31*> command in interface configuration mode, as shown in Table 140.

TABLE 140 VTG CHANNEL GROUP

Command Format	Command Mode	Command Function
vtg<*Vtg number*> **e1**< *E1 number* > **channel-group 1 timeslots** <*1-31*>	Interface config	This creates a CPOS interface in the E1 encapsulation format

Result: This creates a CPOS interface in the E1 encapsulation format.

4. To set the clock source of E1 channel, use **vtg<***Vtg number***> e1<** *E1 number* **> clock source** command in interface configuration mode, as shown in Table 141.

TABLE 141 E1 CHANNLE CLOCK SOURCE

Command Format	Command Mode	Command Function
vtg<*Vtg number***> e1<** *E1 number* **> clock source**	Interface config	This sets the clock source of E1 channel

Result: This sets the clock source of E1 channel.

5. To configure the network address of the CPOS interface, use **ip address** command in interface configuration mode, as shown in Table 142.

TABLE 142 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address	Interface configuration	This configures the network address of the CPOS interface

Result: This configures the network address of the CPOS interface.

6. To configure crc mode, use **ip address** command in interface configuration mode, as shown in Table 143.

TABLE 143 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address	Interface config	This configures the crc mode

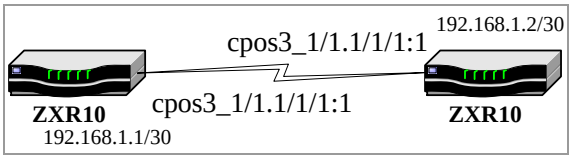
Result: This configures the crc mode.

END OF STEPS

Example:

As shown in Figure 69, CP3 of a ZXR10 GER router is interconnected with that of a remote ZXR10 GER router. It adopts channelized configuration, 1-24 timeslots, layer-2 WAN encapsulation protocol PPP, crc16 frame format and internal clock mode.

FIGURE 69 EXAMPLE OF CHANNELIZED CPOS CONFIGURATION



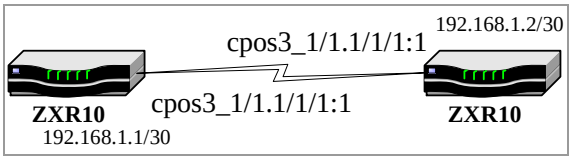
ZXR10 configuration:

```
ZXR10(config)# controller cpos3_1/1
ZXR10(config-control)#clock source internal
ZXR10(config-control)# framing sdh
ZXR10(config-control)# aug mapping au-3
ZXR10(config-control)# au-3 1
ZXR10((config-ctrlr-au3)# tug-2 1 t1 1 fr fr
ZXR10((config-ctrlr-au3)# tug-2 1 t1 1 channel-group 1 timeslots 1-24
ZXR10((config-ctrlr-au3)#exit
ZXR10(config-control)#exit
ZXR10(config-control)#exit
ZXR10(config-control)#exit
ZXR10(config)#interface cpos3_1/1.1/1/1:1
ZXR10(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10(config-if)#crc 16
```

Example of Non-channelized CPOS Interface Configuration

As shown in Figure 70, the CP3 of a ZXR10 GER router is interconnected with that of a remote ZXR10 GER router. It adopts non-channelized configuration, layer-2 WAN encapsulation protocol PPP, crc16 frame format and internal clock mode.

FIGURE 70 EXAMPLE OF NON-CHANNELIZED CPOS CONFIGURATION



ZXR10 configuration:

```
ZXR10(config)# controller cpos3_1/1
ZXR10(config-control)#clock source internal
ZXR10(config-control)# framing sdh
ZXR10(config-control)# aug mapping au-3
ZXR10(config-control)# au-3 1
ZXR10((config-ctrlr-au3)# tug-2 1 t1 1 framing unframe
ZXR10((config-ctrlr-au3)#exit
ZXR10(config-control)#exit
ZXR10(config-control)#exit
ZXR10(config-control)#exit
ZXR10(config)#interface cpos3_1/1.1/1/1:1
ZXR10(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10(config-if)#crc 16
```

Chapter 7

V_Switch Configuration

Overview

Introduction This chapter introduces relevant configurations of the V_Switch on the ZXR10 GER router.

Contents This chapter covers following topics.

TABLE 144 TOPICS IN CHAPTER 7

V_Switch Overview

In the "router + BAS" networking, the router serves as two roles:

- Forwarding PPPoE to the BAS equipment
- Implementing data convergence and providing such services as access (VPN), QoS, NAT and multicast for important customers.

Therefore, the ZXR10 GER implements layer 2 transmissions of packets in the static V_Switch transparent transmission mode.

Configuring V_Switch

Purpose Refer to below procedure for configuring V_switch on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To configure the forwarding mode of an interface, use **ip forwarding-mode** command in interface configuration mode, as shown in Table 145.

TABLE 145 IP FORWARDING MODE

Command Format	Command Mode	Command Function
ip forwarding-mode	Interface config	This configures the forwarding mode of an interface

Result: This configures the forwarding mode of an interface.

.2. To configure the forwarding table of the V_Switch, use **vlan-forwarding ingress** command in interface configuration mode, as shown in Table 146.

TABLE 146 VLAN FORWARDING INGRESS

Command Format	Command Mode	Command Function
vlan-forwarding ingress	Interface config	This configures the forwarding table of the V_Switch

Result: This configures the forwarding table of the V_Switch.

END OF STEPS

Example:

Introduction

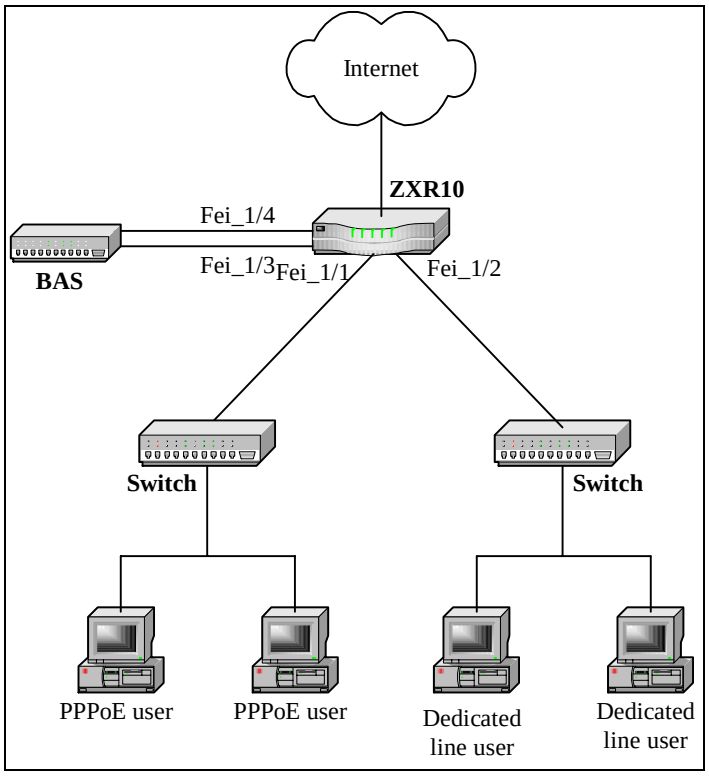
The following takes the Ethernet interface as an example to introduce V_Switch configuration. For detailed V_Switch transparent transmission configurations of the POS and ATM interfaces, refer to "Chapter 10

Bridge Configuration". As shown in Figure 71, the fei_1/3 interface of the ZXR10 GER is connected to the user side of the BAS and the fei_1/4 interface is connected to the network side of the BAS.

PPPoE Connection

The fei_1/3 interface of the ZXR10 GER connects PPPoE users and the fei_1/2 interface connects dedicated line users. The VLAN ID range of PPPoE users is 10~19. The corresponding VLAN ID range at the user side of the BAS is 20~29 and that of dedicated line users is 30~31.

FIGURE 71 V_SWITCH CONFIGURATION EXAMPLE



There are two methods for ZXR10 configuration.

Method 1:

```
ZXR10(config)#interface fei_1/3
ZXR10(config-if)#ip forwarding-mode vlan-switch
ZXR10(config)#interface fei_1/1
ZXR10(config-if)#ip forwarding-mode vlan-switch
ZXR10(config)# vlan-forwarding ingress fei_1/1 10
egress fei_1/3 20 range 10
ZXR10(config)#interface fei_1/4
ZXR10(config-if)#ip      address      192.168.1.1
255.255.255.252
ZXR10(config)#interface fei_1/2.30
ZXR10(config-subif)#encapsulation dot1q 30
ZXR10(config-subif)#ip      address      10.1.1.1
255.255.255.192
ZXR10(config)#interface fei_1/2.31
ZXR10(config-subif)#encapsulation dot1q 31
ZXR10(config-subif)#ip      address      10.1.1.65
255.255.255.192
```

Method 2:

```
ZXR10(config)#interface fei_1/3
ZXR10(config-if)#ip forwarding-mode vlan-switch
ZXR10(config)#interface fei_1/1
```

```
ZXR10(config-if)#ip forwarding-mode vlan-switch
ZXR10(config)#vlan-forwarding ingress fei_1/1 10
egress fei_1/3 20
ZXR10(config)#vlan-forwarding ingress fei_1/1 11
egress fei_1/3 21
ZXR10(config)#vlan-forwarding ingress fei_1/1 12
egress fei_1/3 22
ZXR10(config)#vlan-forwarding ingress fei_1/1 13
egress fei_1/3 23
ZXR10(config)#vlan-forwarding ingress fei_1/1 14
egress fei_1/3 24
ZXR10(config)#vlan-forwarding ingress fei_1/1 15
egress fei_1/3 25
ZXR10(config)#vlan-forwarding ingress fei_1/1 16
egress fei_1/3 26
ZXR10(config)#vlan-forwarding ingress fei_1/1 17
egress fei_1/3 27
ZXR10(config)#vlan-forwarding ingress fei_1/1 18
egress fei_1/3 28
ZXR10(config)#vlan-forwarding ingress fei_1/1 19
egress fei_1/3 29
ZXR10(config)#interface fei_1/4
ZXR10(config-if)#ip      address      192.168.1.1
255.255.255.252
ZXR10(config)#interface fei_1/2.30
ZXR10(config-subif)#encapsulation dot1q 30
ZXR10(config-subif)#ip      address      10.1.1.1
255.255.255.192
ZXR10(config)#interface fei_1/2.31
ZXR10(config-subif)#encapsulation dot1q 31
ZXR10(config-subif)#ip      address      10.1.1.65
255.255.255.192
```

Note: Interface forwarding attributes cover: normal, mix and vlan-switch. Normal: In this mode, packets are forwarded in the mode of searching routes based on the normal IP address; mix: In this mode, search the vlan-switch forwarding table first. If there is a matched vlan-switch table, packets are forwarded in the vlan-switch transparent transmission mode. Otherwise, packets are forwarded by searching routes based on the normal IP address; vlan-switch: In this mode, search the vlan-switch forwarding table first. If there is a matched vlan-switch table, packets are forwarded in the vlan-switch transparent transmission mode. Otherwise, packets are discarded.

V_Switch Maintenance and Diagnosis

Purpose Refer to below procedure for configuring V_switch maintenance and diagnosis on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To display the V_Switch configuration information of the specified interface, use **show running-config** command in interface configuration mode, as shown in Table 147.

TABLE 147 SHOW RUNNING CONFIG

Command Format	Command Mode	Command Function
show running-config	Interface config	This displays the V_Switch configuration information of the specified interface

. **Result:** This displays the V_Switch configuration information of the specified interface.

2. To view the entries in the VLAN forwarding table, use **show vlan forwarding** command in interface configuration mode, as shown in Table 148.

TABLE 148 SHOW VLAN FORWARDING

Command Format	Command Mode	Command Function
show vlan forwarding	Interface config	This view the entries in the VLAN forwarding table

Result: This view the entries in the VLAN forwarding table.

END OF STEPS

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Chapter 8

Smart Group Configuration

Overview

Introduction This chapter introduces SMARTGROUP and relevant configurations on ZXR10 GER.

Contents This chapter covers the following topics.

TABLE 149 TOPICS IN CHAPTER 8

SMARTGROUP Overview

Access Network Requirements ZXR10 GER is a mid-/high-end router to meet market demands for the metropolitan area network, finance network, government network, military information network, and enterprise network. It provides secure, controllable, manageable, high-performance broadband network solutions for users.

Functions Based on user demands and market location, the SMARTGROUP function is available in the ZXR10 GER, which can be used to provide more flexible, efficient networking schemes for users. With the function, ZXR10 products improve the flexibility and stability of the network, especially the Ethernet networking environment and the network environment for applying Ethernet interfaces during network planning and networking design.

SMARTGROUP function can expand the bandwidth, improve the stability and rationalize the network construction cost. Various

Ethernet interfaces can be bound to a SMARTGROUP logic interface:

Functions of the SMARTGROUP are as follows:

- It supports the binding of Ethernet interfaces on the same interface card.
- For different interface cards, it only supports the binding of Ethernet interfaces of the same IQ.
- Load sharing supports two modes: per-packet and per-destination. The per-destination mode considers the source IP address and destination IP address.
- It supports various routing protocols: RIP (with low priority), BGP, OSPF and ISIS. That is, these routing protocols can be run in the SmartGroup interface.
- It supports MPLS and VPN access.
- It also supports NAT, ACL, QoS and VRRP.

In the ZXR10 GER system:

- Up to 64 SmartGroup interfaces can be configured.
- Each SMARTGROUP interface can bind a maximum of eight Ethernet interfaces of the same type and the same rate.
- The throughput after binding is slightly different from the throughput of each interface and 10% is targeted.

Configuring SMARTGROUP

Purpose Refer to below procedure for configuring smartgroup on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To create a SMARTGROUP interface, use **interface smartgroup** command in interface configuration mode, as shown in Table 150.

TABLE 150 SMART GROUP COMMAND

Command Format	Command Mode	Command Function
interface smartgroup	Interface config	This creates a SMARTGROUP interface

Result: This creates a SMARTGROUP interface.

.2. To bind the link, use **interface smartgroup<**smartgrup no**>** command in interface configuration mode, as shown in Table 151.

TABLE 151 BIND COMMAND

Command Format	Command Mode	Command Function
interface smartgroup<smartgrup no**>**	Interface config	This bind the link

Result: This bind the link.

.3. To configure the load sharing function on the SMARTGROUP interface, use **smartgroup load-balance** command in interface configuration mode, as shown in Table 152.

TABLE 152 SMART GROUP LOAD BALANCE COMMAND

Command Format	Command Mode	Command Function
smartgroup load-balance	Interface config	This configures the load sharing function on the SMARTGROUP interface

Result: This configures the load sharing function on the SMARTGROUP interface.

.4. To implement the ACL function on the SMARTGROUP interface, use **ip access-group** command in interface configuration mode, as shown in Table 153.

TABLE 153 IP ACCESS GROUP COMMAND

Command Format	Command Mode	Command Function
ip access-group	Interface config	This implements the ACL function on the SMARTGROUP interface

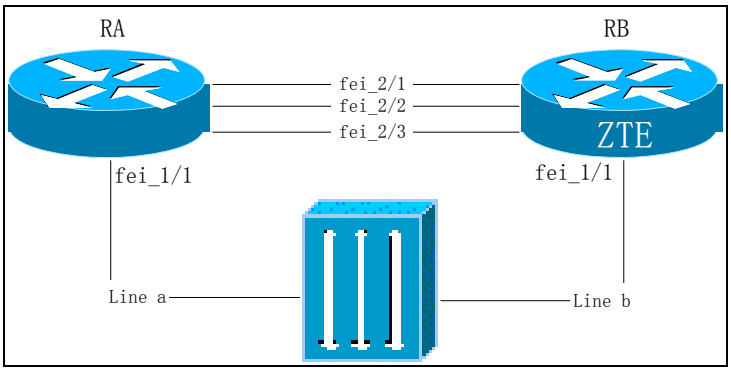
Result: This implements the ACL function on the SMARTGROUP interface.

ND OF STEPS

Example:

Figure 72 shows the SMARTGROUP configuration example. The fei_2/1~fei_2/3 interface of the RA is connected to the fei_2/1~fei_2/3 interface of the RB respectively. Bind the interfaces to the smartgroup, and connect the fei_1/1 interface of RA and RB to the SMARTBITS tester.

FIGURE 72 SMARTGROUP CONFIGURATION EXAMPLE



Configurations of RA are as follows:

```
ZXR10(config)#interface smartgroup1
ZXR10 (config-if)#ip address 10.10.10.1
255.255.255.0
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/1
ZXR10 (config-if)#smartgroup 1 mode active
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/2
ZXR10 (config-if)#smartgroup 1 mode active
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/3
ZXR10 (config-if)#smartgroup 1 mode active
ZXR10 (config-if)#exit
ZXR10(config)#interface smartgroup1
ZXR10 (config-if)#smartgroup load-balance per-
packet
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_1/1
ZXR10 (config-if)#ip address 192.18.1.1
255.255.255.0
ZXR10 (config-if)#exit
ZXR10 (config)#ip route 192.19.1.0 255.255.255.0
10.10.10.2
```

Configurations of RB are as follows:

```
ZXR10(config)#interface smartgroup1
ZXR10    (config-if)#ip    address    10.10.10.2
255.255.255.0
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/1
ZXR10 (config-if)#smartgroup 1 mode active
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/2
ZXR10 (config-if)#smartgroup 1 mode active
```

```
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_2/3
ZXR10 (config-if)#smartgroup 1 mode active
ZXR10 (config-if)#exit
ZXR10(config)#interface smartgroup1
ZXR10 (config-if)#smartgroup load-balance per-packet
ZXR10 (config-if)#exit
ZXR10 (config)#interface fei_1/1
ZXR10 (config-if)#ip address 192.19.1.1 255.255.255.0
ZXR10 (config-if)#exit
ZXR10 (config)#ip route 192.18.1.0 255.255.255.0 10.10.10.1
```

SMARTGROUP Maintenance and Diagnosis

Purpose Refer to below procedure for configuring smartgroup maintenance and diagnosis on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To display the configuration information of the smartgroup interface, use **show running-config** command in interface configuration mode, as shown in Table 154.

TABLE 154 SHOW RUNNING CONFIG COMMAND

Command Format	Command Mode	Command Function
show running-config	Interface config	This displays the configuration information of the smartgroup

Result: This displays the configuration information of the smartgroup.

2. Display the relevant information of smartgroup group members; use **show lacp** command in interface configuration mode, as shown in Table 155.

TABLE 155 SHOW LACP COMMAND

Command Format	Command Mode	Command Function
show lacp	Interface config	This displays the relevant information of smartgroup group members

Result: This displays the relevant information of smartgroup group members.

END OF STEPS

Chapter 9

Link Protocol Configuration

Overview

Introduction This chapter introduces the link protocol PPP and related configurations on the ZXR10 GER.

Contents This chapter covers the the following topics.

TABLE 156 TOPICS IN CHAPTER 9

PPP Protocol

Overview

Background This chapter describes how to configure Link protocols, Point-to-Point Protocol (PPP) and Multilink PPP that can be configured on serial interfaces of ZTE ZXR10 GER.

Point to Point Protocol

Background

Point-to-Point Protocol (PPP) originally emerged as an encapsulation protocol for transporting IP traffic over point-to-point links. PPP also established a standard for assignment and management of IP addresses asynchronous (start/stop), bit-oriented synchronous encapsulation, network protocol multiplexing, link configuration as network layer address negotiation and data-compression negotiation.

PPP supports these functions by providing an extensible Link Control Protocol (LCP) and a family of Network Control Protocols (NCPs) to negotiate optional configuration parameters and facilities. In addition to IP, PPP supports other protocols, including Novell's Internetwork Packet Exchange (IPX) and DECnet.

Components

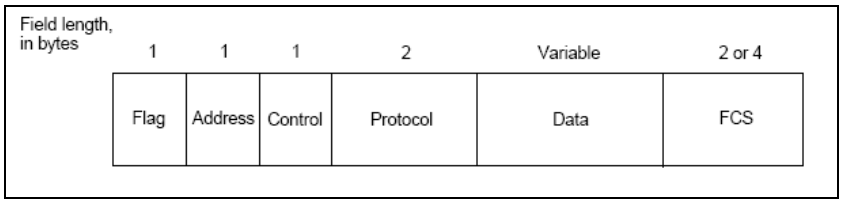
PPP provides a method for transmitting datagram’s over serial point-to-point links. PPP contains three main components:

- A method for encapsulating datagram’s over serial links. PPP uses High-Level Data Link Control.
- (HDLC) protocol as a basis for encapsulating datagram over point-to-point links.
- An extensible LCP that establishes, configures, and test the data link connection.
- A family of NCPs for establishing and configuring different network layer protocols. PPP is designed to allow the simultaneous use of multiple network layer protocols.

PPP Link Layer

- PPP uses principles, terminology and frame structure of International Organization for Standardization (ISO) HDLC procedures (ISO 3309-1979 Transmission.” ISO 3309-1979 specifies HDLC frame structure for use in synchronous environments.
- ISO 3309:1984/PDAD1 specifies proposed modifications to ISO 3309-1979 to allow its use in asynchronous environments. PPP control procedures use definitions and control field encodings standardized in ISO 4335-1979 and ISO 4335-1979/Addendum 1-1979. PPP frame format appears in Figure 73.

FIGURE 73 SIX FIELDS MAKE UP PPP FRAME



Following descriptions summarize PPP frame fields illustrated in Figure 73.

- Flag—A single byte that indicates the beginning or end of a frame. The flag field consists of binary sequence 01111110.
- Address—a single byte that contains binary sequence 1111111, the standard broadcast address. PPP does not assign individual station addresses.
- Control—a single byte that contains binary sequence 00000011, which calls for transmission of user data in an unsequenced frame. A connectionless link service similar to that of Logical Link Control (LLC) Type 1 is provided.
- Protocol—two bytes that identify protocol encapsulated in information field of frame. The most up-to-date values of protocol field are specified in most recent Assigned Numbers Request for Comments (RFC).
- Data—Zero or more bytes that contain datagram for the protocol specified in the protocol field. The end of the information field is found by locating the closing flag sequence and allowing 2 bytes for the FCS field. The default maximum length of the information field is 1,500 bytes. By prior agreement, consenting PPP implementations can use other values for the maximum information field length.
- Frame check sequence (FCS)—normally 16 bits (2 bytes). By prior agreement, consenting PPP implementations can use a 32-bit (4-byte) FCS for improved error detection. The LCP can negotiate modifications to the standard PPP frame structure. Modified frames, however, always will be clearly distinguishable from standard frames.

LCP can negotiate modifications to standard PPP frame structure. Modified frames, however, always must be clearly distinguishable from standard frames.

PPP Authentication Protocols

Background

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

- PAP (Password Authentication Protocol)
- CHAP (Challenge Handshake Authentication Protocol)

Password Authentication Protocols (PAP)

Background

PAP provides a simple method for a remote node to establish its identity using a two-way handshake. After PPP link establishment phase is complete, a username and password pair is repeatedly sent by the remote node across the link (in clear text) until authentication is acknowledged, or until the connection is terminated.

Unidirectional and Bidirectional Authentication

PAP supports bi-directional (two ways) and unidirectional (one way) authentication. With unidirectional authentication, only the side receiving the call (NAS) authenticates the remote side (client). The remote client does not authenticate the server.

With bi-directional authentication, each side independently sends an Authenticate-Request (AUTH−REQ) and receives either an Authenticate -Acknowledge (AUTH−ACK) or Authenticate- Not Acknowledged (AUTH−NAK).

Purpose

This procedure describes how to do password authentication protocol (PAP) on ZTE ZXR10 GER.

Prerequisite

Router CLI (Privileged Mode) has been accessed.

Steps

1. To enter into configuration mode by writing **config terminal** command in privilged mode as shown in Table 157.

TABLE 157 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To configure PPP (PAP) on interface, use **ppp authentication** {**pap**} command in interface configuration mode as shown in Table 158.

TABLE 158 PPP AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
ppp authentication {pap }	Interface	This configures PPP (PAP) authentication mode

Result: This sets PPP (PAP) authentication mode on an interface.

Note: Router uses PPP (PAP) to verify identity of the other side (peer). This means other side (peer) must present its username/password to the local device for verification.

3. To configure username and password for PPP (PAP) authentication use **ppp pap sent-username** <*username*> <*password*> command in interface configuration mode as shown in Table 159.

TABLE 159 PPP USER-PASSWORD COMMAND

Command Format	Command Mode	Command Function
ppp pap sent-username <*username*> <*password*>	Interface	This configures the PAP username and password that are sent when the local router is authenticated by the peer router in the PAP mode

Result: This configures the PAP username and password that are sent when the local router is authenticated by the peer router in the PAP mode.

Note: This is username and password used by local router to authenticate PPP peer. When peer sends its PAP username and password, local router checks whether that username and password are configured locally. If there is a successful match, the peer is authenticated.

4. To setup PPP link with peer router, use **ppp open** command in interface configuration mode as shown in Table 160.

TABLE 160 PPP OPEN COMMAND

Command Format	Command Mode	Command Function
ppp open	Interface	This takes initiative in setting up a PPP link with peer router

Result: This sets PPP link with peer router.

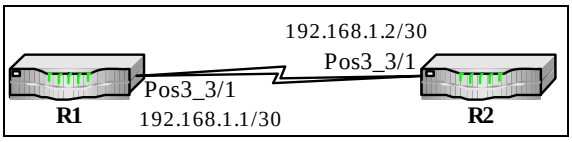
Note: This enables outbound PAP authentication. Local router uses username and password that is specified by ppp pap sent- username command to authenticate it to a remote device. The other router must have this same username/password configured using the username command described above.

Important! If one-way authentication is used, this command is only necessary for router initiating call. For two-way authentication this command must be configured on both sides.

END OF STEPS

Example: As shown in Figure 74 , pos3_3/1 interface of router R1 is connected to pos3_3/1 of router R2. PAP authentication mode is used. User name and password configured on each interface are used for local and remote authentication. User names and passwords at both ends must be consistent with each other.

FIGURE 74 PPP CONFIGURATION EXAMPLE



Configuration of R1:

```
ZXR10_R1(config)#interface pos3_3/1
ZXR10_R1(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10_R1(config-if)#ppp authentication pap
ZXR10_R1(config-if)# ppp pap sent-username pap user password
hello
ZXR10_R1(config-if)#ppp open
```

Configuration of R2:

```
ZXR10_R2(config)#interface pos3_3/1
ZXR10_R2(config-if)#ip address 192.168.1.2 255.255.255.252
ZXR10_R2(config-if)#ppp authentication pap
ZXR10_R2(config-if)# ppp pap sent-username pap user password
hello
ZXR10_R2(config-if)#ppp open
```

Challenge Handshake Authentication Protocol (CHAP)

Background

Challenge Handshake Authentication Protocol (CHAP) verifies the identity of peer by means of a three-way handshake. These are the general steps performed in CHAP.

- LCP (Link Control Protocol) phase is complete,
- CHAP is negotiated between both devices
- Authenticator sends a challenge message to peer.
- Peer responds with a value calculated through a one-way hash function (Message Digest 5 (MD5)).
- Authenticator checks response against its own calculation of expected hash value. If values match, authentication is successful. Otherwise, connection is terminated.

- This authentication method depends on a "secret", known only to authenticator and peer. The secret is not sent over the link. Although authentication is only one-way, this can negotiate CHAP in both directions, with the help of the same secret set for mutual authentication.

Purpose This procedure describes how to do challenge handshake authentication protocol (CHAP) on ZTE ZXR10 GER Routers.

Prerequisite Router CLI (Privileged Mode) has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in privilged configuration mode as shown in Table 161.

TABLE 161 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To configure PPP (CHAP) authentication mode, CHAP is thrice handshake authentication and the password is the key, use **ppp authentication** {chap} command in interface configuration mode as shown in Table 162.

TABLE 162 PPP AUTHENTICATION {CHAP} COMMAND

Command Format	Command Mode	Command Function
ppp authentication {chap}	Interface	This configures PPP (CHAP) authentication mode

Result: This sets PPP (CHAP) authentication mode.

3. To configure PPP (CHAP) hostname, use **ppp chap hostname** <*hostname*> command in interface configuration mode as shown in Table 163.

TABLE 163 PPP {CHAP} HOSTNAME COMMAND

Command Format	Command Mode	Command Function
ppp chap hostname <*hostname*>	Interface	This configures user name when local router is authenticated by peer router in CHAP mode

Result: This sets PPP (CHAP) hostname.

4. To configure PPP (CHAP password, use **ppp chap password** <*password*> command in interface configuration mode as shown in Table 164.

TABLE 164 PPP(PAP) PASSWORD COMMAND

Command Format	Command Mode	Command Function
ppp chap password <*password*>	Interface	This configures the password when the local router is authenticated by the peer router in CHAP mode

Result: This sets PPP (CHAP) password.

5. To setup PPP link with peer router, use **ppp open** command in interface configuration mode as shown in Table 165.

TABLE 165 PPP OPEN COMMAND

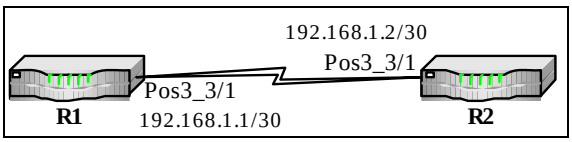
Command Format	Command Mode	Command Function
ppp open	Interface	This takes initiative in setting up a PPP link with peer router

Result: This sets PPP link with peer router.

END OF STEPS

Example: As shown in Figure 75, pos3_3/1 interface of router R1 is connected to that of router R2. CHAP authentication mode is used. User name and password configured on each interface are used for local and remote authentication. User names and passwords at both ends must be consistent with each other.

FIGURE 75 PPP (CHAP) CONFIGURATION EXAMPLE



Configuration of R1:

```
ZXR10_R1(config)#interface pos3_3/1
ZXR10_R1(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10_R1(config-if)#ppp authentication chap
ZXR10_R1(config-if)#ppp chap hostname ZXR10
ZXR10_R1(config-if)#ppp chap password hello
ZXR10_R1(config-if)#ppp open
```

Configuration of R2:

```
ZXR10_R2(config)#interface pos3_3/1
ZXR10_R2(config-if)#ip address 192.168.1.2 255.255.255.252
ZXR10_R2(config-if)#ppp authentication chap
ZXR10_R2(config-if)#ppp chap hostname ZXR10
ZXR10_R2(config-if)#ppp chap password hello
ZXR10_R2(config-if)#ppp open
```

Multilink Point to Point Protocol (MPPP)

Background As higher-speed services are deployed, Multilink-PPP provides a standardized method for spreading traffic across multiple WAN links, while providing multi vendor interoperability, packet fragmentation and proper sequencing and load balancing on both inbound and outbound traffic.

Upon data sending, IP packets are first encapsulated into PPP frame format and then encapsulated frame are segmented into certain data fragments. Each data fragment added with header of MPPP is encapsulated into MPPP frame format.

Purpose This procedure describes how to do multilink PPP on ZTE ZXR10 GER.

Prerequisite Router CLI (Privileged Mode) has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 166.

TABLE 166 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To create multilink interface and to enter into it, use **interface** *<interface-number>* command in global configuration mode as shown in Table 167.

TABLE 167 MULTILINK INTERFACE COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	Global	Creates a multilink interface and enters the interface configuration mode

Result: This enables to create multilink interface and to enter into it.

3. To configure an IP address of an interface, use **ip address** <*ip-address*> <*net-mask*> [<*broadcast-address*>] in interface config mode as shown in Table 168.

TABLE 168 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures an ip address of an interface

Result: This configures an ip address of an interface.

4. To bind physical link of multiple E1s use **multilink-group** <*multilink-number*> command in interface configuration mode as shown in Table 169.

TABLE 169 MULTI-LINK GROUP COMMAND

Command Format	Command Mode	Command Function
multilink-group <*multilink-number*>	Interface	This binds link to multilink

Result: This sets multiple E1 links to a group.

5. To configure end point string of multilink, use **ppp multilink endpoint string** <*string*> command in interface configuration mode as shown in Table 170.

TABLE 170 PPP MULTILINK END POINT COMMAND

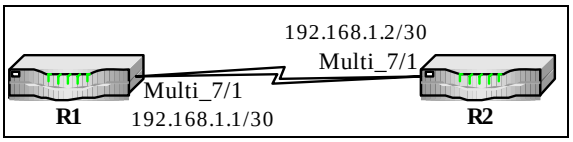
Command Format	Command Mode	Command Function
ppp multilink endpoint string <*string*>	Interface	This configures end point string of multilink

Result: This sets end point string of multilink.

END OF STEPS

Example: As shown in Figure 76, routers R1 and R2 are bound and interconnected in channelized E1 mode. MPPP is configured.

FIGURE 76 MPPP CONFIGURATION EXAMPLE



Configuration of R1:

```
ZXR10_R1(config)#interface multilink 7/1
ZXR10_R1(config-if)#ip address 192.168.1.1 255.255.255.252
ZXR10_R1(config)#controller e1_7/1
ZXR10_R1(config-control)#framing frame
ZXR10_R1(config-control)#channel-group 1 timeslots 1-31
ZXR10_R1(config)#interface e1_7/1.1
ZXR10_R1(config-if)#multilink-group multi_7/1
```

Configuration of R2:

```
ZXR10_R2(config)#interface multi_7/1
ZXR10_R2(config-if)#ip address 192.168.1.2 255.255.255.252
ZXR10_R2(config)#controller e1_7/1
ZXR10_R2(config-control)#framing frame
ZXR10_R2(config-control)#channel-group 1 timeslots 1-31
ZXR10_R2(config)#interface e1_7/1.1
ZXR10_R2(config-if)#multilink-group multi_7/1
```

Note: When one device is interconnected with multiple routers through multilink, E1 interfaces corresponding to multilink interfaces of routers must have different identifiers.

Following command can be used to view information about multilink.

TABLE 171 SHOW PPP COMMAND

Command Format	Command Mode	Command Function
show ppp multilink	User, Privileged	This Displays summary information about multilink

FR Protocol

FR protocol covers the following topics which are described below.

FR Overview

Frame Relay Architecture

FR (Frame Relay) protocol is a high-performance WAN protocol running in the physical layer and data link layer of the OSI reference model. FR is a packet switching technology and is a simplified version of X.25. With the omission of some complicated functions of X.25 (such as window technology and data retransmission technology), FR relies on upper-level protocols to support error correction, since the FR works on a piece of WAN equipment that is better than the WAN equipment where the X.25 works.

Equipment has higher reliability. The FR strictly corresponds to the bottommost two layers of the OSI reference model, while X.25 also provides L3 services. Therefore, the FR has higher performance and more efficient transmission efficiency than X.25.

The WAN equipment of FR is divided into Data Terminal Equipment (DTE) and Data Circuit Equipment (DCE). Normally, routers serve as DTE.

DLCI

FR technology provides communications of connection-oriented data link layer. A defined communication link is available between each pair of equipment, and also the link has a Data Link Connection Identity (DLCI). Such a service is implemented via FR virtual circuits. Each FR virtual circuit identifies itself with DLCI. Normally, DLCI is designated by the FR service provider. FR supports PVC as well as SVC.

LMI

Local Management Interface (LMI) of the FR is an extension of the basic FR standards. As the signaling standard between the router and FR switch, the FR LMI provides the FR management mechanism. The FR LMI provides many features to manage a complicated internetwork, including such functions as global addressing, virtual circuit status message and multi-destination sending.

Configuring FR

Purpose

This procedure describes how to do FR configuration on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. To select an interface to be configured and to enter into interface configuration mode, use the following command, as shown in Table 172.

TABLE 172 INTERFACE CONFIG COMMAND

Command Format	Command Mode	Command Function
Interface <***interface-name***>.	Global configuration	This selects an interface to be configured and to enter into interface configuration mode

Result: This selects an interface to be configured and to enter into interface configuration mode.

2. To configure FR encapsulation for the interface, use the following command, as shown in

TABLE 173 ENCAPSULATION FRAME RELAY COMMAND

Command Format	Command Mode	Command Function
encapsulation frame-relay	Interface configuration	This configures an FR encapsulation for the interface

Result: This configures an FR encapsulation for the interface.

3. To configure an IP address of the interface, use the following command, as shown in Table 174.

TABLE 174 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address ***<ip-addr>*** ***<net-mask>*** **[**<***broadcast-addr***>**]** **[**secondary**]**	Interface configuration	This configures an IP address of the interface

Result: This configures an IP address of the interface.

4. To configure the equipment type, use the following command, as shown in Table 175.

TABLE 175 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
frame-relay intf-type ***<equip-type>***	Interface configuration	This configures the equipment type

Result: This configures the equipment type.

. **Note:** Equipment type name can be dce, dte (by default) or nni. Communication ends are dte and dce respectively. If one end is configured with "nni" (network-network interface), the other end is also configured with "nni".

5. To configure the LMI signaling format, use the following command, as shown in Table 176.

TABLE 176 FRAME RELAY LMI TYPE

Command Format	Command Mode	Command Function
frame-relay lmi-type *<lmi-type>*	Interface configuration	This configures the LMI signaling format

Result: This configures the LMI signaling format.

6. Set the FR mode (point-to-point and point-to- multipoint). Following command is used. **frame-relay interface-mode** *<mode>.*
7. Configure address mapping
   i. The following command is used in the point-to-point mode and used to define DLCI mapping between the local end and the peer end. Following command is used. **frame-relay interface-dlci** *<dlci>*
   ii. The following command is used in the point-to-multipoint mode and used to define mapping between the destination protocol address and the DLCI connecting the destination address. Following command is used. **frame-relay map ip** *<ip-addr>* *<dlci>* [*<encap>*]

Note: Here, the IP address should be configured as the peer IP address. At present, the following two encapsulation modes are supported: ietf and cisco (default: ietf).

END OF STEPS

FR Maintenance and Diagnosis

Purpose Refer to below procedure for configuring FR on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To display FR lmi information, use **show frame-relay lmi** [**interface** *<interface-number>*] command in privileged mode, as shown in Table 177.

TABLE 177 FRAME RELAY LMI TYPE COMMAND

Command Format	Command Mode	Command Function
frame-relay lmi-type *<lmi-type>*	Interface configuration	This displays the FR lmi information

Result: This displays the FR lmi information.

2. To display FR ip-dlci mapping table, use **show frame-relay map** command in privileged mode, as shown in Table 178.

TABLE 178 SHOW FRAME RELAY COMMAND

Command Format	Command Mode	Command Function
frame-relay lmi-type *<lmi-type>*	Interface configuration	This displays the FR lmi information

3. To display FR PVC, use **show frame-relay pvc** command in command privileged mode, as shown in Table 179.

TABLE 179 SHOW FRAME RELAY PVC COMMAND

Command Format	Command Mode	Command Function
frame-relay lmi-type *<lmi-type>*	Interface configuration	This displays FR PVC

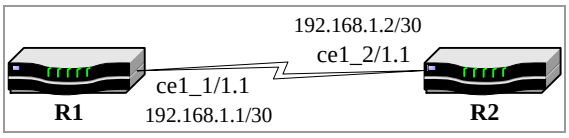
Result: This displays the FR PVC.

END OF STEPS

Example:

As shown in Figure 77, the E1 interface of the router R1 is connected with that of the router R2. The encapsulation FR protocol is used and the point-to-multipoint mode is adopted. R1 serves as DTE and R2 as DCE.

FIGURE 77 FR CONFIGURATION EXAMPLE



R1 configuration:

```
ZXR10_R1(config)# interface ce1_1/1.1
ZXR10_R1(config-if)# encapsulation frame-relay
ZXR10_R1(config-if)# frame-relay interface-mode
point-to-multipoint
ZXR10_R1(config-if)# ip address 192.168.1.1
255.255.255.252
ZXR10_R1(config-if)# frame-realy map ip
192.168.1.2 100
```

R2 configuration:

```
ZXR10_R2(config)# interface ce1_2/1.1
ZXR10_R2(config-if)# encapsulation frame-relay
ZXR10_R2(config-if)# frame-relay interface-mode
point-to-multipoint
ZXR10_R2(config-if)# ip address 192.168.1.2
255.255.255.252
ZXR10_R2(config-if)# frame-relay intf-type dce
ZXR10_R2(config-if)# frame-realy map ip
192.168.1.1 100
```

Chapter 10

Bridge Configuration

Introduction This chapter introduces the bridging of POS and ATM interfaces, and relevant configurations on ZXR10 GER.

Contents This chapter covers the following topics.

TABLE 180 TOPICS IN CHAPTER 10

POS Interface Bridge

POS Bridge Overview

Layer 3 Function Bridge function of the POS interface covers: layer 3 function and transparent transmission of the bridge interface.

- Layer 3 function of the bridge interface indicates that the PPP link is directly connected with the Ethernet with BCP encapsulation. The POS layer 3 interface using BCP encapsulation can serve as an Ethernet interface and has attributes of the Ethernet interface, such as ARP learning.
- Transparent transmission function of the POS bridge interface is implemented through V_Switch functions. With the V_Switch forwarding table, transparent transmission is available between the POS interface and the Ethernet and ATM interfaces.

Link Layer Protocol As a link layer protocol, the PPP is responsible for establishing, deleting and maintaining layer 2 links. PPP negotiation process is as follows: LCP negotiation→Establish (establish links)→CHAP or PAP authentication.

BCP BCP is one NCP, the same as the IPCP described in the above procedure. BCP is mainly used to negotiate and bear bridge parameters. If IPCP negotiation is performed during NCP negotiation, the BCP is an ordinary PPP interface.

BCP Negotiation If IPCP negotiation is performed during NCP negotiation, the BCP is an ordinary PPP interface.if BCP negotiation is performed during NCP negotiation, the BCP is a bridge interface. Although an interface becomes a PPP bridge interface through negotiation, it still adopts PPP encapsulation at layer 2.

The difference is that 802.3 encapsulation is performed before PPP encapsulation and then the whole 802.3 frame is encapsulated in the PPP. At this moment, the PPP link also supports 802.1q, just like a true Ethernet link.

Configuring POS Bridge

Purpose This procedure describes how to configure POS Bridge ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To select a POS interface to be configured, use **interface** command in global configuration mode, as shown in Table 181.

TABLE 181 INTERFACE CONFIGURATION COMMAND

Command Format	Command Mode	Command Function
interface	global config	This selects a POS interface to be configured.

Result: This selects a POS interface to be configured.

2. To encapsulate vlan id in the sub interface, use **encapsulation dot1Q** command in interface configuration mode, as shown in Table 182.

TABLE 182 ENCAPSULATION DOT1Q COMMAND

Command Format	Command Mode	Command Function
encapsulation dot1Q	interface config	This encapsulates vlan id in the sub interface

Result: This encapsulates vlan id in the sub interface.

3. To configure the IP address of an interface, use **ip address** command in interface configuration mode, as shown in Table 183.

TABLE 183 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address	interface config	This configures the IP address of an interface

Result: This configures the IP address of an interface.

4. To configure the V_Switch forwarding table, use **vlan-forwarding ingress** command in interface configuration mode as shown in Table 184.

TABLE 184 VLAN FORWARDING INGRESS COMMAND

Command Format	Command Mode	Command Function
vlan-forwarding ingress	interface config	This configures the V_Switch forwarding table

Result: This configures the V_Switch forwarding table.

5. To configure interface forwarding attributes, use **ip forwarding-mode** command in interface configuration, mode as shown in Table 185.

TABLE 185 IP FORWARDING MODE

Command Format	Command Mode	Command Function
ip forwarding-mode	interface config	This configures the interface forwarding attributes

Result: This configures the interface forwarding attributes.

END OF STEPS

Configuring POS BCP Bridge

Purpose This procedure describes how to configure POS Bridge ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To enable BCP Bridge, use **ppp bcp enable** command in interface configuration mode, as shown in Table 186.

TABLE 186 PPP BCP ENABLE COMMAND

Command Format	Command Mode	Command Function
ppp bcp enable	interface config	This enables the BCP Bridge

Result: This enables the BCP Bridge.

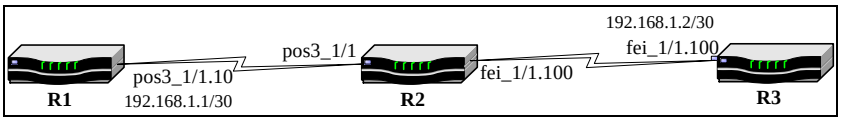
Note: ppp bcp enable and ip forwarding-mode attributes are provided only in the POS real interface. These two attributes of the POS VLAN sub interface are the same as those of its parent interface. In addition, the POS VLAN sub interface can only be used for bridge and will be inactived if its parent interface does not enable the BCP.

END OF STEPS

Example:

As shown in Figure 78, R1 is connected with R2 through the POS3 interface. R2 is connected with R3 through the 100M interface. In the networking, R2 must be a transparent transmission device. Througth BCP Encapsulation and Vlan-Switch configurate, POS Vlan interface can communice to the ethernet interface of R3 directly, and actived as a pair of ethernet interfaces in a network.

FIGURE 78 POS BRIDGE CONFIGURATION EXAMPLE



R1 configuration:

```
ZXR10_R1(config)#interface pos3_1/1
ZXR10_R1(config-if)#ppp bcp enable
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#interface pos3_1/1.10
ZXR10_R1(config-subif)#encapsulation dot1Q 10
ZXR10_R1(config-subif)#ip address 192.168.1.1
255.255.255.252
```

R2 configuration:

```
ZXR10_R2(config)#interface pos3_1/1
ZXR10_R2(config-if)#ppp bcp enable
ZXR10_R2(config-if)#ip forwarding-mode mix
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip forwarding-mode mix
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#vlan-forwarding ingress pos3_1/1 10 egress
fei_1/1 100
```

R3 configuration:

```
ZXR10_R3(config)#interface fei_1/1.100
ZXR10_R3(config-subif)#encapsulation dot1Q 100
ZXR10_R3(config-subif)#ip address 192.168.1.2
255.255.255.252
```

ATM Interface Bridge

ATM Interface Bridge consists of following topics which are in below table.

ATM Interface Bridge

Bridge Function

Bridge function of the ATM interface is same as that of the POS interface, covering layer 3 functions and transparent transmission function of the bridge interface.

Layer 3 Function

Layer 3 function of the bridge interface indicates that the ATM link is directly connected with the Ethernet with encapsulation in the RFC2684B message format. The ATM layer 3 interface encapsulated in the RFC2684B message format can serve as an Ethernet interface and has attributes of the Ethernet interface, such as ARP learning.

Transport Transmission

The transparent transmission function of the ATM bridge interface is implemented through V_Switch functions. With the V_Switch forwarding table, transparent transmission is available between the ATM interface and the Ethernet and POS interfaces. ATM is the transmission mode in which the cell serves as the basic carrier. It is required to segment the user information of different lengths into short cells with the fixed length or form the user information of different lengths again through short cells with the fixed length.

Common Part Convergence

RFC2684 does not specify a new method for segmentation and reassembly (SAR) to route and bridge the protocol data unit (PDU) but makes the load area of the Common Part Convergence Sublayer (CPCS) of ATM Adaption Layer 5 (AAL5) to carry the PDU. RFC2684 describes two methods to carry connectionless network interconnection service information, route and bridge PDUs on the ATM network.

LLC Encapsulation

In the first method, multiple protocols can be reused on the single ATM virtual circuit. The protocol type carrying the PDU is identified by adding a Logic Link Control (LLC) title specified in the IEEE802.2 standard to the PDU. This method is called “LLC encapsulation”. Using this method needs a few virtual circuits in the multi-protocol environment.

ATM Virtual Circuits

The second method is to imply higher-layer protocols to ATM virtual circuits. This method is called “VC-based multi-channel reuse”. To use multiple protocols, configure virtual circuits for each protocol.

Configuring ATM Bridge

Purpose This procedure describes how to do ATM Bridge configuration on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To select an ATM interface to be configured, use **interface** command in global configuration mode, as shown in Table 187.

TABLE 187 INTERFACE COMMAND

Command Format	Command Mode	Command Function
interface	global config	This configures ATM interface

Result: This configures ATM interface.

2. To enable BCP Bridge, use **bridge enable** command in interface configuration mode as shown in Table 188.

TABLE 188 BRIDGE ENABLE COMMAND

Command Format	Command Mode	Command Function
bridge enable	global config	This enables BCP Bridge

Result: This enables BCP Bridge.

3. To configure interface forwarding attributes, use **ip forwarding-mode** command in interface configuration mode, as shown in Table 189.

TABLE 189 IP FORWARDING MODE COMMAND

Command Format	Command Mode	Command Function
ip forwarding-mode	interface config	This configures interface forwarding attributes

Result: This configures interface forwarding attributes.

4. To configure ATM PVC, use **atm pvc** command in interface configuration mode, as shown in Table 190.

TABLE 190 ATM PVC COMMAND

Command Format	Command Mode	Command Function
atm pvc	interface config	This configures ATM PVC

Result: This configures ATM PVC.

Note: ATM real interfaces do not support bridge. The bridge enable attribute is available only in ATM virtual interfaces. But the VLAN sub interface of the ATM virtual interface is a bridge interface once it is created. The attributes ip forwarding-mode and atm pvc are available only in ATM virtual interfaces. And this attribute of the VLAN sub interface of the ATM virtual interface is the same as that of the parent interface.

5. To encapsulate vlan id, use **encapsulation dot1Q** command in vlan sub interface configuration mode, as shown in Table 191.

TABLE 191 ENCAPSULATOPN DOT1Q COMMAND

Command Format	Command Mode	Command Function
atm pvc	interface config	This encapsulates vlan id

Result: This encapsulates vlan id.

6. To configure the IP address of the interface, use **ip address** command in interface configuration mode, as shown in Table 192.

TABLE 192 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address	interface config	This configures the IP address of the interface

Result: This configures the IP address of the interface.

7. To configure the V_Switch forwarding table, use **vlan-forwarding ingress** command in interface configuration mode, as shown in Table 193.

TABLE 193 VLAN-FORWARING INGRESS COMMAND

Command Format	Command Mode	Command Function
vlan-forwarding ingress	interface config	This configures the V_Switch forwarding table

Result: This configures the V_Switch forwarding table.

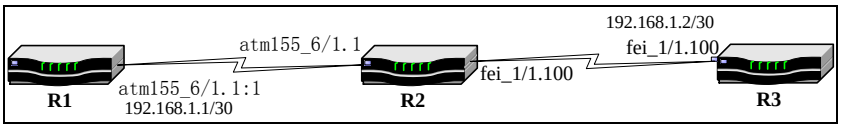
END OF STEPS

Example:

As shown in Figure 79, R1 is connected with R2 through the ATM interface. R2 is connected with R3 through the 100M interface. In the networking, R2 must be a transparent transmission device, and R1 and the VLAN sub interface of the ATM virtual interface

must be in the same network section and can interwork with the 100M interface of R3 through bridge encapsulation.

FIGURE 79 ATM INTERFACE BRIDGE CONFIGURATION EXAMPLE



R1 configuration:

```
ZXR10_R1(config)#interface atm155_6/1.1
ZXR10_R1(config-if)#atm pvc 100 100
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#interface atm155_6/1.1:1
ZXR10_R1(config-subif)#encapsulation dot1Q 1
ZXR10_R1(config-subif)#ip address 192.168.1.1
255.255.255.252
```

R2 configuration:

```
ZXR10_R2(config)#interface atm155_6/1.1
ZXR10_R2(config-if)# atm pvc 100 100
ZXR10_R2(config-if)#ip forwarding-mode mix
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip forwarding-mode mix
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#vlan-forwarding ingress
atm155_6/1.1 1 egress fei_1/1 100
```

R3 configuration:

```
ZXR10_R3(config)#interface fei_1/1.100
ZXR10_R3(config-subif)#encapsulation dot1Q 100
ZXR10_R3(config-subif)#ip address 192.168.1.2
255.255.255.252
```

Chapter 11

Network Protocol Configuration

Overview

Introduction This chapter describes IP addresses and ARP protocol and also introduces related configuration on ZXR10 GER.

Contents This chapter covers the the following topics.

TABLE 194 TOPICS IN CHAPTER 7

IP Address

Introduction Network addresses in IP protocol stack refer to IP addresses. An IP address consists of two parts: One part involves network bits indicating network where address is located and other part involves host bits indicating a special host on network.

IP Classes IP addresses are divided into five classes: A, B, C, D and E. first three classes are commonly used. Addresses of class D are network multicast addresses and addresses of class E are reserved classes. Table 195 lists range of each IP class addresses.

TABLE 195 IP ADDRESSES RANGE

Class	Feature Bit of Header	Network Bit	Host Bit	Range
Class A	0	8	24	0.0.0.0~127.255.255.255
Class B	10	16	16	128.0.0.0~191.255.255.255
Class C	110	24	8	192.0.0.0~223.255.255.255
Class D	1110	Multicast address		224.0.0.0~239.255.255.255
Class E	1111	Reserved		240.0.0.0~255.255.255.255

Among three classes (A, B and C) of IP addresses, some addresses are reserved for private networks. This is recommended that private network addresses must be used for establishing internal networks. These addresses refer to:

Class A: 10.0.0.0~10.255.255.255

Class B: 172.16.0.0~172.31.255.255

Class C: 192.168.0.0~192.168.255.255

Address division is originally intended to facilitate design of routing protocols, so that header feature bit of an IP address is enough for judging type of a network. However, classification method restricts utilization of address space to greatest extent. With rapid expansion of Internet, problem of insufficient addresses becomes more and more serious.

Subnets

To utilize IP addresses to greater extent, a network can be divided into multiple subnets. The "bit borrowing" mode can be used: highest bits of host bits are borrowed to serve as subnet bits and left host bits still serve as host bits. Thus structure of an IP address consists of three parts: Network bits, subnet bits and host bits.

Network bits and subnet bits are used to uniquely identify a network. Use subnet mask to find which part in IP address indicates network bits and subnet bits, which part stands for host bits. The part with subnet mask of "1" corresponds to network bits and subnet bits of IP address, while the part with subnet mask of "0" corresponds to host bits.

Division of subnets greatly improves utilization of IP addresses, which relieves the problem of insufficient IP addresses to some extent.

Regulations on IP addresses:

- (0.0.0.0) is used when a host without an IP address is started. RARP, BOOTP and DHCP are used to obtain IP

address. The address serves as default route in routing table.

- 255.255.255.255 is a destination address used for broadcast and cannot serve as a source address.
- 127. X.X.X is called loopback address. Even if actual IP address of host is unknown, address still can be used to stand for the "local host".
- Only IP addresses with host bits being all "0" indicate network itself. An IP address with host bits being all "1" serves as broadcast address of the network.
- For a legal host IP address, the network part or the host part must not be all "0" or all "1".

Purpose Refer to below procedure for IP address on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 196.

TABLE 196 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enter into interface configuration mode, use **interface** *<interface-number>* command in global configuration mode as shown in Table 197.

TABLE 197 INTERFACE CONFIG COMMAND

Command Format	Command Mode	Command Function
interface <interface-number>	Global config	This enters into interface configuration mode

Result: This enables to enter into interface configuration mode.

3. To configure an IP address of an interface, use **ip address** *<ip-address>* *<net-mask>* [*<broadcast-address>*] in interface config mode as shown in Table 198.

TABLE 198 IP ADDRESS COMMAND

Command Format	Command Mode	Command Function
ip address <ip-address> <net-mask> [<broadcast-address>]	Interface	This configures an ip address of an interface

Result: This configures an ip address of an interface.

END OF STEPS

Example:

Suppose a Gigabit Ethernet interface card is inserted into slot 3 of ZXR10 GER to configure an IP address of second interface as 192.168.3.1 and to set mask code to 255.255.255.0. The detailed configuration is as follows:

```
ZXR10(config)#interface gei_3/2
ZXR10(config-if)#ip address 192.168.3.1 255.255.255.0
```

show ip interface command can be used to view an IP address of the interface.

Configuring ARP

Overview When a piece of network equipment sends data to another piece of network equipment, physical address (MAC address) of destination equipment must also be known in addition to IP address. ARP (Address Resolution Protocol) is used to map IP addresses into physical addresses to guarantee smooth communications.

Procedure Firstly, source equipment advertises an ARP request containing an IP address of destination equipment and all types of equipment on network receives ARP request. If a piece of equipment finds that IP address in request matches with its own IP address, this sends a reply containing its MAC address to source equipment. Source equipment obtains MAC address of the destination equipment according to reply.

ARP aging time To reduce ARP packets on a network and send data faster, mapping relation between IP addresses and MAC addresses is buffered in a local ARP table. When a piece of equipment wants to send data, this first search an ARP table according to IP address. If MAC address of destination equipment is found in ARP table, the equipment no longer sends any ARP request. Dynamic entries in ARP table deletes automatically after a period of time. This period of time is called "ARP aging time".

Purpose Refer to below procedure for configuring basic ARP address on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To configure aging time of ARP table entries in ARP cache, use **arp timeout** <*seconds*>in interface configuration mode as shown in Table 199.

TABLE 199 ARP TIMEOUT COMMAND

Command Format	Command Mode	Command Function
arp timeout <*seconds*>	Interface	This configures aging time of an ARP table entries in ARP cache

Result: This sets aging time of ARP table entries in ARP cache.

2. To delete all dynamic ARP table entries in Ethernet interface ARP cache, use **clear arp-cache** <*interface-number*> in Exec mode as shown in Table 200.

TABLE 200 CLEAR ARP CACHE COMMAND

Command Format	Command Mode	Command Function
clear arp-cache <interface-number>	Exec	This deletes all dynamic ARP table entries in Ethernet interface ARP cache

Result: This deletes dynamic arp table entries in Ethernet interface ARP cache.

END OF STEPS

Example: An ARP configuration example is given as follows.

```
ZXR10(config)#interface fei_1/1
ZXR10(config-if)#arp timeout 1200
```

Following command can be used to view an ARP table entry of a designated Ethernet interface.

Command Format	Command Mode	Command Function
show arp <interface-number>	User Exec	This displays an ARP table entry of an Ethernet interface

View ARP table of Ethernet interface fei_1/1:

```
ZXR10#show arp fei_1/1
AddressAge(min)        Hardware Addr          Interface
10.1.1.1               -       000a.010c.e2c6      fei_1/1
10.1.100.100   18              00b0.d08f.820a          fei_1/1
ZXR10#
```

Chapter 12

Static Route Configuration

Overview

Introduction The chapter covers static route and its configuration, covering special summary static route and default route.

Contents This chapter covers following topics.

TABLE 201 TOPICS IN CHAPTER 12

Background

User Defined Routes Static routes are user-defined routes that cause packets moving between a source and a destination to take a specified path. They are useful for specifying a gateway of last resort to which all unroutable packets will be sent. Static route, unlike a dynamic route, does not set up the routing table based on routing algorithm.

When configuring a dynamic route, routing information of entire Internet must be sent to a router, such that the router is hard to hold the load. In this case, static routes can be used to solve the problem. However, in a routing environment where there are multiple routers and multiple paths, this is very complicated to configure static routes.

Implementation Router operating system (ROS) remembers static routes until to remove them explicitly. However, this can override static routes with dynamic routing information through prudent assignment of administrative distance values.

Each dynamic routing protocol has a default administrative distance, as listed in Table 202 . If static route to be overridden by information from a dynamic routing protocol, simply ensures that the administrative distance of the static route is higher than that of the dynamic protocol.

TABLE 202 DEFAULT ADMINISTRATIVE DISTANCE

Route Source	Default Distance
Connected interface	0
Static Route	1
Enhanced IGRP (EIGRP) summary route	5
Exterior Border Gateway Protocol (BGP)	20
Internal EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
EIGRP external route	170
Interior BGP	200
Unknown	255

Advertisement

Static routes that point to an interface is advertised via RIP, IGRP and other dynamic routing protocols, regardless of whether redistribute static router configuration commands were specified for those routing protocols. These static routes are advertised because static routes that point to an interface are considered in the routing table to be connected and hence lose their static nature. In a routing environment where there are multiple routers and multiple paths, it is very complicated to configure static routes.

Redistribute Static

When an interface goes down, all static routes through that interface are removed from IP routing table. Also, when router operating system (ROS) can no longer find a valid next hop for the address specified as the address of the forwarding router in a static route, the static route is removed from the IP routing table.

Purpose

This procedure describes how to do static route configuration on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 203.

TABLE 203 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To configure static route, use **ip route** <*prefix*> <*net-mask*> {[<*interface-number*>] [<*forwarding-address*>]} [<*distance-metric*>] [**globle**] [**tag** <*tag*>] command in global configuration mode, as shown in Table 204.

TABLE 204 STATIC ROUTE COMMAND

Command Format	Command Mode	Command Function
ip route <*prefix*> <*net-mask*> {[<*interface-number*>] [<*forwarding-address*>]} [<*distance-metric*>] [**globle**] [**tag** <*tag*>]	global config	This configures static route.

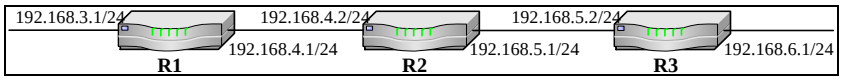
Result: This sets static route.

Tag is a route label. Two static routes (with different next hop IP addresses) to same destination network cannot have the same tag value.

END OF STEPS

Example: Figure 80 shows a simple network on which three routers are interconnected.

FIGURE 80 STATIC ROUTE CONFIGURATION



For R1 to access the network on R3, static route configuration is as follows:

```
ZXR10_R1(config)#ip route 192.168.5.0 255.255.255.0 192.168.4.2
ZXR10_R1(config)#ip route 192.168.6.0 255.255.255.0 192.168.4.2
```

This can be seen from above configuration that a static route is configured in global configuration mode and only one static route can be configured at a time. After ip route command, remote network, its subnet mask code and next IP address to the remote network is configured.

In other words, for R1 to send a packet to network 192.168.5.0/24, this must give the packet to R2 with IP address of 192.168.4.2, since R1 is directly connected to R2.

Multiple Static Routes

If there are multiple paths to same destination, a router can be configured with multiple static routes with different tag. However, routing table only displays information about route with minimum distance.

Parameter

Parameter <distance-metric> in static route configuration command in ip route can be used to change administrative distance value of a static route. Suppose there are two different routes from R1 to network section 192.168.6.0/24, the configuration is as follows:

```
ZXR10_R1(config)#ip route 192.168.6.0 255.255.255.0 192.168.4.2
ZXR10_R1(config)#ip route 192.168.6.0 255.255.255.0 192.168.3.2
25 tag 10
```

Above two commands configure two different static routes to same network. First command does not configure administrative distance, so default value "1" is used. Second command configures administrative distance of 25.

Administrative Distance

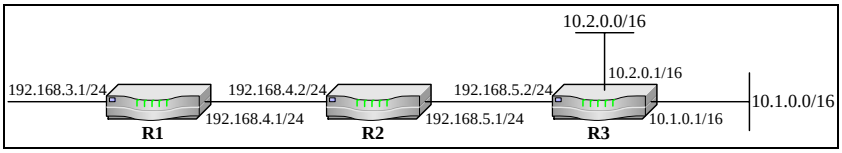
Since administrative distance of first route is less than that of the second route, only information about first route appears in routing table, that is to say, the router arrives at destination network 192.168.6.0/24 through next-hop address 192.168.4.2. The second route appears in routing table only when first route fails and disappears from routing table.

Static Route Summary

One Expression

A summary static route is a special kind of static route, which can summarize two or multiple special route expressions into one expression to reduce entries of routing table but to reserve the all the original links. The detailed description of static route summary is shown in Figure 81.

FIGURE 81 STATIC ROUTE SUMMARY



Example

As shown in Figure 81, R3 has two networks: 10.1.0.0/16 and 10.2.0.0/16. For R1 to access these networks, normally R1 must be configured with following two static routes.

```
ZXR10_R1(config)#ip route 10.1.0.0 255.255.0.0 192.168.4.2
ZXR10_R1(config)#ip route 10.2.0.0 255.255.0.0 192.168.4.2
```

Suppose that R3 has been configured normally, and the above configuration can be used to complete IP connection. However, static route summary can be used to optimize the routing table

of R1. The following command can be used to replace the above two commands:

```
ZXR10_R1(config)#ip route 10.0.0.0 255.0.0.0 192.168.4.2
```

The above command shows that, all packets to destination network 10.0.0.0/8 pass 192.168.4.2, that is to say, packets to subnets (subnet 10.1.0.0/16 and subnet 10.2.0.0/16) of destination network 10.0.0.0/8 are sent to 192.168.4.2. In this way, static routes are used to summarize all subnets of main network 10.0.0.0/8.

Default Route

Introduction A router might not be able to determine routes to all other networks. To provide complete routing capability, the common practice is to use some routers as smart routers and give the remaining routers default routes to the smart router. (Smart routers have routing table information for the entire internetwork.) These default routes can be passed along dynamically, or can be configured into individual routers. Most dynamic interior routing protocols include a mechanism for causing a smart router to generate dynamic default information that is then passed along to other routers.

Implementation If a router cannot route a packet, packet has to be dropped. However, this is not hoped that packet is dropped in an "unknown" destination. To support complete connection of router, this must have a route connected to a network. If router wants to keep complete connection and meanwhile does not need to record each independent route, default route can be used. By use of default route, an independent route can be designated to indicate all other routes.

Purpose Refer to below procedure for configuring default route on ZTE ZXR10 GER Routers.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 205.

TABLE 205 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To configure default route, use **ip route** *<prefix> <net-mask>* {[*<interface-number>*] [*<forwarding-address>*]}

[<*distance-metric*>] [**globle**] [**tag** <*tag*>] command in global configuration mode as shown in Table 206.

TABLE 206 DEFAULT ROUTE COMMAND

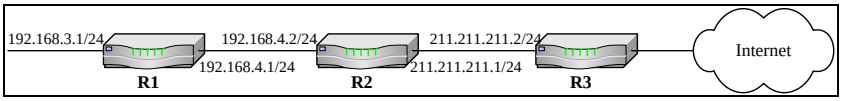
Command Format	Command Mode	Command Function
ip route <prefix> <net-mask> {[<interface-number>] [<forwarding-address>]} [<distance-metric>] [**globle**] [**tag** <tag>]	global config	This configures default route

Result: This sets default route.

Tag is a route label. Two static routes (with different next hop IP addresses) to same destination network cannot have same tag value.

Example: An example is given in the following to describe the functions and use of the default route.

FIGURE 82 DEFAULT ROUTE COMMAND



As shown in Figure 82, R2 is connected to router R3 in Internet. R2 does not record addresses of all networks on the Internet, so it uses a default route to directly send unknown packets to R3 for proper processing. The configuration of the default route in R2 is as follows:

```
ZXR10_R2(config)#ip route 0.0.0.0 0.0.0.0 211.211.211.2
```

When default route is used in routing protocol configuration, default route varies with routing protocols.

RIP Protocol If default route is configured for a router where an RIP runs, the RIP will advertise default route 0.0.0.0/0 to its neighbor, and even route redistribution is not needed in RIP domain.

OSPF Protocol For OSPF protocol, a router where the OSPF protocol runs will not inject the default route into its neighbor automatically. For OSPF to send the default route to OSPF domain, the command notifies default route must be used. If this is necessary to redistribute the default route in OSPF domain, such an advertisement is normally implemented by an ASBR (Autonomous System Border Router) in OSPF domain.

Default route configuration is completely the same as static route configuration and only difference is that the network part

and subnet mask part are all 0.0.0.0. This can be seen in routing of R2:

```
ZXR10_R2#show ip route
IPv4 Routing Table:
  Dest          Mask          Gw          Interface    Owner    pri metr
0.0.0.0         0.0.0.0       211.211.211.2  fei_2/2    static   1   0
211.211.211.0   255.255.255.0 211.211.211.1  fei_2/2  direct   0   0
192.168.4.0     255.255.255.0 192.168.4.2   fei_2/1    direct   0   0
ZXR10_R2#
```

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Chapter 13

RIP Configuration

Overview

Introduction This chapter describes how to configure Routing Information Protocol (RIP) on ZTE ZXR10 GER.

Contents This chapter covers following topics.

TABLE 207 TOPICS IN CHAPTER 13

Background

RFC 1058 Protocol RIP is a relatively old but still commonly used interior gateway protocol created for use in small, homogeneous networks. This is a classical distance-vector routing protocol. RIP is documented in RFC 1058.

UDP RIP uses broadcast User Datagram Protocol (UDP) data packets to exchange routing information. The metric that RIP uses to rate value of different routes is hop count. Hop count is number

of routers that can be traversed in a route. ZXR10 GER supports RIPv1 and RIPv2 completely (RIPv2 is used by default).

Routing Updates

RIP Topology

RIP sends routing-update messages at regular intervals and when network topology changes. When a router receives a routing update that includes changes to an entry, it updates its routing table to reflect the new route. The metric value for path is increased by 1 and sender is indicated as next hop. RIP routers maintain only best route (the route with the lowest metric value) to a destination.

After updating its routing table, router immediately begins transmitting routing updates to inform other network routers of the change. These updates are sent independently of regularly scheduled updates that RIP routers send.

RIP Routing Metric

Single Routing Metric

RIP uses a single routing metric (hop count) to measure distance between source and a destination network. Each hop in a path from source to destination is assigned a hop count value, which is typically 1.

When a router receives a routing update that contains a new or changed destination network entry, the router adds 1 to metric value indicated in update and enters the network in the routing table. The IP address of the sender is used as the next hop.

RIP Stability Features

Routing Loops

RIP prevents routing loops from continuing indefinitely by implementing a limit on number of hops allowed in a path from source to a destination. The maximum number of hops in a path is 15. If a router receives a routing update that contains a new or changed entry and if increasing the metric value by 1 causes metric to be infinity (that is, 16), the network destination is considered unreachable.

Stability Features

The downside of this stability feature is that it limits the maximum diameter of a RIP network to less than 16 hops. RIP includes a number of other stability features that are common to many routing protocols. These features are designed to provide stability despite potentially rapid changes in a network's topology. For example, RIP implements the split horizon and hold-down mechanisms to prevent incorrect routing information from being propagated.

RIP Timers

Routing Updates

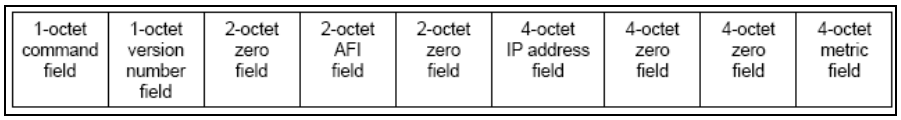
RIP uses numerous timers to regulate its performance. These include a routing-update timer, a route-timeout timer, and a route-flush timer. The routing-update timer clocks the interval between periodic routing updates.

This is done to help prevent congestion, which could result from all routers simultaneously attempting to update their neighbors. Each routing table entry has a route-timeout timer associated with it. When the route-timeout timer expires, the route is marked invalid but is retained in table until the route-flush timer expires.

RIP Packet Format

Figure 83 illustrates the IP RIP packet format.

FIGURE 83 IP RIP PACKET



Following descriptions summarize the IP RIP packet format fields illustrated in Figure 83.

- **Command**—indicates whether the packet is a request or a response. The request asks that a router send all or part of its routing table. The response can be an unsolicited regular routing update or a reply to a request. Responses contain routing table entries. Multiple RIP packets are used to convey information from large routing tables.
- **Version number**—specifies the RIP version used. This field can signal different potentially incompatible versions.
- **Zero—**this field is not actually used by RFC 1058 RIP; it was added solely to provide backward compatibility with pre standard varieties of RIP. Its name comes from its defaulted value: zero.
- **Address-family identifier (AFI)—**Specifies the address family used. RIP is designed to carry routing information for several different protocols. Each entry has an address-family identifier to indicate the type of address being specified. The AFI for IP is 2.
- **Address—**Specifies the IP address for the entry.
- **Metric—**Indicates how many internetwork hops (routers) have been traversed in the trip to the destination. This value

is between 1 and 15 for a valid route, or 16 for an unreachable route.

Note: Up to 25 occurrences of AFI, Address and Metric Fields are permitted in single IP RIP Packet.

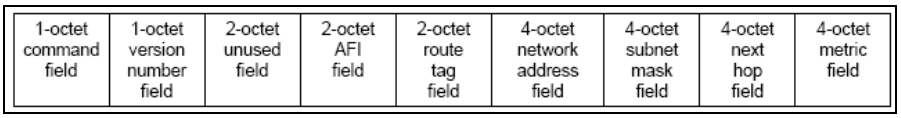
RIPv2 Packet Format

Simple Authentication Mechanism

RIP 2 specifications (described in RFC 1723) allows more information to be included in RIP packets and provides a simple authentication mechanism that is not supported by RIP.

Figure 84 shows IP RIP 2 packet format.

FIGURE 84 IP RIPV2 PACKET



Following descriptions summarize IP RIP 2 packet format fields illustrated in Figure 84.

- **Command**—indicates whether the packet is a request or a response. The request asks that a router send all or a part of its routing table. The response can be an unsolicited regular routing update or a reply to a request. Responses contain routing table entries. Multiple RIP packets are used to convey information from large routing tables.
- **Version**—Specifies RIP version used. In a RIP packet implementing any of the RIP 2 fields or using authentication, this value is set to 2.
- **Unused**—has a value set to zero.
- **Address-family identifier (AFI)**—Specifies the address family used. RIPv2's AFI field functions identically to RFC 1058 RIP's AFI field, with one exception: If the AFI for the first entry in the message is 0xFFFF, the remainder of the entry contains authentication information. Currently, the only authentication type is simple password.
- **Route tag**—provides a method for distinguishing between internal routes (learned by RIP) and external routes (learned from other protocols).
- **IP address**—specifies the IP address for the entry.
- **Subnet mask**—contains the subnet mask for the entry. If this field is zero, no subnet mask has been specified for the entry.
- **Next hop**—indicates the IP address of the next hop to which packets for the entry should be forwarded.

- **Metric**—Indicates how many internetwork hops (routers) have been traversed in trip to destination. This value is between 1 and 15 for a valid route or 16 for an unreachable route.

  NOTE: Up to 25 occurrences of AFI, Address and Metric Fields are permitted in single IP RIP Packet. That is, up to 25 routing table entries can be listed in a single RIP packet. If the AFI specifies an authenticated message, only 24 routing table entries can be specified.

  Given that individual table entries aren't fragmented into multiple packets, RIP does not need a mechanism to again make a sequence datagram's bearing routing table updates from neighboring routers.

Purpose This procedure describes how to configure RIP on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 208.

TABLE 208 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enable RIP, use the following command,as shown in Table 209.

TABLE 209 ROUTER RIP COMMAND

Command Format	Command Mode	Command Function
router rip	config	This establish rip routing process

Result: This configures RIP routing process.

3. To associate a network with RIP routing process, use command **network <**ip address**>** in RIP config mode as shown in Table 210.

TABLE 210 NETWORK COMMAND WINDOW

Command Format	Command Mode	Command Function
network <ip-address> <wildcard-mask>	RIP config	This designates a network table for RIP routing

<ip-address> refers to format 0.0.0.0.

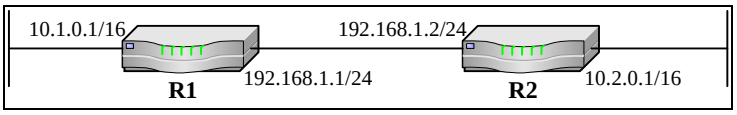
<wildcard-mask> A wildcard mask is a 32-bit quantity used in conjunction with an Internet address to determine which bits in an Internet address should be ignored when comparing that address with another Internet address. This refers to filter out a subnet.

Result: This configures RIP interfaces between certain numbers of a specified network address.

END OF STEPS

Example: As shown in Figure 85 , RIP runs on router R1 and router R2.

FIGURE 85 BASIC RIP CONFIGURATION



Configuration of R1:

```
ZXR10_R1(config)#router rip
ZXR10_R1(config-router)#network 10.1.0.0 0.0.255.255
ZXR10_R1(config-router)#network 192.168.1.0 0.0.0.255
```

Configuration of R2:

```
ZXR10_R2(config)#router rip
ZXR10_R2(config-router)#network 10.2.0.0 0.0.255.255
ZXR10_R2(config-router)#network 192.168.1.0 0.0.0.255
```

RIP Enhanced Configuration

Purpose This below procedure delivers information about enhanced RIP configuration

Prerequisite

- Router Command Line Interface has been accessed.
- RIP is running on a network as described in above basic IP configuration.

Steps

1. To adjust timer for better rip performance in some cases, use command ***timers basic <update> <invalid> <holddown> <flush>*** in RIP config mode as shown in Table 211. To restore the default timers, use the **no** form of this command.

TABLE 211 TIMERS COMMAND WINDOW

Command Format	Command Mode	Command Function
timers basic <update> <invalid> <holddown> <flush>	RIP Config	This sets the timers for good rip performance

<update> parameter range is from <1-65535> seconds. This configures Rate in seconds at which update are sent. This is the fundamental timing parameter of routing protocol.

<invalid> ranges from <1-65535> seconds. This configures Interval of time (in seconds) after which a route is declared invalid.

<holddown> ranges from <0-65535>. This is an Interval (in seconds) during which routing information regarding better paths is suppressed.

<flush> ranges from <1-65535>. This is an Amount of time (in seconds) that must pass, before this route removes from the routing table. This interval measures from last update received for the route.

Timing Parameters

The basic timing parameters for RIP are adjustable. Since RIP is executing a distributed, asynchronous routing algorithm, it is important that these timers be the same for all routers and access servers in the network.

Result: This configures RIP network timers for adjusting parameters with other RIP neighbor.

2. To change the interpacket delay for RIP updates sent, use the **output-delay** command in RIP configuration mode as shown in Table 212. To remove the delay, use the no form of this command.

TABLE 212 OUTPUT COMMAND WINDOW

Command Format	Command Mode	Command Function
output-delay *<packets> <delay>*	RIP Config	This defines interpacket delay for RIP updates

<packets> *<delay>* ranges from <1-4294967295>. Consider using this command if there is a high-end router sending at high speed to a low-speed router that might not be able to receive at the high speed. Configuring this command will help prevent the routing table from losing information.

Result: This configures interpacket delay for RIPupdates.

3. To define a neighboring router with which to exchange routing information, use **neighbor** command in RIP configuration mode as shown in Table 213 . To remove an entry, use the no form of this command.

TABLE 213 NEIGHBOR COMMAND WINDOW

Command Format	Command Mode	Command Function
neighbor <*ip-address*>	RIP Config	This defines neighboring router with which routing information is exchanged

<*ip-address*> refers to IP address of a peer router with which routing information exchanges.

This command permits the point-to-point (non-broadcast) exchange of routing information, when use with combination of passive-interface router configuration command, routing information exchanges between a subset of routers and access servers on a LAN.

Result: This configures a peer router with whom routing information exchanges.

4. To enable authentication for RIP Version 2 packets and to specify set of keys that uses on an interface, use **ip rip authentication key** command in RIP interface configuration mode as shown in Table 214 . Use the no form of this command to prevent authentication.

TABLE 214 IP RIP AUTHENTICATION KEY

Command Format	Command Mode	Command Function
ip rip authentication key <*key*>	RIP Interface Config	This designates a key that can be used for simple text authentication of an interface

<*key*> refers to authentication key in characters ranges from <1- 16>.

This command specifies, to accept only those RIP update packets coming from the peer that is authenticated.

Result: This configures authentication for RIP routing updates.

5. To specify the type of authentication used in RIP Version 2 packets, use **ip rip authentication mode** command in RIP interface configuration mode as shown in below table. Use the no form of this command to restore clear text authentication.

TABLE 215 AUTHENTICATION MODE COMMAND

Command Format	Command Mode	Command Function
ip rip authentication mode {**text**|**md5**}	RIP Interface Config	This designates authentication type used for RIP packets

text refers to Clears text authentication.

Md5 refers to Keyed MD5 authentication.

RIP Version 1 does not support authentication.

Result: This configures authentication mode for RIP.

6. To enable split horizon mechanism, use **ip split-horizon** command in RIP interface configuration mode as shown in Table 216 . To disable the split horizon mechanism, use the no form of this command.

TABLE 216 SPLIT HORIZON COMMAND WINDOW

Command Format	Command Mode	Command Function
ip split-horizon	**RIP Interface Config**	**This enables the split horizon mechanism**

This command has no arguments or keywords.

IP Split Horizon

For all interfaces except those for which either Frame Relay or SMDS encapsulation is enabled, the default condition for this command is ip split-horizon; in other words, the split horizon feature is active.

Important! For networks that include links over X.25 PSNs, the ***neighbor*** RIP router configuration command use to defeat the split horizon feature.

No-IP Split Horizon

This can act, as an alternative explicitly specify the no ip split-horizon command in your configuration. However, if this happens there must similarly disable split horizon for all routers in any relevant multicast groups on that network.

Important! If split horizon is disabled on an interface and there is requirement to enable it, use the ip split-horizon command to restore the split horizon mechanism

Important! In general, changing state of the default for the ip split-horizon command is not recommended, this is certain that application requires a change in order to properly advertise routes. If split horizon is disabled on a serial interface (and that interface is attached to a packet-switched network), this is must to disable split horizon or all routers and access servers in any relevant multicast groups on that network.

Result: This configures split horizon mechanism.

7. To enable the poison reverse mechanism, use the **ip poison-reverse** command in RIP interface configuration mode as shown in Table 217.To disable the split horizon mechanism, use the no form of this command.

TABLE 217 IP POISON REVERSE COMMAND WINDOW

Command Format	Command Mode	Command Function
ip poison-reverse	RIP Interface Config	This enables redistribution of other protocols in RIP routing domain.

Result: This enables redistribution of other protocols in RIP routing domain.

8. To redistribute a route from another routing domain to rip routing domain use command **redistribute** <*protocol*> [**metric** <*value*>] [**route-map** <*map-tag*>] in RIP configuration mode as shown in Table 218 .To disable this, use the no form of this command.

TABLE 218 REDISTRIBUTE COMMAND WINDOW

Command Format	Command Mode	Command Function
redistribute <*protocol*> [**metric** <*value*>] [**route-map** <*map-tag*>]	RIP Config	This helps to configure metric values for other routing protocols.

<*protocol*> refers to both EGP and IGP protocols.

<*value*> ranges from <0-16>.

<*map-tag*> refers to a tag values through route recognize.

Result: This enables redistribution of other protocols in RIP routing domain.

9. To set default metric values for RIP, use this form of the ***default-metric*** command in RIP router configuration mode as shown in Table 219 . To return to the default state, use the no form of this command.

TABLE 219 DEFAULT METRIC COMMAND WINDOW

Command Format	Command Mode	Command Function
default-metric <*number*>	RIP Interface Config	This enables the poison reverse mechanism

<*number*> ranges from <1-16>.

Default-metric command is used in conjunction with the redistribute router configuration command to cause the

current routing protocol to use the same metric value for all redistributed routes.

Default Metric

A default metric helps solve the problem of redistributing routes with incompatible metrics. Whenever metrics do not convert, using a default metric provides a reasonable substitute and enables the redistribution to proceed.

Important! When enabled, the default-metric command applies a metric value of 0 to redistributed connected routes. The default-metric command does not override metric values that are applied with the redistribute command.

Result: This helps to configure metric values for other routing protocols.

END OF STEPS

Version Configuration

ZXR10 GER supports RIPv1 and RIPv2 (RIPv2 is used by default).

1. To specify a RIP version used globally by the router, use **version** command in RIP router configuration mode, as shown in Table 220. Use the no form of this command to restore the default value.

TABLE 220 RIP VERSION COMMAND WINDOW

Command Format	Command Mode	Command Function
version {**1**|**2**}	RIP Config	This designates the RIP version used in a router globally
ip rip receive version {**1**|**2**} [**1**|**2**]	RIP Config	This designates the RIP version received on an interface
ip rip send version {**1**|**2** {**broadcast multicast**}}	RIP Config	This designates the RIP version sent on an interface

{**1**|**2**} specifies RIP version 1 and RIP version 2.

To specify RIP versions used on an interface basis, use the ***ip rip receive version*** and ***ip rip send version*** commands.

ip rip receive version command is used to override the default behavior of RIP as specified by the **version** command. This command applies only to the interface configuration. There can be configuration for accepting both the versions.

ip rip send version command to override the default behavior of RIP as specified by the router **version** command. This command applies only to the interface configuration.

Result: These commands specify RIP versions for receiving and sending routing updates.

RIP Maintenance & Diagnosis

Purpose This below procedure describes debugging of Routing information protocol on ZTE ZXR10 GER router.

Prerequisites

- Router Command Line Interface has been accessed.
- Make sure that RIP is running on a network as described in above basic RIP configurations.

Steps

1. To display protocol information, use **show ip rip** command in Exec mode as shown in Table 221.

TABLE 221 SHOW IP RIP COMMAND

Command Format	Command Mode	Command Function
show ip rip	Exec	This displays the basic RIP running information

Result: This show basic rip routing information.

2. To display rip routing interface and its parameters information, use **show ip rip interface** <interface-number> in Exec mode as shown in Table 222.

TABLE 222 SHOW IP RIP INTERFACE COMMAND

Command Format	Command Mode	Command Function
show ip rip interface *<interface-number>*	Exec	This displays the current configuration and status of an RIP interface

Result: This show rip routing interface information and parameters.

3. To display the RIP adjacent neighbors, use **show ip rip neighbors** command in Exec mode as shown in Table 223.

TABLE 223 SHOW IP RIP NEIGHBORS COMMAND

Command Format	Command Mode	Command Function
show ip rip neighbors	Exec	This displays the information about all neighbors configured by the user

Result: This show all the information about RIP neighbors.

4. To display the route item database, use **show ip rip database** command in Exec mode as shown in Table 224.

TABLE 224 SHOW IP RIP DATABASE COMMAND WINDOW

Command Format	Command Mode	Command Function
show ip rip database	Exec	This displays the information about all neighbors configured by the user

Result: This show all the database information about RIP.

5. To display all RIP interface information configured by the user, use **show ip rip networks** in Exec mode as shown in Table 225.

TABLE 225 IP RIP NETWORK COMMAND WINDOW

Command Format	Command Mode	Command Function
show ip rip networks	Exec	This displays the information about all neighbors configured by the user

Result: This shows all RIP interface information configured by the user.

Debugging

ZXR10 GER also provides the debug command to debug RIP and trace related information.

1. To trace the basic rip sending and receiving packet, use **debug ip rip** command in Exec mode as shown in Table 226.

TABLE 226 DEBUG IP RIP COMMAND WINDOW

Command Format	Command Mode	Command Function
debug ip rip	Exec	This traces the basic packet sending/receiving process of RIP

Result: This traces RIP sending/ receiving packet.

2. To Traces the change process of the RIP routing table, use **debug ip rip database** command in Exec mode as shown in Table 227.

TABLE 227 DEBUG IP RIP DATABASE COMMAND WINDOW

Command Format	Command Mode	Command Function
debug ip rip database	Exec	Traces the change process of the RIP routing table

Result: This traces the change process of the RIP routing table.

```
ZXR10#debug ip rip
RIP protocol debugging is on
ZXR10#
11:01:28: RIP: building update entries
              130.1.0.0/16 via 0.0.0.0, metric 1, tag 0
              130.1.1.0/24 via 0.0.0.0, metric 1, tag 0
              177.0.0.0/9 via 0.0.0.0, metric 1, tag 0
              193.1.168.0/24 via 0.0.0.0, metric 1, tag 0
              197.1.0.0/16 via 0.0.0.0, metric 1, tag 0
              199.2.0.0/16 via 0.0.0.0, metric 1, tag 0
              202.119.8.0/24 via 0.0.0.0, metric 1, tag 0
11:01:28: RIP: sending v2 periodic update to 224.0.0.9 via
pos3_3/1 (193.1.1.111)
              130.1.0.0/16 via 0.0.0.0, metric 1, tag 0
              130.1.1.0/24 via 0.0.0.0, metric 1, tag 0
              177.0.0.0/9 via 0.0.0.0, metric 1, tag 0
              193.1.1.0/24 via 0.0.0.0, metric 1, tag 0

11:01:28: RIP: sending v2 periodic update to 193.1.168.95
via fei_1/1 (193.1.168.111)

11:01:28: RIP: sending v2 periodic update to 193.1.168.86
via fei_1/1 (193.1.168.111)
```

```
11:01:28: RIP: sending v2 periodic update to 193.1.168.77
via fei_1/1 (193.1.168.111)
11:01:28: RIP: sending v2 periodic update to 193.1.168.68
via fei_1/1 (193.1.168.111)
```

```
ZXR10#debug ip rip
RIP protocol debugging is on
ZXR10#
11:01:28: RIP: building update entries
              130.1.0.0/16 via 0.0.0.0, metric 1, tag 0
              130.1.1.0/24 via 0.0.0.0, metric 1, tag 0
              177.0.0.0/9 via 0.0.0.0, metric 1, tag 0
              193.1.168.0/24 via 0.0.0.0, metric 1, tag 0
              197.1.0.0/16 via 0.0.0.0, metric 1, tag 0
              199.2.0.0/16 via 0.0.0.0, metric 1, tag 0
              202.119.8.0/24 via 0.0.0.0, metric 1, tag 0
11:01:28: RIP: sending v2 periodic update to 224.0.0.9 via
```

```
pos3_3/1 (193.1.1.111)
             130.1.0.0/16 via 0.0.0.0, metric 1, tag 0
             130.1.1.0/24 via 0.0.0.0, metric 1, tag 0
             177.0.0.0/9 via 0.0.0.0, metric 1, tag 0
             193.1.1.0/24 via 0.0.0.0, metric 1, tag 0
11:01:28: RIP: sending v2 periodic update to 193.1.168.95
via fei_1/1 (193.1.168.111)
11:01:28: RIP: sending v2 periodic update to 193.1.168.86
via fei_1/1 (193.1.168.111)
11:01:28: RIP: sending v2 periodic update to 193.1.168.77
via fei_1/1 (193.1.168.111)
11:01:28: RIP: sending v2 periodic update to 193.1.168.68 via
fei_1/1 (193.1.168.111)
```

Chapter 14

OSPF Configuration

Overview

Introduction

OSPF refers to Open Shortest Path First. OSPF protocol is a kind of link state routing protocol. OSPF can meet the requirements for large and scalable networks while distance vector routing protocols such as RIP cannot meet the requirements.

Contents

This chapter covers the following topics.

TABLE 228 TOPICS IN CHAPTER 14

OSPF

OSPF Basics

Open Shortest Path First (OSPF) protocol is one of the most popular and widely used routing protocols. OSPF is a link state protocol, which has overcome the disadvantages of RIP and other distance vector protocols. OSPF is also an open standard, and different types of equipment from multiple manufacturers can implement protocol interconnection.

OSPF version 1 is defined in RFC1131. At present, OSPF version 2 is used, which is defined in RFC2328. ZXR10 GER supports OSPF of version 2 completely.

OSPF Features

- Fast convergence: OSPF guarantees database synchronization and also calculates routing table synchronously by means of fast flooding of link state update.
- No route loop: Shortest Path First (SPF) algorithm is applied to guarantee that no loops will be generated.
- Route aggregation: Reduces the size of the routing table.
- Classless routing completely: supporting Variable Length Subnet Mask (VLSM) and Classless Inter-Domain Routing (CIDR).
- Reduction of network bandwidth: Since triggered update mechanism is used, the update information will be sent only when the network changes.
- Support interface packet authentication to guarantee the security of routing calculation
- Sending update in multicast mode: Reduces interferences upon unrelated network equipment while plays the broadcast role at the same time.

OSPF Network Type

- A network type that is connected to an interface is used to judge the default OSPF behavior on interface. The network type affects the adjacency formation and method in which a router assigns timers to the interface.

OSPF covers the following five network types:

- Broadcast network
- Non-broadcast Multi-access (NBMA) network
- Point-to-point network
- Point-to-multipoint network
- Virtual links

Hello Packets and Timers

OSPF routers exchange Hello packets at a certain interval to keep alive status among neighbors. Hello packets can find OSPF neighbors, set up association and adjacency among neighbors and select designated routers. Among the three network types (that is, broadcast network, point-to-point network and point-to-multi-point network), Hello packets are multicast packets.

However, in NBMA networks and virtual links, Hello packets are unicast to neighbor routers.

OSPF uses three types of timers related to Hello packets:

1. Call interval

   Call interval is an attribute of an interface, which defines at which interval a router sends a Hello packet out each interface. The default call interval depends on network type. In broadcast and point-to-point networks, the default call interval is 10s. In NBMA and point-to-multipoint networks, the default call interval is 30s. Two adjacent routers must agree with call interval to become neighbors.

2. Dead interval of router

   A router dead interval refers to a time interval between receiving of last Hello packet from its neighbor and detection of offline status of neighbor. Default dead interval is four times the call interval (the same is true for all types of networks).

3. Polling interval

   Polling interval is only used in NBMA networks.

OSPF Neighbors

OSPF neighbors are a group of routers on same network. These routers have agreed with some configuration parameters. To form adjacency, routers must be neighbors.

To form adjacency, routers must analyze Hello packets of each other to confirm whether they have agreed on necessary parameters. The parameters are as follows: area ID, area tag, authentication information, call interval and dead interval of router.

Adjacency and Router Designation

When two routers form an adjacent relation, they can exchange routing information. Whether two routers can form an adjacent relation depends upon network type connected to routers.

Point-to-point networks and virtual links only have two routers, so routers form adjacency automatically. A point-to-multipoint network can be regarded as a set of point-to-point networks, so adjacency is formed between each pair of routers.

NBMA Network

- In a broadcast or an NBMA network, adjacency may not be formed between two neighbors. If adjacency has been set up among all routers (the number of routers is "n" for example) on a network, each router will have "(n-1)" adjacent connections and the network will have "n (n-1)/2" adjacent connections. In a large multi-access network, if each router traces so many neighbor routers, the router will have too heavy traffic, and furthermore, the routing information between each neighboring routers will waste many network bandwidth.

Designated Router (DR)

Therefore, OSPF defines a Designated Router (DR) and a Backup Designated Router (BDR). The DR and BDR must form an adjacent relation with each OSPF router on network and each

OSPF router forms an adjacent relation with only DR and BDR. If the DR stops work, the BDR will become a DR.

Router Priority and DR Election

Each router interface has a priority, which will affect the router's capability of becoming a DR or BDR on the network to which router is connected. A router priority is expressed with an eight-bit unassigned integer, ranging from 0 to 255 (the default value is "1").

Upon DR election, the router with highest priority will become DR. If two routers have same priority, the one with the highest IP address will become the DR. The router with priority "0" cannot be DR or BDR.

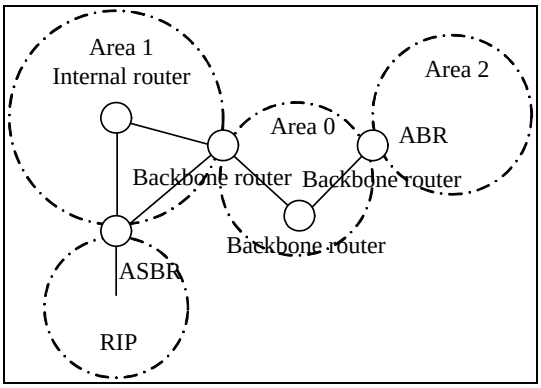
OSPF Area

OSPF areas divide a network into certain smaller parts to reduce the information volume stored and maintained in each router. Each router must have complete information about area where it is located. The information among different areas is shared and routing information can be filtered on edges of areas to reduce routing information volume stored in router.

Backbone Area

An area is identified with a 32-bit unsigned integer. Area 0 is reserved and is used to indicate backbone network. The other areas must be directly connected to area 0. An OSPF network must have a backbone area. According to specific task in area where a router is located, the router can be one or multiple types of following routers, as shown in Figure 86.

FIGURE 86 OSPF ROUTER TYPE



- Internal router: Interfaces of the router are inside the same area.
- Backbone router: At least one interface of the router is inside area 0.
- Area Border Router (ABR): At least one interface of router is inside area 0 and at least one interface is in other area.
- Autonomous System Border Router (ASBR): the router connects an AS running OSPF to another AS running other protocol (e.g. RIP .

LSA Type and Flooding

LSA is a mode of exchanging link state database information among OSPF routers. A router uses LSAs to construct an

accurate and complete network diagram and generate routes used in its routing table. ZTE ZXR10 GER supports following six types of LSAs:

- Type 1: Router LSA
- Type 2: Network LSA
- Type 3: Network summary LSA
- Type 4: ASBR summary LSA
- Type 5: External LSA of AS
- Type 7: External LSA of NSSA A

OSPF Operation

The operation of OSPF depends upon all routers sharing same common link state database in one area. Therefore, all LSAs are flooded via this area and processing must be reliable. Each router receiving LSAs in a special area will flood LSAs to other interfaces in area. LSAs do not have their own packets, and they are included in Link state Update (LSU) packets.

LSU

Several LSAs can be included in same LSU. When a router receives an LSU, this does not send out the packets simply, but separates the packets from LSA and inputs them to its database. In addition, the router will construct its own LSU and send the updated LSU to the neighbor router(s).

Link State Acknowledgement

OSPF uses Link State Acknowledgement (LSAck) to confirm whether each LSA is successfully received by its neighbor. An LSAck has header of an acknowledged LSA which provides sufficient information for uniquely identifying an LSA. When a router sends an LSA to an interface, the LSA will be recorded in the retransmission queue of interface.

The router will wait for maximum time interval to receive the LSAck of LSA. If the router does not receive the LSAck in specified time, the router will retransmit the LSA. The router can send the original LSU in unicast or multicast mode, but the retransmitted LSU is in unicast mode.

Stub Area

If a non-backbone area does not have an ASBR, a router only has one path to an AS external network, that is, through an ABR. Thus, routers in these areas send LSAs sent to an unknown host outside the AS to ABR. Therefore, LSAs of type 5 do not need to be flooded to area and also the area does not have LSAs of type 4. Such an area type is called a stub area.

In a stub area, all routers must be configured as stub routers. A Hello packet contains a "stub area" flag bit. The flag bit must be consistent among neighbors.

Totally Stub Area

An ABR in a stub area can filter LSAs of type 5 to prevent them from being advertised to stub area. In meantime, the ABR will generate an LSA of type 3 to advertise a default route to a destination address external to the AS.

If the ABR also filters the LSA of type 3 and also advertises a default route to the destination address external to an area, such an area is called a totally stubby area.

Not- So-Stubby Area

A router in a stub area does not allow an LSA of type 5, so ASBR is not a part of the stub area. However, it is hoped that a stub area with an ASBR can be generated, such that a router in area can receive AS external routes from ASBR in this area, but external routing information from other areas will be blocked.

Therefore, OSPF defines Not-So-Stubby Area (NSSA). In an NSSA, the ASBR generates Type 7 LSA instead of Type 5 LSA. ABR cannot send Type 7 LSA to other OSPF areas. This blocks external routes from entering the NSSA area at the area border; On the other hand, this converts Type 7 LSA into Type 5 LSA.

OSPF Authentication

The authentication can be used for packet exchange between two OSPF neighbors. The neighbors must agree on authentication type and authentication type is contained in all packets.

Authentication type "0" indicates no authentication, "1" indicates simple password authentication and "2" indicates MD5 password authentication.

When simple password authentication is configured, an interface only allows one password. The password of each interface can be different, but each interface in a special network must have same password. The simple password is sent through OSPF packets in plain text.

CLI Configuration

Purpose

This procedure describes how to configure OSPF on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 229.

TABLE 229 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. Enabling an OSPF process, use **router ospf** <process-id> command in global configuration mode as shown in Table 230.

TABLE 230 ROUTER OSPF COMMAND

Command Format	Command Mode	Command Function

Command Format	Command Mode	Command Function
router ospf *<process-id>*	Global	This enables OSPF routing process

Result: This initiates the OSPF process in router. OSPF process-id is a numeric value local to the router.

3. Assigning areas to interfaces using **network** <network or IP address> <mask> <areaid> command in global configuration mode as shown in Table 231.

TABLE 231 OSPF NETWORK COMMAND

Command Format	Command Mode	Command Function
network <ip-address> <wildcard-mask> **area** <area-id>	OSPF Route	This defines interfaces on which OSPF protocol runs and defines an area ID for these interfaces (if area does not exist, the system will automatically an area)

Result: This assigns an interface to certain area. Mask is used for shortcut, it puts list of interfaces in same area with one line configuration command.

OSPF Interface Attributes

1. For OSPF cost, use **ip ospf cost** <cost> command in OSPF interface mode as shown in Table 232.

TABLE 232 IP OSPF COST COMMAND

Command Format	Command Mode	Command Function
ip ospf cost *<cost>*	OSPF Interface	This configures interface cost in explicit mode

Result: This explicitly specifies the cost of sending a packet on an OSPF interface.

2. For OSPF link state advertisements for an interface, use **ip ospf retransmit-interval** <seconds> command in OSPF interface mode as shown in Table 233.

TABLE 233 IP OSPF RETRANSMIT INTERVAL COMMAND

Command Format	Command Mode	Command Function
ip ospf retransmit-interval *<seconds>*	OSPF Interface	This designates the interval for an interface to retransmit LSA

Result: This specifies the number of seconds between link-state advertisement (LSA) retransmissions for adjacencies belonging to an OSPF interface.

3. For sending LSA update packet to on an OSPF interface, use **ip ospf transmit-delay** <seconds> command in OSPF interface mode as shown in Table 234.

TABLE 234 IP OSPF TRANSMIT DELAY

Command Format	Command Mode	Command Function
ip ospf transmit-delay *<seconds>*	OSPF Interface	This designates delay for an interface to transmit a link state update packet

Result: This sets estimated number of seconds required to send a link-state update packet on an OSPF interface.

4. For OSPF designated router in a network, use **ip ospf priority** <seconds> command in OSPF interface mode as shown in Table 235.

TABLE 235 IP OSPF PRIORITY

Command Format	Command Mode	Command Function
ip ospf priority *<number>*	OSPF Interface	This configures interface priority

Result: This sets priority to help determine the OSPF designated router for a network.

5. For OSPF device that must wait for hello packet of other router, use ***ip ospf dead-interval <seconds>*** command in interface mode as shown in Table 236.

TABLE 236 IP OSPF DEAD-INTERVAL COMMAND

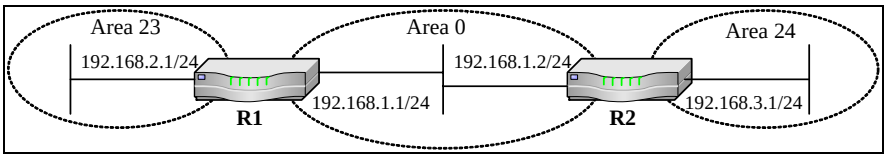
Command Format	Command Mode	Command Function
ip ospf dead-interval *<seconds>*	OSPF Interface	This designates the dead interval of the neighbor on an interface

Result: This sets the number of seconds that a device must wait before it declares a neighbor OSPF router down because this has not received a hello packet.

END OF STEPS

Example: As shown in Figure 87, OSPF runs on routers R1 and R2, and network is divided into three areas.

FIGURE 87 OSPF CONFIGURATION



Configuration of R1:

```
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 192.168.2.0 0.0.0.255 area 23
ZXR10_R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
```

Configuration of R2:

```
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network 192.168.3.0 0.0.0.255 area 24
ZXR10_R2(config-router)#network 192.168.1.0 0.0.0.255 area 0
```

Related Information For additional information on OSPF additional configurations, please refer to below procedures.

Configuring OSPF for Non-Broadcast Network

Purpose This procedure describes how to configure OSPF for non-broadcast network.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. To configure routers that interconnect to non-broadcast networks, use **neighbor** <ip-address> [priority <number>] command in OSPF route mode as shown in Table 237.

TABLE 237 NEIGHBOR COMMAND

Command Format	Command Mode	Command Function
neighbor *<ip-address>* [**priority** *<number>*]	OSPF route	This configures neighbor router on a non-broadcast network

Result: This configures a router interconnecting to non-broadcast networks.

END OF STEPS

Related Information For additional information on OSPF additional configurations, please refer to below procedures.

Configuring OSPF Authentication

Purpose This below procedure describes how to enable OSPF authentication.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. To enable authentication in OSPF routing process, use **area <area-id> authentication** [message-digest] command in OSPF route mode as shown in Table 238.

TABLE 238 AREA AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
area <*area-id*> authentication [message-digest]	OSPF Route	This enables authentication in an OSPF area

Result: This enables authentication in the OSPF area.

2. For assigning password on OSPF interface used by neighboring OSPF routers, use **ip ospf authentication-key** <password> command in OSPF interface mode as shown in Table 239.

TABLE 239 IP OSPF AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
ip ospf authentication-key <*password*>	OSPF Interface	This configures password for an interface of simple password authentication type

Result: This assigns a password to be used by neighboring OSPF routers on a network segment that is using the OSPF simple password authentication.

3. For enabling OSPF MD5 authentication on OSPF interface, use **ip ospf message-digest-key** <keyid> **md5** <password> [delay <time>] command in OSPF interface mode as shown in Table 240.

TABLE 240 IP OSPF MESSAGE DIGEST KEY

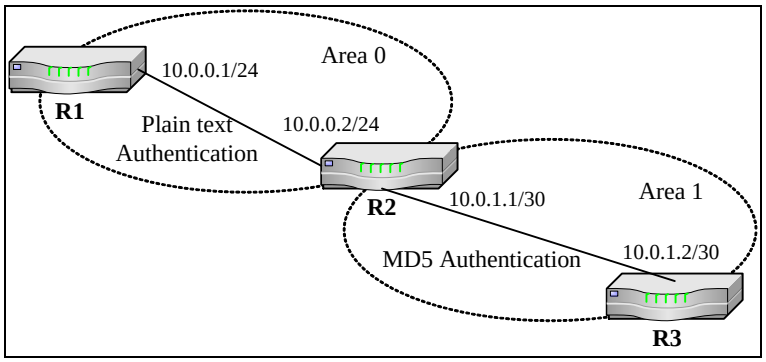
Command Format	Command Mode	Command Function
ip ospf message-digest-key <*keyid*> **md5** <*password*> [delay <*time*>]	OSPF Interface	This configures password serial number pair for an interface of MD5 authentication type

Result: This enables OSPF MD5 authentication. The values for key-id and key arguments must match values specified for other neighbors on a network segment.

END OF STEPS

Example: Figure 88 shows an OSPF authentication example. The plain text authentication is used in area 0, while the MD5 encryption authentication is used in area 1.

FIGURE 88 OSPF AUTHENTICATION EXAMPLE



The detailed configuration of each router is as follows:

Configuration of R1:

```
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address 10.0.0.1 255.255.255.0
ZXR10_R1(config-if)#ip ospf authentication-key ZXR10
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
ZXR10_R1(config-router)#area 0 authentication
```

Configuration of R2:

```
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip address 10.0.0.2 255.255.255.0
ZXR10_R2(config-if)#ip ospf authentication-key ZXR10
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#interface fei_1/2
ZXR10_R2(config-if)#ip address 10.0.1.1 255.255.255.252
ZXR10_R2(config-if)#ip ospf message-digest-key 1 md5 ZXR10
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
```

```
ZXR10_R2(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R2(config-router)#area 0 authentication
ZXR10_R2(config-router)#area 1 authentication message-digest
```

Configuration of R3:

```
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip address 10.0.1.2 255.255.255.252
ZXR10_R3(config-if)#ip ospf message-digest-key 1 md5 ZXR10
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip address 10.0.2.1 255.255.255.0
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R3(config-router)#network 10.0.2.0 0.0.0.255 area 0.0.0.2
ZXR10_R3(config-router)#area 1 authentication message-digest
```

Related Information

For additional information on OSPF additional configurations, please refer to below procedures.

Configuring OSPF Area Parameters and NSSA

Purpose

This below procedure describes how to configure OSPF area parameters and NSSA.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Note: There are three types of areas configurations

- Stub area

- Totally stubby area
- Not so stubby area

1. To enable authentication in OSPF routing process, use **area <area-id> authentication** [message-digest] command in OSPF route mode as shown in Table 241.

TABLE 241 AREA AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
area <area-id> authentication [message-digest]	OSPF Route	This enables authentication in an OSPF area

Result: This enables authentication in the OSPF area.

2. For configuring OSPF stubby area, use **area** <area-id> **stub** [default-cost <cost>] command in OSPF route mode as shown in Table 242.

TABLE 242 STUBBY AREA COMMAND

Command Format	Command Mode	Command Function
area <*area-id*> **stub** [default-**cost** <*cost*>]	OSPF Route	This defines an area as a stub area

Result: This defines an area as a stub area.

3. For configuring OSPF totally stubby area, use **area** <area-id> **stub no-summary** [default-cost <cost>] command in OSPF route mode as shown in Table 243.

TABLE 243 TOTALLY STUBBY AREA

Command Format	Command Mode	Command Function
area <*area-id*> **stub no-summary** [default-cost <*cost*>]	OSPF Route	This defines an area as a totally stubby area

Result: This defines an area as a totally stubby area.

4. To specify area parameters as needed to configure OSPF NSSA, use **area** <area-id> **nssa** [no-redistribution] [default-information-originate [metric <metric>] [metric-type <type>]] [no-summary] command in OSPF route mode as shown in Table 244.

TABLE 244 NOT-SO-STUBBY AREA

Command Format	Command Mode	Command Function
area <*area-id*> **nssa** [no-redistribution] [default-information-originate [metric <*metric*>] [metric-type <*type*>]] [no-summary]	OSPF Route	This defines an area as a not-so-stubby area

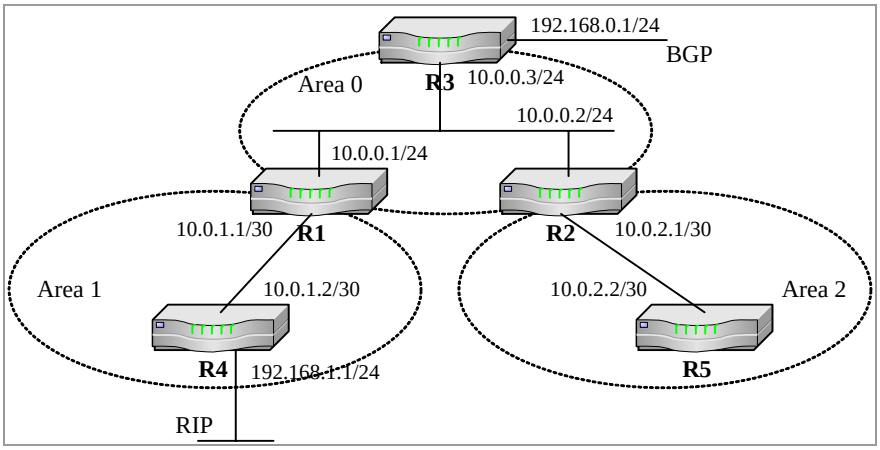
Result: This defines an area as a NSSA area.

END OF STEPS

Example: When a single-area network increase to a certain scale, the network must be designed such that network is divided into multiple OSPF areas.

Figure 89 shows an example of multi-area OSPF configuration.

FIGURE 89 MULTI-AREA OSPF CONFIGURATION



The detailed configuration of each route is described as follows.

Area 0.0.0.1 is an NSSA area, and R1 is an ABR working between NSSA area 0.0.0.1 and the backbone area. R1 advertises a default route to the local area.

Configuration of R1:

```
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address 10.0.1.1 255.255.255.252
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#interface fei_1/2
ZXR10_R1(config-if)#ip address 10.0.0.1 255.255.255.0
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
ZXR10_R1(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R1(config-router)#area 0.0.0.1 nssa default-information-
originate
```

Area 0.0.0.2 is a stub area, and R2 is an ABR working between NSSA area 0.0.0.2 and the backbone area. In the stub area, ABR will automatically advertise a default route to the stub area.

Configuration of R2:

```
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip address 10.0.2.1 255.255.255.252
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#interface fei_1/2
ZXR10_R2(config-if)#ip address 10.0.0.2 255.255.255.0
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
ZXR10_R2(config-router)#network 10.0.2.0 0.0.0.3 area 0.0.0.2
ZXR10_R2(config-router)#area 0.0.0.2 stub
```

R3 is a router working in backbone area 0, and is externally connected to another AS network through BGP. As an egress router of the entire AS, R3 advertises a default route to the entire OSPF by means of manual configuration.

Configuration of R3:

```
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip address 10.0.0.3 255.255.255.0
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip address 192.168.0.1 255.255.255.0
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
ZXR10_R3(config-router)#notify default route always
```

R4 is an ASBR in NSSA area 0.0.0.1. R4 also runs the RIP at the same time when it runs the OSPF protocol. The RIP protocol can be injected into the OSPF protocol by means of route redistribution.

Configuration of R4:

```
ZXR10_R4(config)#interface fei_1/1
ZXR10_R4(config-if)#ip address 192.168.1.1 255.255.255.0
ZXR10_R4(config-if)#exit
ZXR10_R4(config)#interface fei_1/2
ZXR10_R4(config-if)#ip address 10.0.1.2 255.255.255.252
ZXR10_R4(config-if)#exit
ZXR10_R4(config)#router ospf 1
ZXR10_R4(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R4(config-router)#area 0.0.0.1 nssa
ZXR10_R4(config-router)#redistribute rip metric 10
```

R5 is a router working in stub area 0.0.0.2.

Configuration of R5:

```
ZXR10_R5(config)#interface fei_1/1
ZXR10_R5(config-if)#ip address 10.0.2.2 255.255.255.252
ZXR10_R5(config-if)#exit
ZXR10_R5(config)#router ospf 1
ZXR10_R5(config-router)#network 10.0.2.0 0.0.0.3 area 0.0.0.2
ZXR10_R5(config-router)#area 0.0.0.2 stub
```

Related Information

For additional information on OSPF additional configurations, please refer to below procedures.

Configuring Inter-Area Route Aggregation

Introduction

One of the features that have made OSPF so popular is route aggregation. Route aggregation can happen among areas or ASs. The inter-area route aggregation takes place in an ABR, while route aggregation among ASs takes place in an ASBR.

Stub Area Configuration

The configuration of a stub area can save the resources of routers in the stub area, but it does not provide any help to the backbone network. If the allocation of network addresses in an area is consecutive, an ABR can be configured to advertise an aggregated route to replace these consecutive independent routes. Route aggregation can save the resources in the backbone area, implemented by advertising a group of network addresses as an aggregated address.

Purpose

This procedure describes how to configure inter area route aggregation in OSPF.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. To configure area route aggregation, use **area** <*area-id*> **range** <*ip-address*> <*net-mask*> [**advertise|not-advertise**] command in OSPF route mode as shown in Table 245.

TABLE 245 INTER AREA ROUTE AGGREGATION COMMAND

Command Format	Command Mode	Command Function
area <*area-id*> **range** <*ip-address*> <*net-mask*> [**advertise|not-advertise**]	Route	This configures the range of summary address in an area

Result: This sets range of summary address in an area.

Configuring Route Aggregation upon Route Redistribution

Introduction

After routes of other routing protocols are redistributed into the OSPF, each independent route is advertised as an external LSA. By means of aggregation, these external routes can be advertised as an independent route, which will greatly reduce the size of the link state database of the OSPF.

Purpose

This below procedure describes how to configure inter area route aggregation in OSPF.

Prerequisite

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. To configure route aggregation for route redistribution, use **summary-address** <*ip-address*> <*net-mask*> command in OSPF route mode as shown in Table 246.

TABLE 246 SUMMARY ADDRESS COMMAND

Command Format	Command Mode	Command Function
summary-address <ip-address> <net-mask>	OSPF Route	This sets up summary address for OSPF and summarizes other routing protocol paths being redistributed to the OSPF

Result: This defines summary address for OSPF and summarizes other routing protocol paths being redistributed to the OSPF.

Generating Default Route

Introduction An ASBR can be configured to advertise a default route to entire OSPF domain. When a router uses a redistributed route, it becomes an ASBR. By default, the ASBR cannot automatically advertise the default route to entire OSPF domain. When a command is used to configure a router to advertise a default route, the router becomes an ASBR automatically.

Purpose This below procedure describes how to configure inter area route aggregation in OSPF.

Prerequisite

- Router Command Line Interface has been accessed.
- Make sure that OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. To configure a default route in order to inject into OSPF by ASBR, use **notify default route** [**always**] [**metric** <*value*>] [**metric-type** <*type*>] [**route-map** <*map-tag*>] command in OSPF route mode as shown in Table 247.

TABLE 247 DEFAULT ROUTE COMMAND

Command Format	Command Mode	Command Function
notify default route [always] [metric <*value*>] [metric-type <*type*>] [route-map <*map-tag*>]	OSPF Route	This configures ASBR to advertise the default route to OSPF

Result: This sets ASBR to advertise the default route to OSPF.

Configuring Virtual Links

Introduction OSPF typically requires coordination among many internal routers: Area Border Routers (ABRs), which are routers connected to multiple areas, and Autonomous System Boundary Routers (ASBRs). At a minimum, OSPF-based routers or access servers can be configured with all default parameter values, no authentication, and interfaces assigned to areas.

In OSPF, all areas must be connected to a backbone area. If there is a break in backbone continuity, or the backbone is purposefully partitioned, there can be a virtual link.

ABRs The two endpoints of a virtual link are ABRs. The virtual link must be configured in both routers. The configuration information in each router consists of the other virtual endpoint (the other ABR) and the non-backbone area that the two routers have in common (called the transit area). Note that virtual links cannot be configured through stub areas.

Purpose Refer to below procedure for configuration of OSPF virtual links.

Prerequisite

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. For virtual link configuration, use **area** <area-id> **virtual-link** <router-id> [hello-interval <seconds>] [retransmit-interval <seconds>] [transmit-delay <seconds>] [dead-interval <seconds>] [authentication-key <key>] [message-digest-key <keyid> **md5** <cryptkey> [delay <time>]] command in OSPF route mode as shown in Table 248.

TABLE 248 VIRTUAL LINK COMMAND

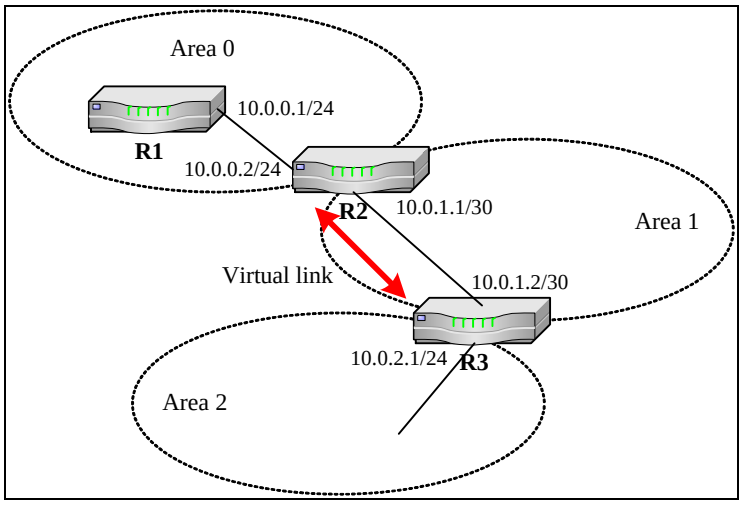
Command Format	Command Mode	Command Function
area <*area-id*> **virtual-link** <*router-id*> [hello-interval <*seconds*>] [retransmit-interval <*seconds*>] [transmit-delay <*seconds*>] [dead-interval <*seconds*>] [authentication-key <*key*>] [message-digest-key <*keyid*> **md5** <*cryptkey*> [delay <*time*>]]	OSPF Route	This defines an OSPF virtual link (if designated area does not exist, an area will be created automatically)

Result: This established a virtual link.

END OF STEPS

Example: Figure 90 shows an example of OSPF virtual link configuration.

FIGURE 90 OSPF VIRTUAL LINK CONFIGURATION



Detailed configuration of each router is as follows.

Configuration of R1:

```
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address 10.0.0.1 255.255.255.0
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
```

Configuration of R2:

```
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip address 10.0.0.2 255.255.255.0
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#interface fei_1/2
ZXR10_R2(config-if)#ip address 10.0.1.1 255.255.255.252
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network 10.0.0.0 0.0.0.255 area 0.0.0.0
ZXR10_R2(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R2(config-router)#area 1 virtual-link 10.0.1.2
```

Configuration of R3:

```
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip address 10.0.1.2 255.255.255.252
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip address 10.0.2.1 255.255.255.0
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network 10.0.1.0 0.0.0.3 area 0.0.0.1
ZXR10_R3(config-router)#network 10.0.2.0 0.0.0.255 area 0.0.0.2
ZXR10_R3(config-router)#area 1 virtual-link 10.0.0.2
```

Related Information

For additional information on OSPF additional configurations, please refer to below procedures.

Redistributing Other Routing Protocols

Introduction

Different dynamic routing protocols can implement the sharing of routing information by means of route redistribution. In OSPF, the routing information of other routing protocols is routing information external to the AS. The routing information external to an AS can be flooded to the entire OSPF network via LSAs of the OSPF only after the information is redistributed to the OSPF protocol.

Purpose

Refer to below procedure for configuration of redistribution of other routing protocols into OSPF.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. Use the **redistribute** command to control the redistribution of routes of other routing protocols into an OSPF autonomous system in OSPF route mode as shown in Table 249.

TABLE 249 REDISTRIBUTE COMMAND

Command Format	Command Mode	Command Function
redistribute <protocol> [as <as-no>] [peer <peer-address>] [tag <tag-value>] [metric <value>] [**metric-type** <*type*>] [**route-map** <*map-tag*>]	Route	This controls the redistribution of routes (these routes meet the relative conditions) of other protocols into an OSPF autonomous system. After the command is carried out, the router becomes an ASBR

Result: This establish a process of redistribution of other routing protocols into OSPF.

END OF STEPS

Related Information

For additional information on OSPF additional configurations, please refer to below procedures.

Configuring Administrative Distance

Introduction

The administrative distance stands for the reliability of information source. Normally, the administrative distance is an integer ranging from 0 to 255. Higher value indicates lower reliability. If the administrative distance is 255, it indicates that the source of the routing information is unreliable, so the related route will be neglected.

ZXR10 GER can define the administrative distances of three types of routes of OSPF: Internal route, external route type 1 and external route type 2. By default, the administrative of all the three types of routes are 110.

Purpose

Refer to below procedure for configuration of redistribution of other routing protocols into OSPF.

Prerequisites

- Router Command Line Interface has been accessed.
- OSPF is running on a network as described in above basic OSPF configuration.

Steps

1. For modifying the administrative distance of OSPF, use **distance ospf** {[**internal** <*distance*>] [**ext1** <*distance*>]

[**ext2** <*distance*>]} command in OSPF route mode as shown in Table 250.

TABLE 250 ADMINISTRATIVE DISTANCE COMMAND

Command Format	Command Mode	Command Function
distance ospf {[**internal** <*distance*>] [**ext1** <*distance*>] [**ext2** <*distance*>]}	OSPF Route	This defines OSPF route administrative distance based on route type

Result: This modifies the administrative distance of OSPF.

OSPF Maintenance & Diagnosis

Introduction

OSPF is more complicated than RIP. It is relatively difficult to overcome faults of the OSPF protocol, since the same phenomenon may be caused by multiple reasons. Common commands used in OSPF maintenance and diagnosis are as follows.

Refer to below procedure for OSPF maintenance and diagnosis.

Router Command Line Interface has been accessed.

OSPF is running on a network as described in above basic OSPF configuration.

1. To display protocol information, use **show ip ospf** [<*process-id*>] command in Exec mode as shown in Table 251.

TABLE 251 SHOW IP OSPF COMMAND

Command Format	Command Mode	Command Function
show ip ospf [<*process-id*>]	Exec	This displays the detailed information about OSPF process

Result: This shows detailed information about OSPF process.

2. To display an OSPF interface, use **show ip ospf interface** [<*interface-number*>] [**process** <*process-id*>] command in Exec mode as shown in Table 252.

TABLE 252 SHOW IP OSPF INTERFACE COMMAND

Command Format	Command Mode	Command Function
show ip ospf interface [<*interface-*	Exec	This displays the current configuration and status of an OSPF interface

Command Format	Command Mode	Command Function
number>] [**process** <*process-id*>]		

Result: This shows the current configuration and status of an OSPF interface.

3. To display OSPF neighbors, use **show ip ospf neighbor** [**interface** <*interface-number*>] [**neighbor-id** <*neighbor*>] [**process** <*process-id*>] command in Exec mode as shown in Table 253.

TABLE 253 SHOW IP OSPF NEIGHBOR COMMAND

Command Format	Command Mode	Command Function
show ip ospf neighbor [**interface** <*interface-number*>] [**neighbor-id** <*neighbor*>] [**process** <*process-id*>]	Exec	This displays the information about an OSPF neighbor

Result: This shows the information about an OSPF neighbor.

Important! If routing information between two routers cannot implement communications, possibly the adjacency has not been formed yet. Check whether the adjacency status between two OSPF routers is "FULL". The "FULL" status is a flat indicating normal running between the OSPF protocols.

4. To display an OSPF link state database, use **show ip ospf database** in Exec mode as shown in Table 254.

TABLE 254 SHOW IP OSPF DATABASE

Command Format	Command Mode	Command Function
show ip ospf database	Exec	This displays full or partial information about the link state database

Result: This shows full or partial information about the link state database.

NOTE: Link state database is source of all OSPF routes in IP routing table. Possibly many route problems are caused by incorrect information or information loss of the link state database.

Debugging ZXR10 GER provides the debug command to debug OSPF protocol and trace related information.

1.To turn on the debugging information switch for OSPF, use **debug ip ospf adj** in Exec mode as shown in Table 255**.**

TABLE 255 DEBUG IP OSPF COMMAND

Command Format	Command Mode	Command Function
debug ip ospf adj	Exec	This turns on debugging information switch for returning OSPF adjacency events

Result: This sets debugging information switch for returning OSPF adjacency events.

2. To turn on for debugging OSPF switch packets, use **debug ip ospf packet** command in OSPF in Exec mode as shown in Table 256.

TABLE 256 DEBUG IP OSPF PACKET

Command Format	Command Mode	Command Function
debug ip ospf packet	Exec	This turns on the debugging information switch for returning OSPF packet sending/receiving events and monitors the sending and receiving of all OSPF packets

Result: This turn on debugging for OSPF packets.

3. To turn on debugging information for OSPF LSA, use **debug ip ospf lsa-generation** command in Exec mode as shown in Table 257.

TABLE 257 DEBUG IP OSPF LSA GENERATION

Command Format	Command Mode	Command Function
debug ip ospf lsa-generation	Exec	This turns on debugging information switch for returning OSPF LSA generation events

Result: This turns on debugging information for OSPF LSA.

4.To turn on debugging information for important OSPF events, use **debug ip ospf events** command in Exec mode as shown in Table 258.

TABLE 258 DEBUG IP OSPF EVENTS

Command Format	Command Mode	Command Function
debug ip ospf	Exec	This turns on debugging

Command Format	Command Mode	Command Function
events		information switch for returning important OSPF events

Result: This turns on debugging information switch for returning important OSPFevents.

Chapter 15

IS-IS Configuration

Overview

Introduction

IS-IS protocol, put forward by the International Standardization Organization (ISO), is a routing protocol used for Connectionless Network Service (CLNS). The IS-IS protocol is a link state routing protocol based on the Dijkstra SPF algorithm. The IS-IS protocol is similar to the OSPF protocol in many aspects.

Contents

This chapter covers the following topics.

TABLE 259 TOPICS IN CHAPTER 15

IS-IS Overview

Definition

IS-IS is a routing protocol used for Connectionless Network Service (CLNS). This protocol is a link state routing protocol based on the Dijkstra SPF algorithm. IS-IS protocol is similar to OSPF protocol in many aspects.

PDU

Since the IS-IS protocol is based on CLNS (not IP), IS-IS uses Protocol Data Unit (PDU) defined by ISO to implement communications among routers. The types of PDUs used in the IS-IS protocol are as follows:

- Call PDU
- Link state PDU (LSP)
- Serial Number PDU (SNP)

Where, call PDU is similar to the HELLO packet in the OSPF protocol, which is responsible for the formation of the adjacency between routers, discovery of new neighbors and the detection of exit of any neighbors.

Link State PDU

IS-IS routers exchange routing information, set up and maintain link state database by use of link state PDUs. An LSP indicates important information about a router, covering area and connected network. SNP is used to ensure reliable transmission of LSPs. SNP contains summary information about each LSP on a network.

When a router receives an SNP, it compares SNP with link state database. If router loses an LSP in SNP, it originates a multicast SNP and asks for necessary LSPs from other routers on the network. LSPs are used in conjunction with SNPs so that IS-IS protocol can complete reliable route interaction on a large network.

Dijkstra SPF Algorithm

Likewise, the IS-IS protocol also uses the Dijkstra SPF algorithm to calculate routes. Based on the link state database, the IS-IS protocol uses the SPF algorithm to calculate the best route and then adds the route to the IP routing table.

IS-IS Area

Reduce Traffic

For convenience of link-state database management, concept of IS-IS area is introduced. Routers in an area are only responsible for maintaining the link state database in the local area to reduce the traffic of the routers themselves.

IS-IS areas are classified into backbone areas and non-backbone areas:

- Routers in the backbone area have the information about the database of the entire network.
- Routers in a non-backbone area only have information about the area.

Based on the area division, IS-IS defines three types of routers:

Three Types

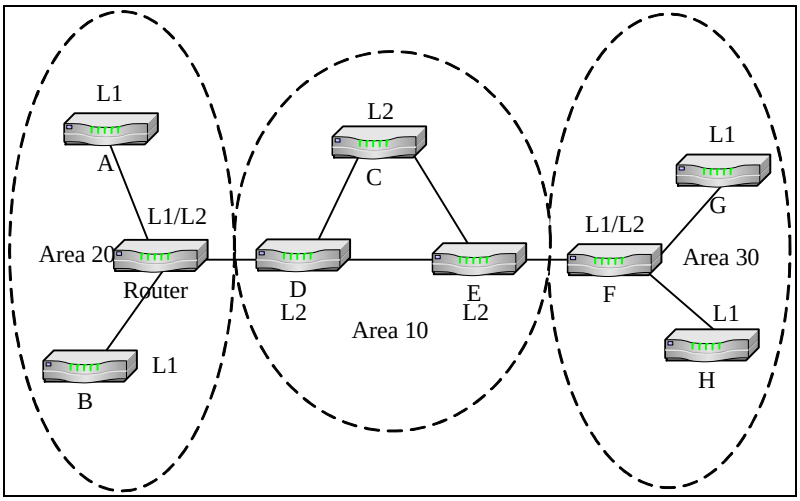
L1 router: Exists in a non-backbone area and only exchanges routing information with L1 router and L1/L2 router in the area.

L2 router: Exists in the backbone area and exchanges routing information with other L2 routers and L1/L2 routers.

L1/L2 router: Exists in a non-backbone area and exchanges routing information between non-backbone area and the backbone area.

IS-IS area division and router types are shown in Figure 91.

FIGURE 91 IS-IS AREAS



DIS & Router Priority

Designated Router

In a broadcast network, IS-IS protocol, similar to OSPF protocol, also uses designated router (DIS, that is, Designated Intermediate System). The DIS is responsible for advertising network information to all routers on the broadcast network and meanwhile all other routers only advertise one adjacency to the DIS.

DIS Election

The router priority parameters can be IS-IS configured for DIS election, and L1 and L2 can be independently IS-IS configured with different priorities. Upon DIS election, a highest priority router plays the role of DIS.

If priorities are same, for a frame relay interface, a router with higher system ID will be elected as the DIS; while for an Ethernet interface, a router with higher interface MAC value will be elected as the DIS.

Basic IS-IS Configuration

Purpose

Refer to below procedure for IS-IS configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- IS-IS is running in a network.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 260.

TABLE 260 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enable IS-IS, use **router isis** command in global config mode as shown in Table 261.

TABLE 261 IS-IS COMMAND WINDOW

Command Format	Command Mode	Command Function
router isis	global config	This establish isis routing process

Result: This enables IS-IS routing process.

3. For defining an IS-IS area use ***area <area-string>*** command in IS-IS config mode as shown in Table 262. ***<area-string>*** refers to format e.g. 1111.1111.1111.

TABLE 262 AREA COMMAND WINDOW

Command Format	Command Mode	Command Function
area <string>	IS-IS config	identify an area to which IS-IS instance is assigned

Result: This enables an area to which router interface belongs.

4. To designate router for specific area, use **system-id** <system-id> [range <range- number>] command in IS-IS config mode as shown in Table 263.

<system-id> normally expressed a unique ID of an interface of router. ***[range <range- number>]*** parameter is 1-32.

TABLE 263 SYSTEM ID COMMAND WINDOW

Command Format	Command Mode	Command Function
system-id <system-id> [range <range- number>]	IS-IS config	This identify router in an area

Result: This configures system - id of the IS-IS

5. To designate the interface on which IS-IS runs, use command ***ip router isis*** in interface config mode as shown in Table 264.

TABLE 264 IP ROUTER IS-IS COMMAND WINDOW

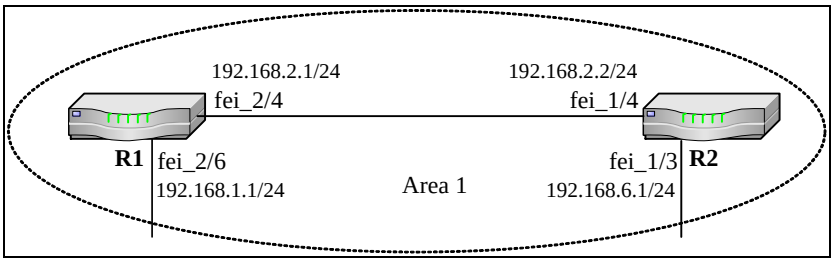
Command Format	Command Mode	Command Function
ip router isis	interface config	This enables IS-IS protocol on an interface

Result: This configures running of IS-IS protocol on an interface.

END OF STEPS

Example Before IS-IS configuration, analyze the entire network. Please determine network topology, whether network needs to be divided into multiple areas and whether multiple routing protocols run on the network according to network scale.
A single-area network is used to describe basic IS-IS configuration in following, as shown in Figure 92.

FIGURE 92 IS-IS CONFIGURATION EXAMPLE



In the above figure, routers R1 and R2 make up area 1, running the IS-IS protocol. The detailed IS-IS configuration is displayed as follows.

Configuration of R1:

```
ZXR10_R1(config)#router isis
ZXR10_R1(config-router)#area 01
ZXR10_R1(config-router)#system-id 00D0.D0C7.53E0
ZXR10_R1(config-router)#exit
ZXR10_R1(config)#interface fei_2/4
ZXR10_R1(config-if)#ip address 192.168.2.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
ZXR10_R1(config)#interface fei_2/6
ZXR10_R1(config-if)#ip address 192.168.1.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
```

Configuration of R2:

```
ZXR10_R2(config)#router isis
ZXR10_R2(config-router)#area 01
ZXR10_R2(config-router)#system-id 00D0.D0C7.5460
ZXR10_R2(config-router)#exit
ZXR10_R2(config)#interface fei_1/4
ZXR10_R2(config-if)#ip address 192.168.2.2 255.255.255.0
ZXR10_R2(config-if)#ip router isis
ZXR10_R2(config)#interface fei_1/3
ZXR10_R2(config-if)#ip address 192.168.6.1 255.255.255.0
ZXR10_R2(config-if)#ip router isis
```

Related Information For More information about IS-IS configuration please follow the below procedures.

Configuring Global IS-IS Parameters

Overview If all routers running on network are ZTE ZXR10 GER, just use default parameters in IS-IS configuration. However, upon interconnection with routers of other manufacturers, related interface parameters and timers need adjustment so that IS-IS protocol can run more efficiently on network.

IS-IS parameter configuration in IS-IS involves the IS-IS configuration of global parameters and interface parameters.

Purpose Below procedure delivers the information about configuration of global IS-IS parameters.

Prerequisite

- Router Command Line Interface has been accessed.
- IS-IS is running in a network.

Steps

1. To define the operation type of router, use command **is-type *{level-1|level-1- 2|level-2-only}*** in IS-IS config mode as shown in Table 265.

TABLE 265 IS-TYPE COMMAND

Command Format	Command Mode	Command Function
is-type {level-1|level-1-2|level-2-only}	IS-IS config	This defines the permitted IS-IS level

Result: This configures permitted IS-IS level for router.

2. To define PSNP (Serial Number PDU) for point to point networks, use command **isis psnp-interval** <num> [level-1|level-2] in IS-IS interface config mode as shown in Table 266.

TABLE 266 IS-IS PSNP-INTERVAL COMMAND

Command Format	Command Mode	Command Function
isis psnp-interval <num> [level-1|level-2]	IS-IS interface config	This defines PSNP sending interval

This parameter is used to configure the sending interval between two PSNPs (default value: 3). the <num> range is from 1-65535.

Result: This configures PSNP sending interval time for IS-IS interface.

3. To notify insufficient resources of router running an IS-IS protocol, use command **set-overload-bit** in IS-IS config mode as shown in Table 267.

TABLE 267 SET-OVERLOAD-BIT

Command Format	Command Mode	Command Function
set-overload-bit	IS-IS config	This defines the OL tab bit of IS-IS

This tag bit is used to identify to other routers running an IS-IS protocol.

Result: This configures tag bit for mentioning overload condition to other routers.

4. To generate default route in IS-IS domain, use command ***default-information originate*** **[always]** ***[metric <metric-value>] [metric-type <type-value>] [level-1\|level-1-2\|level-2]*** in IS-IS config mode as shown in Table 268.

TABLE 268 DEFAULT ROUTE COMMAND WINDOW

Command Format	Command Mode	Command Function
default-information originate [always] [metric <*metric-value*>] [metric-type <*type-value*>] [level-1|level-1-2|level-2]	IS-IS config	This defines the OL tab bit of IS-IS

This command is used to redistribute default routes in routing entries.

[metric <*metric-value*>] parameter range is from <0-4261412864>.

[metric-type <*type-value*>] parameter defines external <Set IS-IS external metric type> internal <Set IS-IS internal metric type >.

Result: This configures default route information in IS-IS routing table.

5. To summarize some entries in IS-IS routing table, use command ***summary-address <ip-address> <net-mask> <value> [level-1|level-1-2|level-2]*** in IS-IS config mode as shown in Table 269.

TABLE 269 SUMMARY-ADDRESS COMMAND

Command Format	Command Mode	Command Function
summary-address <*ip-address*> <*net-mask*> <*value*> [level-1|level-1-2|level-2]	IS-IS config	This defines an address summary of IS-IS

This command generates a summary that advertise without the need of detailed routing entries.

Metric value ranges from <0-4261412864>. The least metric value among the aggregated routing entries regard as the metric value of the summary route.

END OF STEPS

Related Information For More information about IS-IS configuration please follow the below procedures.

IS-IS Interface Parameters

Purpose This below procedure delivers the information about IS-IS interface configuration parameters.

Prerequisites

- Router Command Line Interface has been accessed.
- IS-IS is running in a network.

Steps

1. Use command ***isis circuit-type {level-1|level-1-2|level-2-only}*** in IS-IS interface config mode for defining operation type of an IS-IS interface as shown in Table 270.

TABLE 270 INTERFACE-LEVEL COMMAND

Command Format	Command Mode	Command Function
isis circuit-type {level-1|level-1-2|level-2-only}	IS-IS interface config	This defines the type of adjacency on an the interface

Result: This configures type of adjacency that can be set up on an interface.

2. For configuring isis hello-multiplier in order to save time for sending hello packets use command **isis hello-multiplier** <num> [level-1|level-2] in IS-IS interface config mode as shown in Table 271.

TABLE 271 IS-IS HELLO MULTIPLIER

Command Format	Command Mode	Command Function
isis hello-multiplier <num> [level-1|level-2]	IS-IS interface config	This defines the save time and Hello interval multiplier of an interface

The hello-multiplier values ranges from <3-1000>.

Result: This configures save time and hello interval multiplier of an interface.

3. For defining time to transmit LSP packets, use command ***isis lsp-interval <num> [level-1|level-2]*** in IS-IS interface config mode as shown in Table 272.

TABLE 272 IS-IS LSP-INTERVAL

Command Format	Command Mode	Command Function
isis lsp-interval <num> [level-1|level-2]	IS-IS interface config	This define an LSP Packet transmission interval

The value of lsp-interval ranges from <1-65535>.

Result: This configures an LSP packet transmission interval for maintaining Routing database.

4. For designating DIS election priority interface, use command isis ***priority <num> [level-1|level-2]*** in IS-IS interface config mode as shown in Table 273.

TABLE 273 IS-IS PRIORITY

Command Format	Command Mode	Command Function
isis priority <num> [level-1|level-2]	IS-IS interface config	This defines DIS election priority of an interface

The value of <num> ranges from <0-127>

Result: This configures DIS (Designated Intermediate system) priority of an interface.

5. IS-IS configure metric of an interface to participate in calculation for number of shortest IS-IS paths, use command

isis metric <metric-value> [level-1|level-2] in IS-IS interface config mode as shown in Table 274.

TABLE 274 IS-IS METRIC COMMAND

Command Format	Command Mode	Command Function
isis metric <metric-value> [level-1|level-2]	IS-IS interface config	This defines the metric value of an interface

The <metric-value> ranges from <0-16777214> and divides into two modes: Narrow mode (0-63); wide mode (0-16777214).

Result: This configures metric value of an interface.

6. IS-IS configure CSNP interval in order to set the interval between CSNP packets, use command **isis csnp-interval** <num> [level-1|level-2] in IS-IS interface config mode as shown in Table 275.

TABLE 275 IS-IS CSNP COMMAND

Command Format	Command Mode	Command Function
isis csnp-interval <num> [level-1|level-2]	IS-IS interface config	This defines CSNP packet sending interval

In a broadcast network, the default value of <num> is 10. In point to point network default value of <num> is 3600. Range is from (1-65535).

Result: This configures CSNP packet interval.

END OF STEPS

Related Information For More information about IS-IS configuration please follow the below procedures.

Configuring IS-IS Authentication

Overview ZTE ZXR10 GER supports four types of IS-IS authentication.

- Inter-neighbor authentication
- Intra-area authentication
- Inter-area authentication
- Inter-SNP authentication

At present, ZXR10 GER only supports plain text authentication.

Purpose This below procedure delivers information about how to do authentication in IS-IS protocol on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- IS-IS is running in a network.

Steps

1. To authenticate IS-IS neighbor, use command **isis authentication** <key> [level-1|level-2] in IS-IS interface config mode as shown in Table 276.

TABLE 276 IS-IS AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
isis authentication <key> [level-1|level-2]	IS-IS interface config	This defines authentication of IS-IS neighbor

<*key*> is from 1-180 characters.

Result: This configures Adjacent IS-IS router authentication in same area.

2. For intra-area authentication, authentication between different IS-IS areas, use command **authentication** <key> [level-1|level-2] in IS-IS config mode as shown in Table 277.

TABLE 277 INTRA-AREA AUTHENTICATION COMMAND

Command Format	Command Mode	Command Function
authentication <key> [level-1|level-2]	IS-IS interface config	This defines inter area authentication

<*key*> is from 1-180 characters.

Result: This configures inter-area authentication between different IS-IS routers.

3. Configure SNP authentication by using command **set-snp-authentication** in IS-IS config mode as shown in Table 278.

TABLE 278 SNP AUTHENTICATION COMMAND WINDOW

Command Format	Command Mode	Command Function
set-snp-authentication	IS-IS config	This sets the SNP PDU authentication.

Result: This configures SNP-authentication.

END OF STEPS

Related Information

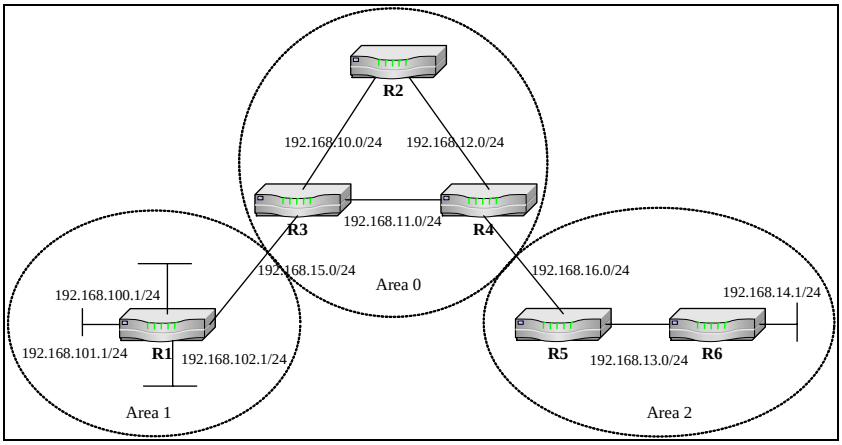
For More information about IS-IS configuration please follow the below procedures.

Multi-Area IS-IS

Reduce Memory

If a network is a larger one, consider the use of multiple IS-IS areas. Based on geographic locations and functions, close routers can be divided into same area. The area division helps to reduce the requirements for memory, so that routers in the area only need to maintain a smaller link state database. Figure 93 show a multi-area IS-IS configuration example.

FIGURE 93 MULTI-AREA CONFIGURATION



Where, R1 belongs to area 1, R2, R3 and R4 belong to area 0, and R5 and R6 belong to area 2. On R1, route aggregation is performed for network sections in area 1. Default routes on R6 are redistributed into IS-IS.

The detailed configuration of each router in the above figure is as follows:

Configuration of R1:

```
ZXR10_R1(config)#router isis
ZXR10_R1(config-router)#area 01
ZXR10_R1(config-router)#system-id 00D0.D0C7.53E0
ZXR10_R1(config-router)#is-type LEVEL-1-2
ZXR10_R1(config-router)#exit
ZXR10_R1(config)#interface fei_2/4
ZXR10_R1(config-if)#ip address 192.168.15.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
ZXR10_R1(config-if)#isis circuit-type LEVEL-2
ZXR10_R1(config-router)#exit
ZXR10_R1(config)#interface fei_2/6
ZXR10_R1(config-if)#ip address 192.168.100.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
ZXR10_R1(config-if)#isis circuit-type LEVEL-1
```

```
ZXR10_R1(config-if)#exit

ZXR10_R1(config)#interface fei_2/7
ZXR10_R1(config-if)#ip address 192.168.101.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
ZXR10_R1(config-if)#isis circuit-type LEVEL-1
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#interface fei_2/8
ZXR10_R1(config-if)#ip address 192.168.102.1 255.255.255.0
ZXR10_R1(config-if)#ip router isis
ZXR10_R1(config-if)#isis circuit-type LEVEL-1
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#router isis
ZXR10_R1(config-router)#summary-address 192.168.100.0
255.255.252.0 10
```

Configuration of R2:

```
ZXR10_R2(config)#router isis
ZXR10_R2(config-router)#area 00
ZXR10_R2(config-router)#system-id 00D0.E0D7.53E0
ZXR10_R2(config-router)#is-type LEVEL-2
ZXR10_R2(config-router)#exit
ZXR10_R2(config)#interface fei_2/4
ZXR10_R2(config-if)#ip address 192.168.10.2 255.255.255.0
ZXR10_R2(config-if)#ip router isis
ZXR10_R2(config-if)#isis circuit-type LEVEL-2
ZXR10_R2(config-router)#exit
ZXR10_R2(config)#interface fei_2/6
ZXR10_R2(config-if)#ip address 192.168.12.2 255.255.255.0
ZXR10_R2(config-if)#ip router isis
ZXR10_R2(config-if)#isis circuit-type LEVEL-2
ZXR10_R2(config-if)#exit
```

Configuration of R3:

```
ZXR10_R3(config)#router isis
ZXR10_R3(config-router)#area 00
ZXR10_R3(config-router)#system-id 00D0.E0C7.53E0
ZXR10_R3(config-router)#is-type LEVEL-2
ZXR10_R3(config-router)#exit
ZXR10_R3(config)#interface fei_2/4
ZXR10_R3(config-if)#ip address 192.168.15.3 255.255.255.0
ZXR10_R3(config-if)#ip router isis
ZXR10_R3(config-if)#isis circuit-type LEVEL-2
ZXR10_R3(config-router)#exit
```

```
ZXR10_R3(config)#interface fei_2/6
ZXR10_R3(config-if)#ip address 192.168.10.3 255.255.255.0
ZXR10_R3(config-if)#ip router isis
ZXR10_R3(config-if)#isis circuit-type LEVEL-2
ZXR10_R3(config-if)#exit
ZXR10_R3(config)#interface fei_2/7
ZXR10_R3(config-if)#ip address 192.168.11.3 255.255.255.0
ZXR10_R3(config-if)#ip router isis
ZXR10_R3(config-if)#isis circuit-type LEVEL-2
ZXR10_R3(config-if)#exit
```

Configuration of R4:

```
ZXR10_R4(config)#router isis
ZXR10_R4(config-router)#area 00
ZXR10_R4(config-router)#system-id 00D0.E0E7.53E0
ZXR10_R4(config-router)#is-type LEVEL-2
ZXR10_R4(config-router)#exit
ZXR10_R4(config)#interface fei_2/4
ZXR10_R4(config-if)#ip address 192.168.12.4 255.255.255.0
ZXR10_R4(config-if)#ip router isis
ZXR10_R4(config-if)#isis circuit-type LEVEL-2
ZXR10_R4(config-router)#exit
ZXR10_R4(config)#interface fei_2/6
ZXR10_R4(config-if)#ip address 192.168.11.4 255.255.255.0
ZXR10_R4(config-if)#ip router isis
ZXR10_R4(config-if)#isis circuit-type LEVEL-2
ZXR10_R4(config-if)#exit
ZXR10_R4(config)#interface fei_2/7
ZXR10_R4(config-if)#ip address 192.168.16.4 255.255.255.0
ZXR10_R4(config-if)#ip router isis
ZXR10_R4(config-if)#isis circuit-type LEVEL-2
ZXR10_R4(config-if)#exit
```

Configuration of R5:

```
ZXR10_R5(config)#router isis
ZXR10_R5(config-router)#area 02
ZXR10_R5(config-router)#system-id 00D0.D0CF.53E0
ZXR10_R5(config-router)#is-type LEVEL-1-2
ZXR10_R5(config-router)#exit
ZXR10_R5(config)#interface fei_2/4
ZXR10_R5(config-if)#ip address 192.168.16.5 255.255.255.0
ZXR10_R5(config-if)#ip router isis
ZXR10_R5(config-if)#isis circuit-type LEVEL-2
ZXR10_R5(config-router)#exit
ZXR10_R5(config)#interface fei_2/6
```

```
ZXR10_R5(config-if)#ip address 192.168.13.5 255.255.255.0
ZXR10_R5(config-if)#ip router isis
ZXR10_R5(config-if)#isis circuit-type LEVEL-1
ZXR10_R5(config-if)#exit
```

Configuration of R6:

```
ZXR10_R6(config)#router isis
ZXR10_R6(config-router)#area 02
ZXR10_R6(config-router)#system-id 00D0.0ECD.53E0
ZXR10_R6(config-router)#is-type LEVEL-1
ZXR10_R6(config-router)#exit
ZXR10_R6(config)#interface fei_2/4
ZXR10_R6(config-if)#ip address 192.168.13.6 255.255.255.0
ZXR10_R6(config-if)#ip router isis
ZXR10_R6(config-if)#isis circuit-type LEVEL-1
ZXR10_R6(config-router)#exit
ZXR10_R6(config)#interface fei_2/8
ZXR10_R6(config-if)#ip address 192.168.14.1 255.255.255.0
ZXR10_R6(config-if)#exit
ZXR10_R6(config)#ip route 0.0.0.0 0.0.0.0 192.168.14.10
ZXR10_R6(config)#router isis
ZXR10_R6(config-router)#default-information originate
ZXR10_R6(config-router)#redistribute protocol static metric 10
ZXR10_R6(config-if)#end
```

Chapter 16

BGP Configuration

Overview

Introduction Border Gateway Protocol (BGP) is a main inter-domain routing protocol. BGP-4 is being widely applied to the Internet, used to exchange network reachability information among ASs.

Contents This chapter covers following topics.

TABLE 279 TOPICS IN CHAPTER 16

BGP Overview

Definition

Border Gateway Protocol (BGP) is an inter-domain routing protocol used among ASs, to exchange network reachability information among ASs running the BGP. The information is a list of ASs where a route passes, which is sufficient to set up a diagram indicating the connection status of the ASs. Thus, routing policy based on ASs is possible, and also the route loopback problem is solved.

Version

BGP of version 4 (BGP4) is the latest BGP version, which is defined in RFC1771. BGP4 supports the implementation of CIDR, supernet and subnet and the functions such as route aggregation and route filtering. At present, BGP4 has found wide application on the Internet.

Autonomous System

An administrative area with independent routing policy is called an Autonomous System (AS). An important feature of an AS is that there is a unified internal route for another AS and has consistent topology for a reachable destination. The indicator for an AS is a 16-bit value, ranging from 1 to 65535. Where, 1 through 32767 are assignable, 32768 through 64511 are reserved, and 64512 through 65534 are used for private ASs (similar to private network addresses among IP addresses).

EBGP & IBGP

A session set up between BGP routers in different ASs is called an EBGP session, while a session established between BGP routers in the same AS is called an IBGP session.

Transmission Protocol

BGP runs on a reliable transmission protocol. TCP is used as its bottom-layer protocol, and the TCP port is port 179. Two routers running BGP first set up a TCP connection, and then pass packet authentication and exchange all the routing table information. After that, when the route changes, the routers will send a routing update message to all BGP neighbors, and then the BGP neighbors will flood the routing information until the entire network receives the routing information.

Path Attribute

When a router sends BGP update messages about the destination network to its peer router, the messages contain information about BGP metric (called path attribute). The path attribute is divided into four independent types:

- **Accepted and compulsory attributes:** The attributes need to appear in route description.
  - AS-path
  - Next-hop
  - Origin
- **Accepted and self-determined attributes:** The attributes do not have to appear in route description.
  - Local preference
  - Atomic aggregate

- **Optional and transferable attributes:** The attributes do not need support in all BGP implementations. However, if an attribute is supported, the attribute can be transferred to its BGP neighbor, while attributes not supported by the current router need to be continuously transferred to other BGP routers.
  - Aggregator
  - Community
- **Optional and non-transferred attribute:** The attribute indicates that routers that do not support the attribute need to be deleted.
  - Multi-Exit Discriminator (MED)

In addition to above attributes, the weight attribute (defined by CISCO) is also a common attribute.

Basic BGP Configuration

Purpose Refer to below procedure for BGP configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 280.

TABLE 280 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Exec	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enable BGP, use **router bgp** <*as-number*> command in global config mode as shown in Table 281.

TABLE 281 ROUTER BGP COMMAND

Command Format	Command Mode	Command Function
router bgp <*as-number*>	Global config	This enables BGP routing process

Result: This establish BGP routing process.

3. To configure BGP neighbor for BGP communication, use **neighbor** <*ip-address*> **remote-as** <*number*> command in BGP route mode as shown in Table 282.

TABLE 282 BGP-NEIGHBOUR COMMAND

Command Format	Command Mode	Command Function
neighbor *<ip-address>* **remote-as** *<number>*	BGP route	This configures a BGP neighbor

Result: This sets BGP neighbor for BGP communication.

4. To advertise network into BGP, use **network** *<ip-address>* *<net-mask>* command in BGP route mode as shown in Table 283.

TABLE 283 BGP-NETWORK COMMAND

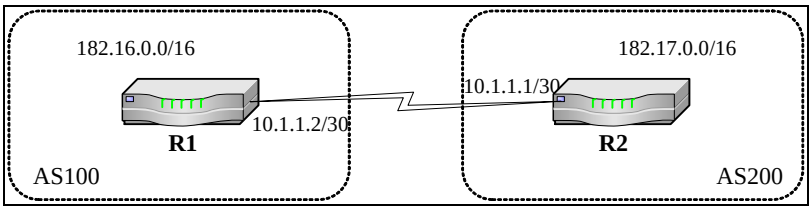
Command Format	Command Mode	Command Function
network <ip-address> <net-mask>	BGP route	This designates a network table for BGP routing process

Result: This advertises a network into BGP routing process.

END OF STEPS

Example: Figure 94 shows a BGP configuration example. Where, router R1 belongs to AS 100, while router R2 belongs to AS 200.

FIGURE 94 BASIC BGP CONFIGURATION EXAMPLE



Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 10.1.1.1 remote-as 200
ZXR10_R1(config-router)#network 182.16.0.0 255.255.0.0
```

Configuration of R2:

```
ZXR10_R2(config)#router bgp 200
ZXR10_R2(config-router)#neighbor 10.1.1.2 remote-as 100
ZXR10_R3(config-router)#network 182.17.0.0 255.255.0.0
```

In the above configuration, R1 and R2 mutually define the peer party as the BGP neighbor. Since R1 and R2 belong to different ASs, an EBGP session needs to be set up. R1 will advertise on

network 182.16.0.0/16, and R2 will advertise on network 182.17.0.0/16.

BGP Route Advertisement

Purpose Refer to below procedure for BGP route advertisement configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To advertise network into BGP, use **network** *<ip-address> <net-mask>* command in BGP route mode as shown in Table 284.

TABLE 284 BGP-NETWORK COMMAND

Command Format	Command Mode	Command Function
network <ip-address> <net-mask>	BGP route	This designates a network table for BGP routing process

Result: This advertises a network into BGP routing process.

2. Use the **redistribute** command to redistribute routes learned by other protocols into BGP route mode which is shown in Table 285.

TABLE 285 BGP-REDISTRIBUTE COMMAND

Command Format	Command Mode	Command Function
redistribute *<prot-name>* [**metric** *<value>*] [**route-map** *<string>*]	BGP route	This redistributes routes obtained by other routing protocols into BGP routing table

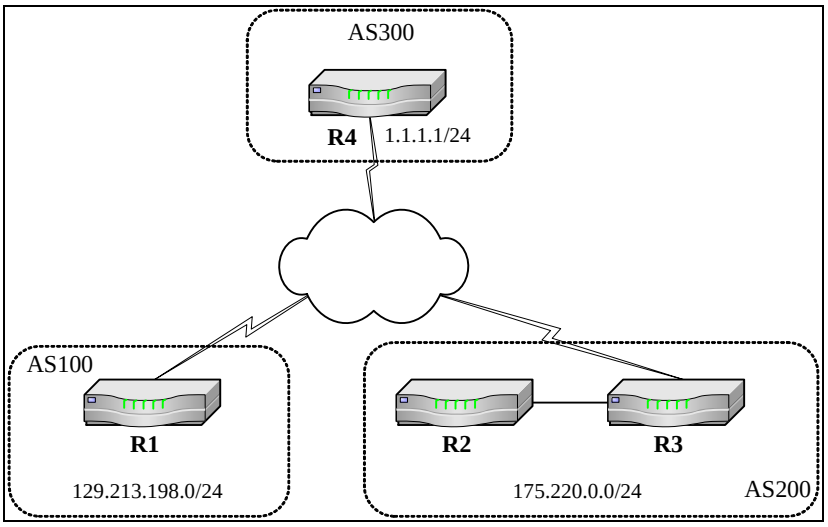
Result: This command redistributes other routing protocols into BGP.

redistribute command can redistribute routes of IGPs (RIP, OSPF and IS-IS) into BGP. Upon the use of the redistribute command, prevent the redistribution of routes that IGP learns from BGP into the BGP once again. Use the filter command to prevent the generation of loops if necessary.

END OF STEPS

Example: An example for route advertisement in BGP in route redistribution mode is given in following. Detailed network diagram is as follows:

FIGURE 95 BGP ROUTE ADVERTISMENT



Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 10.1.1.1 remote-as 200
ZXR10_R1(config-router)#network 182.16.0.0 255.255.0.0
```

Configuration of R2:

```
ZXR10_R2(config)#router bgp 200
ZXR10_R2(config-router)#neighbor 10.1.1.2 remote-as 100
ZXR10_R3(config-router)#network 182.17.0.0 255.255.0.0
```

Configuration of R3:

```
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network 175.220.0.0 0.0.0.255 area 0
ZXR10_R3(config)#router bgp 200
ZXR10_R3(config-router)#neighbor 1.1.1.1 remote-as 300
ZXR10_R3(config-router)#redistribute ospf_int
```

BGP Aggregation Advertisement

Purpose Refer to below procedure for BGP aggregation advertisement configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.

- BGP is running on a network.

Steps

1. To configure BGP aggregation advertisement, use **aggregate-address** *<ip-address>* *<net-mask>* [**count** *<count>*] [**as-set**] [**summary-only**] [**strict**] command in BGP route mode as shown in Table 286.

TABLE 286 BGP-AGGREGATE ADDRESS COMMAND

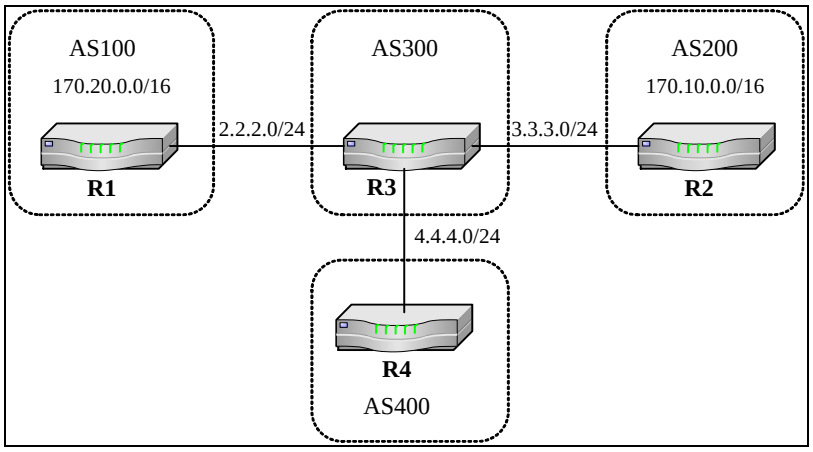
Command Format	Command Mode	Command Function
aggregate-address *<ip-address>* *<net-mask>* [count *<count>*] [as-set] [summary-only] [strict]	BGP Route	This creates an aggregation policy in BGP routing table

Result: This establishes an aggregation policy in BGP routing table.

END OF STEPS

Example: An aggregate address example is shown as follows. As shown in Figure 96 , routers R1 and R2 separately advertise routes 170.10.0.0/16 and 170.20.0.0/16. R3 aggregates the information about the two routes into a route 170.0.0.0/8 and advertises the route to R4. After aggregation configuration, the routing table of R4 can only learn the aggregated route 170.0.0.0/8.

FIGURE 96 BGP-AGGREGATION ADVERTISEMENT



Configuration of R1:

```
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address 2.2.2.2 255.0.0.0
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#network 170.20.0.0 255.255.0.0
ZXR10_R1(config-router)#neighbor 2.2.2.1 remote-as 300
```

Configuration of R2:

```
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip address 3.3.3.3 255.0.0.0
ZXR10_R2(config)#router bgp 200
ZXR10_R2(config-router)#network 170.10.0.0 255.255.0.0
ZXR10_R2(config-router)#neighbor 3.3.3.1 remote-as 300
```

Configuration of R3:

```
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip address 2.2.2.1 255.0.0.0
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip address 3.3.3.1 255.0.0.0
ZXR10_R3(config)#interface fei_1/3
ZXR10_R3(config-if)#ip address 4.4.4.1 255.0.0.0
ZXR10_R3(config)#router bgp 300
ZXR10_R3(config-router)#neighbor 2.2.2.2 remote-as 100
ZXR10_R3(config-router)#neighbor 3.3.3.3 remote-as 200
ZXR10_R3(config-router)#neighbor 4.4.4.4 remote-as 400
ZXR10_R3(config-router)#aggregate-address 170.0.0.0 255.0.0.0
summary-only
```

R3 learns two routes 170.20.0.0 and 170.10.0.0, but only advertises the aggregated route 170.0.0.0/8. Pay attention to the parameter **summary-only** in the aggregation advertisement command. If the parameter is not available, R3 will advertise the aggregated route as well as the detailed route.

Configuration of R4:

```
ZXR10_R4(config)#interface fei_1/1
ZXR10_R4(config-if)#ip address 4.4.4.4 255.0.0.0
ZXR10_R4(config)#router bgp 400
ZXR10_R4(config-router)#neighbor 4.4.4.1 remote-as 300
```

Configuring Multi-Hop in EBGP

Introduction

Normally, an EBGP neighbor needs to be set up on a directly connected interface of two routers. To set up an EBGP neighbor on a non-directly connected interface, multihop technique needs to be used to complete EBGP multi-hop configuration.

Appropriate IGP or static route is also required to configure in order to reach non-directly connected interfaces.

Purpose Refer to below procedure for multi-hop configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To set up an EBGP neighbor on a non-directly connected interface, the **multihop** command needs to be used to complete EBGP multi-hop configuration in BGP route mode. This is shown in Table 287.

TABLE 287 MULTIHOP COMMAND

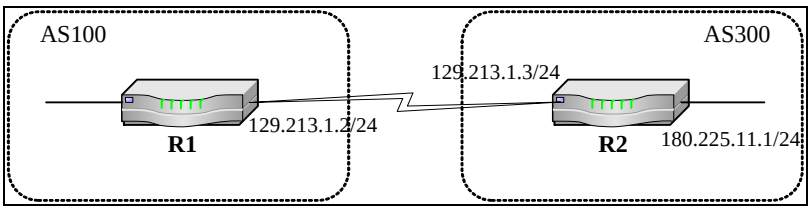
Command Format	Command Mode	Command Function
neighbor <*ip-address*> ebgp-multihop [ttl <*value*>]	BGP Route	This configures EBGP multi-hop

Result: This sets EBGP multi-hop for non-directly connected interface.

END OF STEPS

Example: As shown in Figure 97, router R1 needs to set up adjacency on a non-directly connected interface (with the IP address of 180.225.11.1) of R2. In this case, the multihop command needs to be used.

FIGURE 97 BGP-MULTIHOP CONFIGURATION



Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 180.225.11.1 remote-as 300
ZXR10_R1(config-router)#neighbor 180.225.11.1 ebgp-multihop
```

Configuration of R2:

```
ZXR10_R2(config)#router bgp 300
ZXR10_R2(config-router)#neighbor 129.213.1.2 remote-as 100
```

Filtering Routes using Route Map

Introduction

Route filtering and attribute configuration are the basis of BGP decision. By means of route filtering operations, the input or output route attributes can be controlled according to actual requirements.

A route map is used to control routing information and route redistribution is implemented by means of defining conditions among routing domains. Normally, the route map is used in conjunction with route attributes to make route decision.

Purpose

Refer to below procedure for route-map configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To define a route map for controlling routing information, use **route-map** <*map-tag*> [**permit|deny**] [<*sequence-number*>] in global config mode as shown in Table 288.

TABLE 288 ROUTE-MAP COMMAND

Command Format	Command Mode	Command Function
route-map <*map-tag*> [**permit|deny**] [<*sequence-number*>]	Global config	This defines a route map

Result: This sets a route-map for controlling routing information.

2. To designate neighbor for an input or output route map, use **neighbor** <*ip-address*> **route-map** <*string*> {**in|out**} command in BGP route mode as shown in Table 289.

TABLE 289 NEIGHBOR-ROUTE-MAP COMMAND

Command Format	Command Mode	Command Function
neighbor <*ip-address*> **route-map** <*string*> {in|out}	BGP Route	This configures the filtering of routes advertised from or to the neighbor

Result: This sets route filtration coming from or to the neighbor.

END OF STEPS

Example: In below example, a route map (that is, MAP1) is defined. The route map allows the advertisement of the network 172.3.0.0 to AS 200 and the setting of its MED value to 5. Upon route filtering operation by means of a router map, normally the commands **match** and **set** are used in conjunction. The match

command defines the matching standard, while the set command defines actions executed when the match conditions are satisfied.

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 182.17.20.1 remote-as 200
ZXR10_R1(config-router)#neighbor 182.17.20.1 route-map MAP1 out
ZXR10_R1(config-router)#neighbor 182.17.20.1 send-med
ZXR10_R1(config)#route-map MAP1 permit 10
ZXR10_R1(config-route-map)#match ip address 1
ZXR10_R1(config-route-map)#set metric 5
ZXR10_R1(config)#access-list 1 permit 172.3.0.0 0.0.255.255
```

Route Filtering by Means of NLRI

Introduction To restrict a router from obtaining or advertising routing information, route updates from or to a special neighbor device can be filtered. A filter contains an update list from or to a neighbor router.

Purpose Refer to below procedure for route filtering by means of NLRI configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To designate neighbor for an input or output route map, use **neighbor** <*ip-address*> **route-map** <*string*> {**in|out**} command in BGP route mode as shown in Table 290.

   TABLE 290 NEIGHBOR-ROUTE-MAP COMMAND

Command Format	Command Mode	Command Function
neighbor <*ip-address*> **route-map** <*string*> {in|out}	BGP Route	This configures the filtering of routes advertised from or to the neighbor

   Result: This sets route filtration coming from or to the neighbor.

2. To prevent specific network advertising into BGP for certain Autonomous system, use **access-list** command in global config mode as shown in Table 291.

TABLE 291 ACCESS-LIST COMMAND

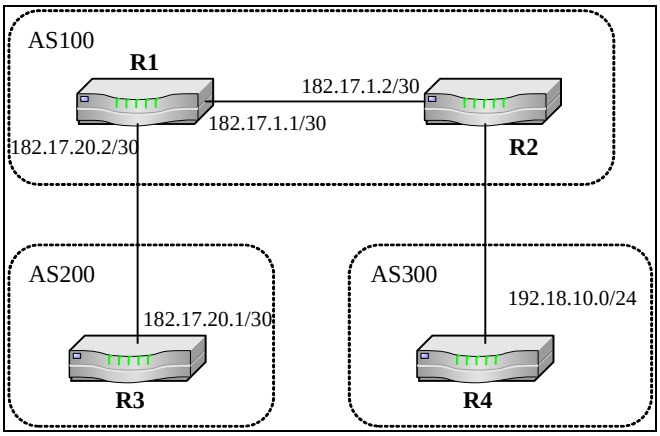
Command Format	Command Mode	Command Function
access-list <number> **deny / permit ip address** <ip address> <network mask>	Global	This prevents certain network prefix for advertising into BGP

Result: This configures a prefix parameter for denying certain network prefix.

END OF STEPS

Example: As shown in Figure 98, R1 and R2 are mutually IBGP peers, R1 and R3 are mutually EBGP peers, and R4 and R2 are mutually EBGP peers.

FIGURE 98 ROUTE FILTERING BY MEANS OF NLRI



To prevent AS100 from playing the role of a transitional AS, the network 192.18.10.0/24 from AS300 can be advertised to AS200. R1 is configured with filtering function as follows:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#no synchronization
ZXR10_R1(config-router)#neighbor 182.17.1.2  remote-as 100
ZXR10_R1(config-router)#neighbor 182.17.20.1  remote-as 200
ZXR10_R1(config-router)#neighbor 182.17.20.1  route-map MAP1
out
ZXR10_R1(config)#route-map MAP1 permit 10
ZXR10_R1(config-route-map)#match ip address 1
ZXR10_R1(config)#access-list 1 deny 192.18.10.0 0.0.0.255
ZXR10_R1(config)#access-list 1 permit 0.0.0.0 255.255.255.255
```

In this example, the **route-map** command and the access list command **access-list** are used to prevent R1 from advertising prefix 192.18.10.0/24 to AS200.

This command can also be used to filter certain network prefix to be advertised.

```
ZXR10(config-router)#bgp filter out deny peer-ip 182.17.20.1
network 192.18.10.0 0.0.0.255
```

Route Filtering by Means of AS_PATH

Introduction If all routers in one or multiple ASs need filtering, normally route filtering based on AS path information is used. This filtering method can avoid the complexity caused by prefix-based filtering.

Purpose Refer to below procedure for route filtering by means of AS_PATH configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To configure route filtering by means of AS_PATH, use **ip as-path access-list** <*access-list-number*> {**permit|deny**} <*as-regular-expression*> command in global config mode as shown in Table 292.

TABLE 292 IP AS-PATH ACCESS-LIST COMMAND

Command Format	Command Mode	Command Function
ip as-path access-list <*access-list-number*> {**permit|deny**} <*as-regular-expression*>	Global	This defines BGP access list

Result: This configures an ip as-path access list.

END OF STEPS

Example: As shown in Figure 98 , router filtering based on AS path also can be used so that R1 will not advertise the network 192.18.10.0/24 from AS300 to AS200. The configuration is as follows:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#no synchronization
ZXR10_R1(config-router)#neighbor 182.17.1.2  remote-as 100
ZXR10_R1(config-router)#neighbor 182.17.20.1  remote-as 200
ZXR10_R1(config-router)#neighbor 182.17.20.1  route-map MAP1
out
ZXR10_R1(config)#route-map MAP1 permit 10
ZXR10_R1(config-route-map)#match as-path 1
ZXR10_R1(config)#ip as-path access-list 1 permit ^$
```

In the above configuration, the operation is based on the AS path access list so that R1 only advertises network originated on AS100 to AS200. Thus, the network 192.18.10.0/24 is filtered.

Local Preference Attribute

Introduction

The attribute value of local preference is used to determine routes among IBGP peers inside an AS.

When two IBGP routers in an AS simultaneously learn routes to the same destination externally, the routers will compare the attribute values of the local preference. A route with a higher value takes the precedence. By default, the attribute value of the local preference is 100.

Purpose

Refer to below procedure for local preference attribute configuration on ZTE ZXR10 GER.

Prerequisite

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To configure local preference attribute, use **bgp default local-preference** <*value*> command in BGP route mode as shown in Table 293.

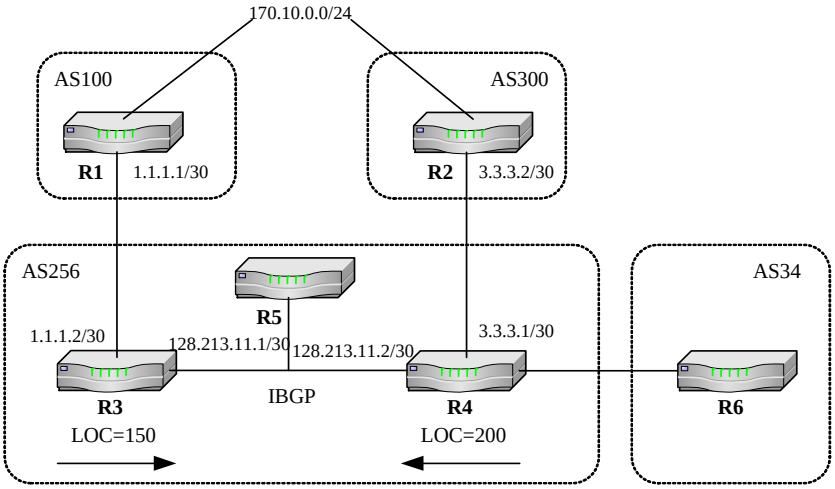
TABLE 293 BGP-DEFAULT LOCAL PREFERENCE

Command Format	Command Mode	Command Function
bgp default local-preference <*value*>	Route	This allows to compare the route MEDs of the neighbors in different AS

Result: This allows to compare the route MEDs of the neighbors in different AS .

As shown in Figure 99 , R3 and R4 learn routes to destination 170.10.0.0 simultaneously. Since the local preference value configured for R4 is greater than that for R3, the R4 egress will be used in precedence from inside AS256 to the destination.

FIGURE 99 LOCAL PREFERENCE ATTRIBUTE



In the following, two methods are used to configure the LOCAL_PREF attribute.

Use the command **bgp default local-preference** to configure the LOCAL_PREF attribute.

END OF STEPS

Configuration of R3:

```
ZXR10_R3(config)#router bgp 256
ZXR10_R3(config-router)#neighbor 1.1.1.1 remote-as 100
ZXR10_R3(config-router)#neighbor 128.213.11.2 remote-as 256
ZXR10_R3(config-router)#bgp default local-preference 150
```

Configuration of R4:

```
ZXR10_R4(config)#router bgp 256
ZXR10_R4(config-router)#neighbor 3.3.3.2 remote-as 300
ZXR10_R4(config-router)#neighbor 128.213.11.1 remote-as 256
ZXR10_R4(config-router)#bgp default local-preference 200
```

Use the **route-map** command to configure the LOCAL_PREF attribute

Configuration of R4:

```
ZXR10_R4(config)#router bgp 256
ZXR10_R4(config-router)#neighbor 3.3.3.2 remote-as 300
ZXR10_R4(config-router)#neighbor 3.3.3.2 route-map setlocalin in
ZXR10_R4(config-router)#neighbor 128.213.11.1 remote-as 256
...
ZXR10_R4(config)#ip as-path access-list 7 permit ^300$
...
ZXR10_R4(config)#route-map setlocalin permit 10
ZXR10_R4(config-route-map)#match as-path 7
```

```
ZXR10_R4(config-route-map)#set local-preference 200
ZXR10_R4(config)#route-map setlocalin permit 20
ZXR10_R4(config-route-map)#set local-preference 150
```

MED Attribute

Introduction

The "metric" attribute is also called the MED (Multi_Exit_Discrimination) attribute, which is used for route interaction and decision among ASs.

By default, a router only compares the metric value of BGP neighbors from the same AS.

Purpose

Refer to below procedure for MED attribute configuration on ZTE ZXR10 GER.

Prerequisites

- Refer Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. If neighbors from different ASs are to be compared, use **bgp always-compare-med** command in BGP route mode as shown in Table 294.

TABLE 294 BGP ALWAYS MED ATTRIBUTE COMMAND

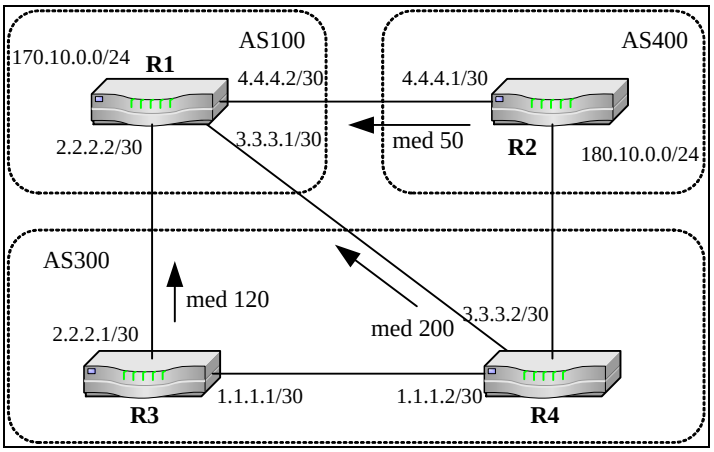
Command Format	Command Mode	Command Function
bgp always-compare-med	Route	This configures the local precedence value of routes advertised by BGP

Result: This configures the local precedence value of routes advertised by BGP.

The default metric value is 0. Smaller is the metric value, the higher the priority. The metric value cannot be transplanted to a third AS, that is, if a router receives an update configured with metric value and also the update needs to be transferred to a third AS, the router will transfer the update with the default metric value.

As shown in Figure 100, R1 receives updates of 180.10.0.0 from R2, R3 and R4 simultaneously. By default, only the metric values of neighbors R3 and R4 in the same AS are compared. The metric value of R3 is less than that of R4, so for the updates of 180.10.0.0. R1 will only accept the update of R3.

FIGURE 100 MED-ATTRIBUTE



In the following, the **route-map** command is used to configure the MED value.

Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 2.2.2.1 remote-as 300
ZXR10_R1(config-router)#neighbor 3.3.3.2 remote-as 300
ZXR10_R1(config-router)#neighbor 4.4.4.1 remote-as 400
....
```

Configuration of R3:

```
ZXR10_R3(config)#router bgp 300
ZXR10_R3(config-router)#neighbor 2.2.2.2 remote-as 100
ZXR10_R3(config-router)#neighbor 2.2.2.2 route-map setmetricout
out
ZXR10_R3(config-router)#neighbor 1.1.1.2 remote-as 300
ZXR10_R3(config)#route-map setmetricout permit 10
ZXR10_R3(config-route-map)#set metric 120
```

Configuration of R4:

```
ZXR10_R4(config)#router bgp 300
ZXR10_R4(config-router)#neighbor 3.3.3.1 remote-as 100
ZXR10_R4(config-router)#neighbor 3.3.3.1 route-map setmetricout
out
ZXR10_R4(config-router)#neighbor 1.1.1.1 remote-as 300
ZXR10_R4(config)#route-map setmetricout permit 10
ZXR10_R4(config-route-map)#set metric 200
```

Configuration of R2:

```
ZXR10_R2(config)#router bgp 400
ZXR10_R2(config-router)#neighbor 4.4.4.2 remote-as 100
```

```
ZXR10_R2(config-router)#neighbor 4.4.4.2 route-map setmetricou
out
ZXR10_R2(config)#route-map setmetricout permit 10
ZXR10_R2(config-route-map)#set metric 50
```

In the following the command **bgp always-compare-med** is used to compare the metric values of R1 and R2 by force. Since the metric value of R2 is less than that of R3, for updates of 180.10.0.0, R1 will select update from R2 instead of R3.

Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 2.2.2.1 remote-as 300
ZXR10_R1(config-router)#neighbor 3.3.3.2 remote-as 300
ZXR10_R1(config-router)#neighbor 4.4.4.1 remote-as 400
ZXR10_R1(config-router)#bgp always-compare-med
```

Community String Attribute

Introduction

The community string attribute is a transferred optional attribute, 0 to 4.294,967,295. The decision on a group of routes can be made according to the community attribute.

The definitions of several known and accepted community attributes are given as follows:

- no-export: Advertisement to EBGP neighbors is disabled
- no-advertise: Advertisement to any BGP neighbors is disabled
- no-export-subconfed: Routes with the attribute will not be advertised outside the community

Purpose

Refer to below procedure for community string attribute configuration on ZTE ZXR10 GER.

Prerequisites

- Refer Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. For sending community string attribute, use **neighbor** <*ip-address*> **send-community** command in BGP route mode as shown in Table 295.

TABLE 295 SEND COMMUNITY ATTRIBUTE COMMAND

Command Format	Command Mode	Command Function
neighbor <*ip-address*> **send-community**	Route	This sends the community attribute upon route advertisement to neighbors

Result: This sends the community attribute upon route advertisement to neighbors.

In the following configuration, R1 will advertise to routes to its neighbors and will be forbidden to advertise routes of 192.166.1.0/24 to other EBGP neighbors.

END OF STEPS

Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 3.3.3.3 remote-as 300
ZXR10_R1(config-router)#neighbor 3.3.3.3 send-community
ZXR10_R1(config-router)#neighbor 3.3.3.3 route-map setcommunity out
ZXR10_R1(config)#route-map setcommunity permit 10
ZXR10_R1(config-route-map)#match ip address 1
ZXR10_R1(config-route-map)#set community no-export
ZXR10_R1(config)#route-map setcommunity permit 20
ZXR10_R1(config)#access-list 1 permit 192.166.1.0 0.0.0.255
```

BGP Synchronization

Purpose Refer to below procedure for BGP synchronization configuration on ZTE ZXR10 GER.

Prerequisites

- Refer Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. For BGP synchronization, use **synchronization** command in BGP route mode as shown in Table 296.

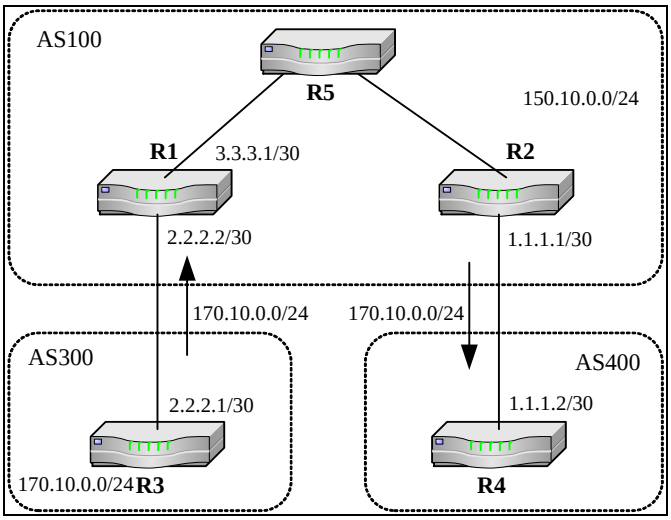
TABLE 296 SYNCHRONIZATION COMMAND

Command Format	Command Mode	Command Function
synchronization	Route	This enables synchronization between BGP and IGP

Result: This enables synchronization between BGP and IGP.

As shown in Figure 101, in AS100, R1 and R2 run IBGP, and R5 is not a BGP router.

FIGURE 101 BGP SYNCHORONIZATION



R2 learns routes to destination 170.10.0.0 by means of IBGP, and the next hop is 2.2.2.1. It can be seen from the above figure that, for R2 to reach 170.10.0.0, the actual next hop is R5. However, R5 does not have a route to 170.10.0.0, so it will drop the packet. In this case, if R2 notifies R4 of its route to 170.10.0.0, the route will also be dropped in R5.

Route Redistribution

For packets to destination 170.10.0.0 to arrive at R3 through R5 smoothly, R5 should have a route to 170.10.0.0. Therefore, route redistribution should be used to make R5 learn the route by means of IGP. Before R2 advertises a BGP route to EBGP neighbors, it should wait for R2 to learn the route by means of IGP (via R5). This process is called route synchronization.

By default, the synchronization function of ZXR10 GER is in enabled status.

Transitional AS

A transitional AS should advertise routes learned from other ASs to a third AS. If a non-BGP route exists inside the AS, route synchronization is needed. Here, R2 uses route synchronization.

If it is not necessary to advertise a BGP route to a third AS or all the routers in an AS run the BGP, route synchronization is not needed.

The following configuration disables route synchronization on R2.

Configuration of R2:

```
ZXR10_R2(config)#router bgp 100
ZXR10_R2(config-router)#network 150.10.0.0
ZXR10_R2(config-router)#neighbor 1.1.1.2 remote-as 400
ZXR10_R2(config-router)#neighbor 3.3.3.1 remote-as 100
ZXR10_R2(config-router)#no synchronization
```

BGP Route Reflector

Introduction

For BGP routes in the same AS, an adjacency should be set up between any two routers. Thus, with the increase of IBPG routers, the number of neighbors will increase by n*(n-1)/2 (n stands for the number of IBGP routers). To reduce the workload of maintenance and configuration, route reflector and route confederation are used.

For routers running IBGP in an AS, one router is selected as a Router Reflector (RR), and all other IBGP routers serve as clients only with adjacency set up with the RR. All clients reflect routes through the RR. In this way, the number of neighbors is reduced to n-1.

Purpose

Refer to below procedure for BGP route reflector configuration on ZTE ZXR10 GER.

Prerequisites

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. For configuring BGP route reflector, use **neighbor** *<ip-address>* **route-reflector-client** command in BGP route mode as shown in Table 297.

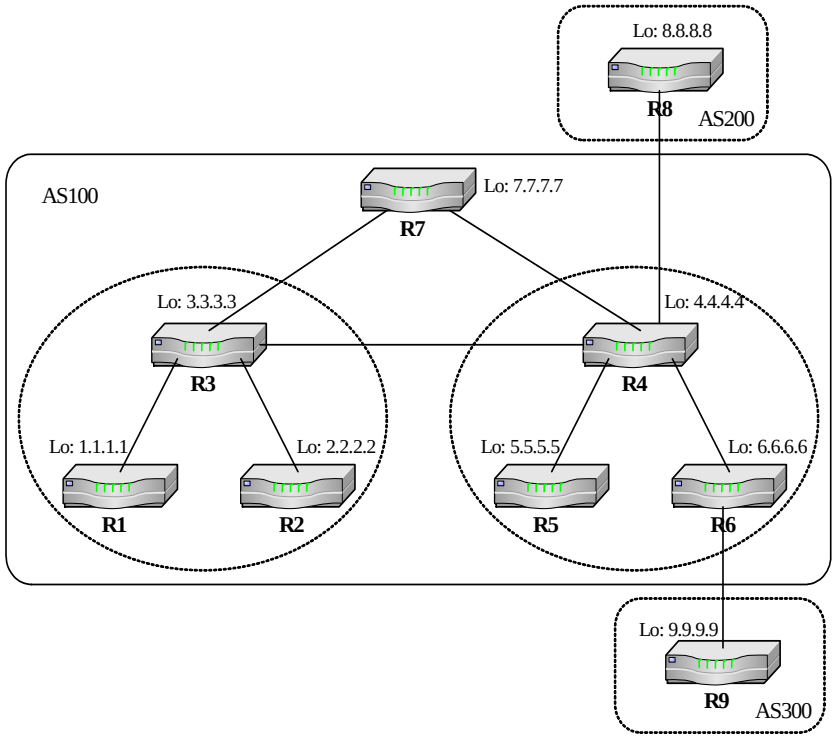
TABLE 297 NEIGHBOR-ROUTE REFLECTOR COMMAND

Command Format	Command Mode	Command Function
neighbor *<ip-address>* **route-refletor-client**	Route	This configures neighbors as client peers of the route reflector

Result: This configures neighbors as client peers of the route reflector.

As shown in Figure 102, there are two route reflectors in AS100: R3 and R4. Where, the clients of R4 are R5 and R6, while those of R3 are R1 and R2.

FIGURE 102 BGP ROUTE REFLECTOR



Configuration of R3:

```
ZXR10_R3(config)#router bgp 100
ZXR10_R3(config-router)#neighbor 2.2.2.2 remote-as 100
ZXR10_R3(config-router)#neighbor 2.2.2.2 route-reflector-client
ZXR10_R3(config-router)#neighbor 1.1.1.1 remote-as 100
ZXR10_R3(config-router)#neighbor 1.1.1.1 route-reflector-client
ZXR10_R3(config-router)#neighbor 7.7.7.7 remote-as 100
ZXR10_R3(config-router)#neighbor 4.4.4.4 remote-as 100
```

Configuration of R2:

```
ZXR10_R2(config)#router bgp 100
ZXR10_R2(config-router)#neighbor 3.3.3.3 remote-as 100
```

If the RR receives a route, it will reflect the route according to different peer types:

1. If the route comes from a non-client peer, the route will be reflected to all client peers.
2. If the route comes from a client peer, the route will be reflected to all non-client and client peers.
3. If the route comes from an EBGP peer, the route will be reflected to all non-client and client peers.

If an AS has multiple RRs, the multiple RRS in the AS can be incorporated into a cluster. An AS can have multiple clusters. A cluster at least has more than one RR.

BGP Confederation

Introduction The function of route confederation is the same as that of a router reflector. The route confederation is used to reduce the number of BGP neighbor connections in an AS. In a route federation, an AS is divided into multiple ASs, multiple IBGP routers in the AS belong to different sub-ASs. IBGP is set up inside each sub-AS, and EBGP is set up among sub-ASs. The sub-AS ID is called confederation ID. Sub-ASs are invisible external to the AS.

Purpose Refer to below procedure for BGP confederation configuration on ZTE ZXR10 GER router.

Prerequisites

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. For dividing autonomous system into sub-autonomous system, use **bgp confederation identifier** <value> command in BGP route mode as shown in Table 298.

TABLE 298 BGP CONFEDERATION IDENTIFIER COMMAND

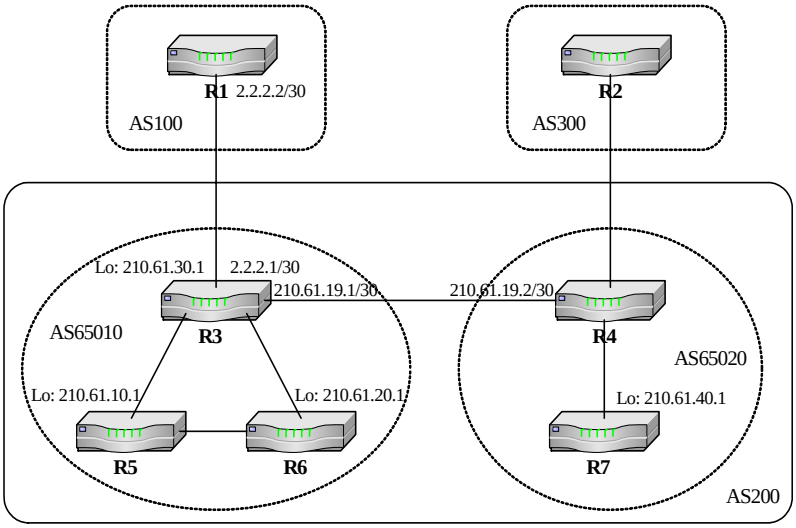
Command Format	Command Mode	Command Function
bgp confederation identifier <value>	Route	This configures confederation ID

Result: This configures confederation ID.

In the following an example will be given to describe the application of route confederation.

As shown in Figure 103, AS200 has five BGP routers, which is divided into two sub-ASs. One is defined as AS65010 (containing routers R3, R5 and R6), and the other is defined as AS65020 (consisting of routers R4 and R7).

FIGURE 103 BGP CONFEDERATION



Configuration of R3:

```
ZXR10_R3(config)#router bgp 65010
ZXR10_R3(config-router)#bgp confederation identifier 200
ZXR10_R3(config-router)#bgp confederation peers 65020
ZXR10_R3(config-router)#neighbor 210.61.10.1 remote-as 65010
ZXR10_R3(config-router)#neighbor 210.61.20.1 remote-as 65010
ZXR10_R3(config-router)#neighbor 210.61.19.2 remote-as 65020
ZXR10_R3(config-router)#neighbor 2.2.2.2 remote-as 100
```

Configuration of R5:

```
ZXR10_R5(config)#router bgp 65010
ZXR10_R5(config-router)#bgp confederation identifier 200
ZXR10_R5(config-router)#neighbor 210.61.30.1 remote-as 65010
ZXR10_R5(config-router)#neighbor 210.61.20.1 remote-as 65010
```

Adjacency

Upon adjacency setup, the EBGP adjacency is set up between R3 and confederation peers, IBGP adjacency is set up inside the confederation, and the EBGP adjacency is set up with AS100. AS100 does not know whether the confederation exists. Therefore, router R1 in AS100 still sets up adjacency with R3 by using AS200.

Configuration of R1:

```
ZXR10_R1(config)#router bgp 100
ZXR10_R1(config-router)#neighbor 2.2.2.1 remote-as 200
```

BGP Route Dampening

Introduction Every time when a route flaps, a penalty of 1000 will be assigned. When the penalty reaches a suppress-limit, the advertisement of the route will be suppressed. For each half-life-time, the penalty will decrease geometrically. When the penalty reduces to the reuse-limit, the route advertisement dampening will be cancelled.

Purpose Refer to below procedure for BGP route dampening configuration on ZTE ZXR10 GER.

Prerequisites

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To reduce instability caused by route flapping, use **bgp dampening** [*<half-life>* *<reuse>* *<suppress>* *<max-suppress-time>*|**route-map** *<map-tag>*] command in BGP route mode as shown in Table 299.

TABLE 299 BGP DAMPENING COMMAND

Command Format	Command Mode	Command Function
bgp dampening [*<half-life>* *<reuse>* *<suppress>* *<max-suppress-time>*|**route-map** *<map-tag>*]	Route	This reduces instability caused by route flapping

Result: This reduces instability caused by route flapping.

Half-life-time: Ranging from 1 to 45min (default: 15min)

- Reuse-value: Ranging from 1 to 20000 (default: 750)
- Suppress-value: Ranging from 1 to 20000 (default: 2000)
- Max-suppress-time: Ranging from 1 to 255 (default: four times the half-life-time)

Enable dampening in routers:

```
ZXR10(config)#router bgp 100
ZXR10(config-router)#bgp dampening
ZXR10(config-router)#network 203.250.15.0 255.255.255.0
ZXR10(config-router)#neighbor 192.208.10.5 remote-as 300
```

BGP Configuration Example

An integrated BGP example is given in the following. Where, the actual application of BGP functions such as route aggregation and static route redistribution.

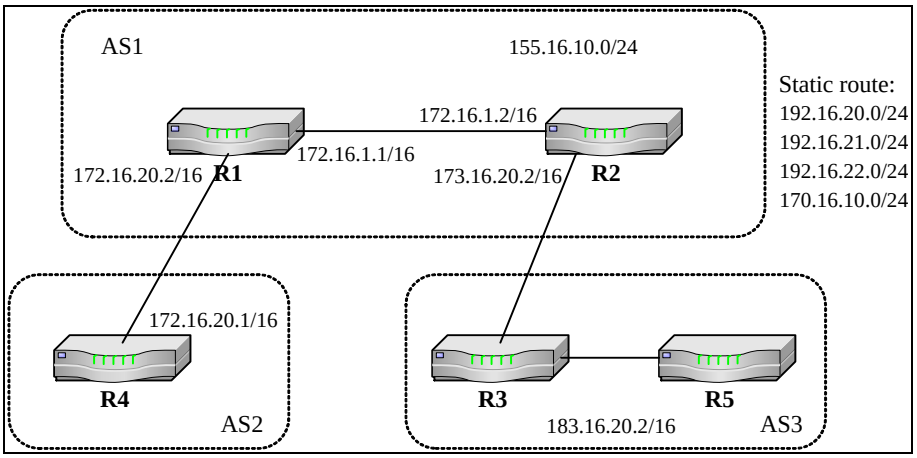
Adjacency

As shown in Figure 104, EBGP adjacency is set up between R4 and R1, IBGP adjacency is set up between R1 and R2, and multi-hop EBGP adjacency is set up between R2 and R5. Where, suppose R4 has four static routes marked on the upper right corner of the figure. In the configuration of R4, only network section 192.16.0.0/16 is aggregated and advertised, and furthermore, a route map is used to disable the advertisement of network section 170.16.10.0/24 by means of BGP.

Multihop Relation

The EBGP multi-hop relation is set up between R2 and R5 through R3. In this case, before BGP configuration, make sure that the IP addresses for the two routers to set up adjacency can implement mutual inter-working.

FIGURE 104 BGP CONFIGURATION EXAMPLE



Configuration of R4:

```
ZXR10_R4(config)#router bgp 2
ZXR10_R4(config-router)#redistribute static
ZXR10_R4(config-router)#neighbor 172.16.20.2 remote-as 1
ZXR10_R4(config-router)#aggregate-address 192.16.0.0
255.255.0.0 count 0 as-set summary-only
ZXR10_R4(config-router)#neighbor 172.16.20.2 route-map
torouter1 out
```

```
ZXR10_R4(config)#access-list 1 permit 172.16.10.0 0.0.0.255
ZXR10_R4(config)#route-map torouter1 deny 10
ZXR10_R4(config-route-map)#match ip address 1
ZXR10_R4(config)#route-map torouter1 permit 20
```

Configuration of R1:

```
ZXR10_R1(config)#router bgp 1
ZXR10_R1(config-router)#no synchronization
ZXR10_R1(config-router)#neighbor 172.16.1.2  remote-as 1
ZXR10_R1(config-router)#neighbor 172.16.1.2  next-hop-self
ZXR10_R1(config-router)#neighbor 172.16.20.1  remote-as 2
```

Configuration of R2:

```
ZXR10_R2(config)#ip route 183.16.0.0 255.255.0.0 fei_1/4
ZXR10_R2(config)#router bgp 1
ZXR10_R2(config-router)#neighbor 172.16.1.1 remote-as 1
ZXR10_R2(config-router)#neighbor 172.16.1.1 next-hop-self
ZXR10_R2(config-router)#neighbor 183.16.20.2 remote-as 3
ZXR10_R2(config-router)#neighbor 183.16.20.2 ebgp-multihop 2
ZXR10_R2(config-router)#neighbor 183.16.20.2 route-map
torouter5 in
ZXR10_R2(config)#access-list 1 permit 155.16.10.0 0.0.0.255
ZXR10_R2(config)#route-map torouter5 deny 10
ZXR10_R2(config-route-map)#match ip address 1
ZXR10_R2(config)#route-map torouter5 permit 20
```

Configuration of R5:

```
ZXR10_R5(config)#ip route 173.16.0.0 255.255.0.0 gei_1/1
ZXR10_R5(config)#router bgp 3
ZXR10_R5(config-router)#neighbor 173.16.20.2 remote-as 1
ZXR10_R5(config-router)#neighbor 173.16.20.2 ebgp-multihop
2
```

BGP Maintenance & Diagnosis

Introduction If a BGP route problem occurs, related debugging commands can be used to help fault location and troubleshooting. The show commands are used more frequently. The show commands can be used to view the current status of a BGP neighbor and the BGP routing information learned by a router.

Purpose Refer to below procedure for BGP maintenance and diagnosis on ZTE ZXR10 GER.

Prerequisites

- Router Command Line Interface has been accessed.
- BGP is running on a network.

Steps

1. To display the configuration information about the BGP module, use **show ip bgp protocol** command in privileged mode as shown in Table 300.

TABLE 300 SHOW IP BGP PROTOCOL COMMAND

Command Format	Command Mode	Command Function
show ip bgp protocol	privileged	This displays the configuration information about the BGP module

Result: This displays the configuration information about the BGP protocol.

2. To view BGP adjacency and display the current neighbor status, use **show ip bgp neighbor** [<ip-address>| {in|out} <ip-address>] command in privileged mode as shown in Table 301.

TABLE 301 SHOW IP BGP NEIGHBOR COMMAND

Command Format	Command Mode	Command Function
show ip bgp neighbor [<ip-address>| {in|out} <ip-address>]	privileged	This displays the BGP adjacency and display the current neighbor status

Result: This displays the BGP adjacency and display the current neighbor status.

3. To display entries in the BGP routing table, use **show ip bgp route** [network <ip-address> [mask <net-mask>]] command in privileged mode as shown in Table 302.

TABLE 302 SHOW IP BGP ROUTE COMMAND

Command Format	Command Mode	Command Function
show ip bgp route [network <ip-address> [mask <net-mask>]]	privileged	This displays the entries in the BGP routing table

Result: This displays the entries in the BGP routing table.

4. To display the status of all BGP neighbor connections, use **show ip bgp summary** command in privileged mode as shown in Table 303.

TABLE 303 SHOW IP BGP SUMMARY COMMAND

Command Format	Command Mode	Command Function
show ip bgp summary	privileged	This displays the status of all BGP neighbor connections

Result: This displays the status of all BGP neighbor connections.

In addition to the **show** commands, the **debug** commands also can be used to observe the BGP adjacency setup process and route update process.

Command Format	Command Mode	Command Function
debug ip bgp in	Privileged	Traces and displays notification packets sent by BGP and lists error ID and sub error ID
debug ip bgp out	Privileged	Traces and displays notification packets sent by BGP and lists error ID and sub error ID
debug ip bgp events	Privileged	Traces and displays the state machine transition of the BGP connection

The **debug ip bgp events** command is used to trace the state transition of BGP:

```
ZXR10#debug ip bgp events
BGP events debugging is on
ZXR10#
04:10:07: BGP: 192.168.1.2 reset due to Erroneous BGP Open received
04:10:07: BGP: 192.168.1.2 went from Connect to Idle
04:10:08: BGP: 192.168.1.2 went from Idle to Connect
04:10:13: BGP: 192.168.1.2 went from Connect to OpenSent
04:10:13: BGP: 192.168.1.2 went from OpenSent to OpenConfirm
04:10:13: BGP: 192.168.1.2 went from OpenConfirm to Established
ZXR10#
```

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Chapter 17

Policy Routing Configuration

Introduction This chapter introduces policy routing and relevant configurations on the ZXR10 GER.

Contents This chapter covers following topics.

TABLE 304 TOPICS IN CHAPTER 17

Overview

Routing Table Traditionally, a router obtains the next hop by searching in the routing table according to the destination address, and then forwards messages. The routing table entry is specified statically by the network administrator or generated dynamically by the routing protocol through the routing algorithm. Compared with the traditional routing, policy routing is more powerful and more flexible. With policy routing, the network administrator can select the forwarding path according to the destination address, message application (TCP/UDP port number) or source IP address.

Message Forwarding Control In message forwarding control, policy routing is more capable than traditional routing. Policy routing can implement traffic engineering to a certain extent, thus making traffic of different service quality or different service data (such as voice and FTP) to go to different paths. The user has higher and higher requirements for network performance, therefore it is necessary to select different packet forwarding paths based on the differences of services or user categories.

Match and Set Commands

In the ZXR10 GER, the network administrator can define different Route-maps according to the **match** and **set** statements, and apply the Route-map to the message receiving interface, thus implementing path selection.

Each Route-map has a series of sequences and each sequence contains multiple **match** and **set** statements. The **match** statement defines match conditions. Policy routing is performed when a received message meets the conditions. The **set** statement specifies the routing behaviors when a message meets the match conditions. If a message does not meet the match conditions in a sequence, the system matches it in the next sequence.

Ingress

When a router receives a message, it judges whether the ingress is bound with policy routing. If not, it searches in the routing table according to the destination address and then performs forwarding. If yes, it processes the message according to the sequence of Route-map. The specific procedures are as follows.

- Router matches the message with the ACL configured in the first sequence. If matching fails, it continues matching the message with the ACL in the next sequence. The rest is deduced by analogy. If matching succeeds, it judges the attributes of the sequence.
- If the attribute of the sequence is **deny**, the message is routed in the normal way. If the attribute is **permit**, the router forwards the message according to the **set** statement in the sequence.
- The router checks whether a valid **set ip next-hop** (direct next-hop) exists. When multiple **set ip next-hop** items exist, the router selects the first valid next-hop according to the sequence. If it exists, the router forwards the message to the specified next-hop.
- If **set ip next-hop** is not set or no valid **set ip next-hop** exists, the router needs to check whether a valid egress exists (The egress exists and is in the UP status.) When multiple **set interface** items exist, the router selects the first valid egress according to the sequence. If it exists, the router sends the message from the egress. Otherwise, the router routes the message in the normal way.
- In normal routing, if the router finds the corresponding route in the forwarding table, it forwards the message according to the route. Otherwise, it forwards the message according to the valid **set ip default next-hop** (direct next-hop) specified in policy routing. When multiple **set ip default next-hop** items exist, the router selects the first default valid next-hop according to the sequence.
- If **set ip default next-hop** is not set or no valid **set ip default next-hop** exists, the router forwards the message according to the valid **set default interface** specified in policy routing. When multiple **set default interface** items

exist, the router selects the first valid default egress according to the sequence.

- If **set default interface** is not set or no valid **set default interface** exists, the router forwards the message according to the default route.
- If no default route is specified in the system, the router discards the message.

NOTE: In the ZXR10 GER, the path selection modes for message forwarding are prioritized as policy routing>normal routing>default routing.

Configuring Policy Routing

Purpose Refer to below procedure for PBR configuration on ZTE ZXR10 GER routers.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To create a route-map policy, use **route-map** command in global configuration mode, as shown in Table 305.

TABLE 305 ROUTE MAP COMMAND

Command Format	Command Mode	Command Function
route-map	privileged	This creates a route-map policy

Result: This creates a route-map policy.

2. To implement the route map policy, use **match** / **set** command in the route mapping configuration mode, as shown in Table 306.

TABLE 306 MATCH/SET COMMAND

Command Format	Command Mode	Command Function
match / **set**	route mapping configuration	This implements the route map policy

Result: This implements the route map policy.

3. To perform policy routing on the data packet that matches the access table, use **match ip address** command in route mapping configuration mode, as shown in Table 307.

TABLE 307 MATCH IP ADDRESS

Command Format	Command Mode	Command Function
match ip address	route mapping configuration	This performs policy routing on the data packet that matches the access table

Result: This performs policy routing on the data packet that matches the access table.

4. To route the data packet to the specified next hop, use **set ip next-hop** command in route mapping configuration mode, as shown in Table 308**.**

TABLE 308 IP NEXT-HOP COMMAND

Command Format	Command Mode	Command Function
ip next-hop	route mapping configuration	This enables to route the data packet to the specified next hop

Result: This enables to route the data packet to the specified next hop

5. To route the data packet to the specified interface, use **set interface** command in route mapping configuration mode, as shown in Table 309**.**

TABLE 309 SET INTERFACE COMMAND

Command Format	Command Mode	Command Function
set interface	route mapping configuration	This enables to route the data packet to the specified interface

Result: This enables to route the data packet to the specified interface

6. To define the default route when destination is not obtained, use **set ip default next-hop** command in route mapping configuration mode, as shown in Table 310.

TABLE 310 SET IP DEFAULT NEXT HOP COMMAND

Command Format	Command Mode	Command Function
set ip default next-hop	route mapping configuration	This defines the default route when destination is not obtained

Result: This defines the default route when destination is not obtained.

7. To route the data packet to the default interface, use **set default interface** command in route mapping configuration mode, as shown in Table 311.

TABLE 311 SET DEFAULT INTERFACE COMMAND

Command Format	Command Mode	Command Function
set default interface	route mapping configuration	This enables to route the data packet to the default interface

Result: This enables to route the data packet to the default interface.

8. To configure rapid forwarding based on the policy routing for the incoming messages of the port, use **ip policy route-map** command in route mapping configuration mode, as shown in Table 312.

TABLE 312 IP POLICY ROUTE-MAP COMMAND

Command Format	Command Mode	Command Function
ip policy route-map	route mapping configuration	This configures the rapid forwarding based on the policy routing for the incoming messages of the port

Result: This configures the rapid forwarding based on the policy routing for the incoming messages of the port.

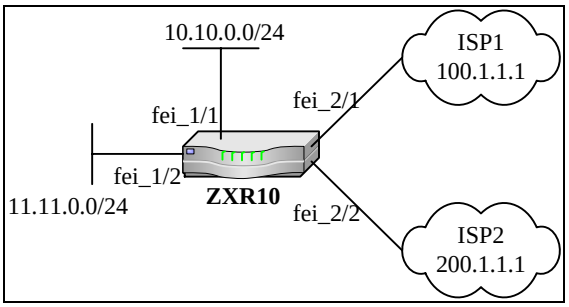
END OF STEPS

Example:

When there are many Internet Service Provider (ISP) egresses on the network, select different ISP egresses for users from different groups through policy routing, or select different ISP egresses based on service types.

As shown in Figure 105, the router accesses the users of two subnets through different interfaces. Two ISP egresses are available, and users with different IP addresses need to select different egresses. The users in the subnet with the IP address 10.10.0.0/24 select ISP1 egress and those in the subnet with the IP address 11.11.0.0/24 select ISP2 egress.

FIGURE 105 POLICY ROUTING CONFIGURATION EXAMPLE



ZXR10 configuration:

```
interface fei_1/1
  description To User1
  ip address  10.10.0.254 255.255.255.0
  ip policy route-map source-ip
!
interface fei_1/2
  description To User1
  ip address  11.11.0.254 255.255.255.0
  ip policy route-map source-ip
!
interface fei_2/1
  description To ISP1
  ip address  100.1.1.2 255.255.255.252
!
interface fei_2/2
  description To ISP2
  ip address  200.1.1.2 255.255.255.252
!
ip route 0.0.0.0 0.0.0.0 100.1.1.1
!
access-list 10 permit 10.10.0.0 0.0.0.255
access-list 20 permit 11.11.0.0 0.0.0.255
!
route-map source-ip permit 10    /*forwards the
messages matching with ACL 10 to 100.1.1.1*/
 match ip address 10
 set ip next-hop 100.1.1.1
!
route-map source-ip permit 20    /*forwards the
messages matching with ACL 20 to 200.1.1.1*/
 match ip address 20
 set ip next-hop 200.1.1.1
```

In this instance, the service connection is as follows:

- When ISP1 and ISP2 are normal, ISP1 and ISP2 are selected for the users in the 10.10.0.0/24 and 11.11.0.0/24 subnets respectively.

- When ISP1 is normal and ISP2 is abnormal, ISP1 is selected for both the users of the two subnets. The default route is adopted for users in the 11.11.0.0/24 subnet.
- When ISP1 is abnormal and ISP2 is normal, the services in the 11.11.0.0/24 subnet are normal, while those in the 10.10.0.0/24 subnet are interrupted.

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Chapter 18

GRE Configuration

Overview

Introduction The chapter introduces several common VPN technologies and also describes the General Route Encapsulation (GRE) technology and its detailed configuration on ZXR10 GER

Contents This chapter covers following topics.

TABLE 313 TOPICS IN CHAPTER 18

Introduction

VPN VPN stands for Virtual Private Network, which is relative to actual private networks. An actual private network (such as a banking network, a governmental network or a large enterprise network) implements interconnection via leased lines, while a VPN is a private to transmit private data over the common Internet.

Implementation A virtual private network is not a real private network, but can implement the functions of a private network. VPN depends upon ISP (Internet Service Provider) and NSP (Network Service Provider) to set up a dedicated data communications network on a public network. The description of IP-based VPNs in the IETF Draft is as follows: "The use of the IP mechanism to simulate a

private WAN" is a technology to simulate a point-to-point leased line on a common data network by using the private tunneling technology.

Public Network

On a virtual private network, the connection between any two nodes does not have any end-to-end physical link necessary for a traditional private network, but is dynamically set up by using the resources of the public network. In addition, a VPN user also can customize a network that best meet the actual requirements and also can control contact with other users. Such a VPN also supports dial-up users.

Tunneling Technology

The tunneling technology, similar to the point-to-point connection technology, is a basic VPN technology, which can set up a data channel (tunnel) on a public network so that packets can be transmitted on the tunnel.

A tunnel is formed by tunneling protocols, covering L2 and L3 tunneling protocols.

L2 Tunneling Protocol

The L2 tunneling protocol first encapsulates network protocols into PPP, and then encapsulates an entire packet into the tunneling protocol. The data packet formed through this kind of dual-layer encapsulation conducts its transmission depending on layer-2 protocol. Packets formed in this dual-layer encapsulation are transmitted based on the L2 protocols such as L2F, PPTP and L2TP.

L2TP stands for L2 Tunneling Protocol formed with the integration of IETF, PPTP and L2F, which is the current IETF standard. This is a VPN technology implemented in a special link layer, which encapsulates packets of the L2 protocol PPP into IP packets for transmission. With this technology, employees of an enterprise on business can directly access the Intranet by means of a dial-up network. For a terminal user to use the technology, the support of the related ISP is needed.

L3 Tunneling Protocol

The L3 tunneling protocols directly encapsulates network protocols into the tunneling protocols, and the formed packets are transmitted by means of the L3 protocols. The L3 tunneling protocols includes VTP and IPSec. IPSec (IP Security) defines a system, which is used to provide security protocol selection, security algorithm and determine the password used so that the security in the IP layer can be guaranteed and the secure data transmission can be implemented.

Encapsulation Mode

The use of this kind of protocols to construct a VPN network means the encapsulation (multiple encapsulation modes can be used) and encryption of IP packets and the transmission of the IP packets on the Internet. The use of IPSec improves the security, but the processing of IPSec occupies large quantities of network equipment (such as routers) resources due to the complexity of protocols and leads to low efficiency. Furthermore, if a piece of dedicated encryption hardware is used, the costs will increase.

Other VPN Technologies

Some other VPN technologies are described as follows.

- The encryption/decryption technology is a mature technology in data communications. The VPN can directly use the existing technology.
- The key management technology is intended to guarantee secure transfer of a key on a public data network so that the key will not be stolen.
- The existing key management technology is divided into two types: SKIP and ISAKMP/OAKLEY.SKIP uses the calculation rules of Diffie-Hellman to transfer keys on networks. In ISAKMP, both parties have two keys used for public or private applications

The most common identity authentication technologies are user name, password and card authentication.

Some other latest technologies, such as MPLS VPN, need the corresponding services of the ISP.

GRE Overview

Definition General Route Encapsulation (GRE) means that an IP header is added externally to an IP packet, that is to say, the private data is processed in a disguise way and added with a "jacket" and then is sent to other places.

Simplest VPN Technology Since IP addresses of a private enterprise network are normally planned by the enterprise itself, so correct routing cannot be completed between the enterprise network and the external Internet. However, on the egress of the enterprise network, normally there will be a unique IP address of the Internet. The address can be identified uniquely on the Internet. GRE is used to encapsulate packets with the destination and source IP addresses being the internal addresses of the enterprise and add an IP header. The destination address is the IP address of the egress of the remote Internet, while the source address is the IP address of the egress of the local Internet. Thus, the packets can be transmitted correctly on the Internet. This technology is the simplest VPN technology.

IP Datagram When a router sends or forwards an IP datagram, if the IP datagram should be sent out a GRE tunnel interface after routing process, GRE encapsulation is needed. Upon encapsulation, the GRE header field is processed according to the option configuration of the GRE tunnel interface, and finally a route is found according to the encapsulated destination address and the datagram is sent to the output network interface to implement forwarding of the datagram.

MTU If the length of the datagram to be sent is greater than the MTU (Maximum Transmission Unit) of the interface, fragmentation operation should be performed before GRE encapsulation and sending, that is, fragmentation is performed before encapsulation. If the DF bit of the IP data header is set to "1"

and also fragmentation is needed, an ICMP message will be returned (the type is 3, the code is 4, with the MTU of the interface included).

Key Tag When a router receives an IP datagram, if the destination address is a local address and the protocol field of the header is 47, it indicates that the datagram has experienced GRE, so resolution on the local router is needed. After validity check, the GRE packet should be mapped to the locally saved GRE tunnel ID according to the source and destination addresses of the GRE packet. If the corresponding GRE tunnel does not exist, the datagram will be dropped and then the GRE options will be processed subsequently. System supports the key、sequence、checksum options. If the key tag in the flag field in the GRE header is different from the key tag of the corresponding tunnel, or the key tags are configured but the key values are different, the datagram will be dropped.

IP Data Header-TTL Minus 1 from the TTL of the resolved IP data header, further process it. A routing process is used to judge whether the datagram is to be locally sent or forwarded.

Configuring GRE

Purpose Below procedure gives information about GRE configuration.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To create a tunnel and enter into the interface configuration mode of the tunnel, use **interface** <tunnel-number> command in global configuration mode as shown in Table 314.

TABLE 314 INTERFACE TUNNEL COMMAND

Command Format	Command Mode	Command Function
interface <tunnel-number>	Global configuration	This creates a tunnel and enables to enter into the interface configuration mode of the tunnel

Result: This creates a tunnel and enables to enter into the interface configuration mode of the tunnel.

2. To configure a source address for the tunnel, use **tunnel source** <ip-address> command in tunnel configuration mode as shown in Table 315.

TABLE 315 TUNNEL SOURCE COMMAND

Command Format	Command Mode	Command Function
tunnel source <ip-address>	tunnel configuration	This configures a source address for the tunnel

Result: This configures a source address for the tunnel.

3. To configure a destination address for the tunnel, use **tunnel destination** <ip-address> command in tunnel configuration mode as shown in Table 316.

TABLE 316 TUNNEL DESTINATION COMMAND

Command Format	Command Mode	Command Function
tunnel destination <ip-address>	Interface configuration	This configures a destination address for the tunnel

Result: This configures a destination address for the tunnel.

4. To configure the GRE tunnel to enable the key option and configure a key, use **tunnel key** <key> command in tunnel configuration mode as shown in Table 317.

TABLE 317 TUNNEL KEY COMMAND

Command Format	Command Mode	Command Function
tunnel key <key>	Interface configuration	This configures the GRE tunnel and enable the key option and configure a key

Result: This configures the GRE tunnel and enables the key option and configures a key.

Note: The key strings at both ends of the tunnel must be the same.

5. To configure the GRE tunnel and to enable the tunnel sequence option, use **tunnel sequencing** command in tunnel configuration mode as shown in Table 318.

TABLE 318 TUNNEL SEQUENCING COMMAND

Command Format	Command Mode	Command Function
tunnel key <key>	Interface configuration	This configures the GRE tunnel and to enable the tunnel sequence option

Result: This configures the GRE tunnel and to enable the tunnel sequence option.

6. To configure the GRE tunnel and to enable the tunnel checksum option, use **tunnel checksum** command in tunnel configuration mode as shown in Table 319.

TABLE 319 TUNNEL CHECKSUM COMMAND

Command Format	Command Mode	Command Function
tunnel key <key>	Interface configuration	This configures the GRE tunnel and to enable the tunnel checksum option

Result: This configures the GRE tunnel and to enable the tunnel checksum option.

END OF STEPS

GRE Maintenance and Diagnosis

Use the **debug gre** command to output the debugging contents of the GRE tunnel encapsulation information, for the convenience of troubleshooting.

GRE Configuration Example

Suppose the public network of a router R1 in place A of a certain cooperation is 100.1.1.1, and private network is 10.1.1.0/24; and public network of a router R2 in place B is 200.1.1.1 and private network is 172.16.0.0/16. To interconnect the network segments of the private networks in the two places, and to realize the VPN function, use the following configuration.

R1 configuration:

```
ZXR10_R1#config terminal
ZXR10_R1(config)#interface tunnel1
ZXR10_R1(config)#ip      address      192.168.1.1
255.255.255.252
ZXR10_R1(config-if)#tunnel source 100.1.1.1
ZXR10_R1(config-if)#tunnel destination 200.1.1.1
ZXR10_R1(config-if)#tunnel key test
ZXR10_R1(config-if)#exit
ZXR10_R1(config)#ip route 172.16.0.0 255.255.0.0
192.168.1.2
```

R2 configuration:

```
ZXR10_R2#config terminal
ZXR10_R2(config)#interface tunnel1
ZXR10_R2(config)#ip      address      192.168.1.2
255.255.255.252
ZXR10_R2(config-if)#tunnel source 200.1.1.1
ZXR10_R2(config-if)#tunnel destination 100.1.1.1
ZXR10_R2(config-if)#tunnel key test
ZXR10_R2(config-if)#exit
ZXR10_R2(config)#ip  route  10.1.1.0  255.255.255.0
192.168.1.1
```

Chapter 19

MPLS Configuration

Overview

Introduction This chapter describes the basic concepts of Multi-Protocol Label Switching (MPLS) technology and MPLS configuration and troubleshooting on ZTE ZXR10 GER router.

Contents This chapter covers the following contents:

TABLE 320 TOPICS IN CHAPTER 19

MPLS Overview

Intdroduction Multi-Protocol Label Switching (MPLS) is a multi-layer switching technology, which combines L2 switching technologies with L3 routing technologies and uses labels to aggregate forwarding information. MPLS runs under the routing hierarchy, supports multiple upper-level protocols and can be implemented on multiple physical platforms.

Label switching Label switching can be visually imagined as postal codes for mails. With the application of postal codes, the destination addresses and some special requirements (such as QoS, CoS

and management information) of the mails are coded in a certain method to facilitate rapid and efficient mail processing and speed up the routing of the mails to individual destinations. The basic concept of MPLS is the assignment of labels, that is, labels are bound with network layer routes.

Hop by hop routing

Basic MPLS routing mode is routing hop by hop, which permits a forwarding mechanism simpler than packets and can implement faster routing. Since the common label allocation method and generic routing protocols are used in multiple types of media (such as packets, cells and frames), MPLS supports efficient definite routing mode (such as QoS) that can be used to fulfill different purposes, common traffic engineering method and other operation modes.

Label Distribution Protocol (LDP)

LDP function

LDP (Label Distribution Protocol) is the core protocol of MPLS. LDP works in conjunction with standard network layer routing protocols and distributes label information among different pieces of equipment on an MPLS network in the connectionless working mode.

MPLS also can use the work mode in which resources are reserved but no definite connection is set up, that is, protocols RSVP and RSVP-LSP-TUNNEL are used to serve traffic engineering.

In addition, CRLDP (Constrained-based Routing LDP) executes some routes with definite paths.

Forwarding Equivalence Class

LDP divides Forwarding Equivalence Class (FEC) based on IP prefixes. In an MPLS network, internal gateway protocols are used to discover the information about IP prefixes. When a Label Switch Router (LSR) discovers such information, it will distribute a label to the FEC and advertise the label to all upstream LDP neighbors.

Hop- By-Hop

Hop-by-hop dynamic label distribution of LDP leads to the generation of a series of labeled paths, called Label Switched Paths (LSPs). Along these LSPs, the label traffic can pass the MPLS backbone to reach a designated destination. With this capability, a service provider can deploy MPLS-based IP VPN, as well as the IP + ATM service over multi-proxy MPLS networks.

The propagation process of IP packets through the MPLS backbone is as follows.

- An ingress border LSR receives a packet, puts the packet into an FEC and then uses the outgoing label corresponding to the FEC to label the packet. For a unicast IP route based on destination address, the FEC corresponds to a destination subnet.

- A backbone LSR receives the labeled packet, searches the label-forwarding table and uses a new outgoing label to replace the label in the input packet.
- An egress border LSR receives the labeled packet, deletes the label and performs the traditional L3 search for the IP packet.

Operational Principles of MPLS

MPLS Operational Principles

MPLS is a label-based IP routing method. These labels can be used to stand for hop-by-hop mode or explicit routes and also to indicate QoS, VPN and the transmission of special types of traffic (or special user's traffic) on a network.

MPLS uses a simplified technology to complete conversion between L2 and L3. MPLS can provide a label for each IP packet that can be encapsulated into a new MPLS packet in conjunction with the IP packet, to determine the transmission path and priority sequence of the IP packet.

Before forwarding the IP packet according to the corresponding path, an MPLS router will read the header label of the MPLS packet, but will not read the information such as the IP address in each IP packet. Therefore, the switching and routing speed of packets is greatly improved.

MPLS in frame relay

MPLS can use different types of L2 protocols. Up to now, the MPLS Task Force has standardized labels used in frame relay, ATM, PPP links and IEEE802.3 LANs. The advantage of the running of MPLS in frame relay and ATM is that it brings the random connectivity of the IP to these connection-oriented technologies.

At present, the major development trend of MPLS is ATM, because ATM supports powerful traffic management and provides QoS. In addition, ATM, with the combination of the MPLS technology can put its functions in traffic management and QoS into full play.

Labels

Labels are used to forward headers of packets, and format of packet headers depends upon network features. In a router network, a label is an independent 32-bit header. In ATM, a label is placed in the cell header of a Virtual Circuit Identifier/Virtual Channel Identifier (VCI/VPI). For the scalability of MPLS, a very key point is that a label is meaningful only between two pieces of equipment in mutual communications.

When an IP packet enters the network core, a border router will assign a label to it. Since then, the MPLS equipment will check the label information all the time and switch the labeled packet to the destination. Since route processing is reduced, the waiting time of the network is shortened and the scalability is improved.

Border Router

Border router of MPLS determines the QoS type of an MPLS packet according to the parameters (such as source/destination IP address, port ID and TOS value) in the IP packet.

For IP packets to the same destination, different forwarding paths can be set up according to the requirements for TOS values, to meet the requirements for transmission quality. In the meantime, the management of special routes also can solve the problem of load balance and congestion on the network efficiently. When congestion occurs in a network, MPLS sets new forwarding routes that disperse the traffic to ease the network congestion.

MPLS Label Header

MPLS Label Header

An MPLS label is inserted between an L2 header and an L3 packet. Therefore, an MPLS label header is also called a shim header. The length of an MPLS label header is four bytes, containing a 20-bit label, a 3 test bits, a 1-bit stack bottom tag and 8-bit TTL (Time-To Live).

A router sending an MPLS packet needs to use a method to notify a router receiving the packet. The transmitted packet is not a pure IP packet, but an MPLS datagram. For Ethernet packets, Ethernet types 8847 and 8848 (in hexadecimal notation) are used to label MPLS packets; while for PPP packets, the protocol field is set to "8282" (in hexadecimal notation) to label MPLS packets.

MPLS LDP

MPLS LDP

LDP label binding is an association relation between a destination prefix and a label. Labels used for label binding are locked from a label set called "label space".

LDP supports two types of label spaces:

Label space per interface

- Label space per interface uses the label resources of the interface. For example, the LC-ATM interface uses VPI/VCI as a label. Based on different configurations, an LDP instance can support or may not support one or multiple interface label spaces.

Label space per platform

- LDP instance supports a label space shared by all interfaces in a platform range. Except the LC-ATM interface, ZXR10 T64/T128 uses the label space per platform on all the other interfaces.

LDP identity

LDP uses six bytes to name a label space, called LDP identity (LDP Id), which is composed of two parts:

- First four bytes indicate the router ID of the router that has the label space.

- Last two bytes indicate the internal label space ID of the LSR. For the label space per platform, the last two bytes are always "0".

Rules for selecting router ID

Rules for selecting the router ID of an LDP on ZXR10 GER Routers are as follows:

- If **mpls ldp router-id** command is used to designate the address of an interface as the router ID, and also the interface has an IP address and is in UP status, the interface will serve as the router ID.
- If there are loopback interfaces configured with an IP address, maximum IP address among the IP addresses of all the loopback interfaces will serve as the router ID.
- Maximum one among the IP addresses of interfaces configured with IP addresses in UP status is selected as the router ID.

LDP hello messages

An LSR sends LDP hello messages periodically, indicating that it hopes to advertise label binding to find LDP peers. A Hello message contains the LDP ID of the label space that the LSR wants to advertise. The LDP uses UDP as a transmission protocol to send the Hello message, with the port ID of 646.

When an LSR receives a Hello message from another LSR, it will "think" that it has found an LSR and its special label space. If two LSRs find each other, they will start to set up an LDP session.

LDP defines two types of discovery mechanisms. At present, ZXR10 GER router supports basic discovery mechanism, used to discover directly-connected peers. Hello message in basic discovery mechanism is sent on all interfaces configured with LDP, with multicast addresses of "all routers on the subnet" as the destination addresses.

Procedure

The procedure for setting up an LDP session between two LSRs is as follows.

1. Open a TCP connection used for label distribution.

   On ZXR10 GER, by default, router ID of LDP serves as the transport address of the TCP connection. Alternatively, in interface configuration mode, **mpls ldp discovery transport-address** command can be used to designate an IP address or source IP address for sending Hello messages can serve as the transport address of the TCP connection.

   NOTE: To set up a TCP connection, an LSR should have a route to TCP transport address of another LSR.

2. Negotiate LDP session parameters

   Parameters to be negotiated are label distribution mode (independent downstream label distribution/downstream label distribution on demand) and other parameters.

   After the LDP session is set up, the LDP can start label distribution.

MPLS Configuration

Purpose Refer to below procedure for MPLS configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. Enter into configuration mode by writing **config terminal** command in global configuration mode as shown in Table 321.

TABLE 321 CONFIG TERMINAL COMMAND

Command Format	Command Mode	Command Function
config terminal	Global	Enters into global configuration mode

Result: This enables to enter into global configuration mode.

2. To enable LDP to set up an LSP along a common hop-by-hop routing path, use **mpls ip** command in global configuration mode as shown in Table 322.

TABLE 322 MPLS IP COMMAND

Command Format	Command Mode	Command Function
mpls ip	global config	This enables LDP to set up an LSP along a common hop-by-hop routing path

Result: This enables LDP to set up an LSP along a common hop-by-hop routing path.

3. To enable LDP label switching on the interface, use **mpls ip** command in interface configuration mode as shown in Table 323.

TABLE 323 MPLS IP COMMAND

Command Format	Command Mode	Command Function
mpls ip	interface config	This enables LDP label switching on the interface

Result: This enables LDP label switching on the interface.

4. To configure the transport address parameter contained in the Hello message, use **mpls ldp discovery transport-address** {**interface|**<*ip-address*>} command in interface configuration mode as shown in Table 324.

TABLE 324 MPLS LDP DISCOVERY COMMAND

Command Format	Command Mode	Command Function
mpls ldp discovery transport-address {interface|<*ip-address*>}	interface config	This configures the transport address parameter contained in the Hello message

Result: This configures the transport address parameter contained in the Hello message.

Note:

By default, ZXR10 GER regards the router ID on an interface in frame mode as transport address and advertises the address in Hello message. Above command can change default behavior of router on an interface.

If parameter interface is used, the LDP will advertise the IP address of the interface in the Hello message of the interface. If parameter <ip_address> is used, LD will advertise designated IP address in Hello message on the interface.

5. To designate the IP address of an interface as the router ID of the LDP, use **mpls ldp router-id <***interface-number***>** [**force**] command in global configuration mode as shown in Table 325.

TABLE 325 MPLS LDP ROUTER-ID COMMAND

Command Format	Command Mode	Command Function
mpls ldp router-id <*interface-number*> **[force]**	global config	This designates the IP address of an interface as the router ID of the LDP

Result: This designates the IP address of an interface as the router ID of the LDP.

6. To control the LDP to create the FEC item (that is, FEC filtering policy) for which destination network sections, use **mpls ldp access-fec** {**for** <*prefix-access-list*>**|host-route-only**} command in global configuration mode as shown in Table 326.

TABLE 326 MPLS LDP ACCESS-FEC COMMAND

Command Format	Command Mode	Command Function
mpls ldp access-fec {for <*prefix-access-*	global config	This configures FEC filtering policy

Command Format	Command Mode	Command Function
list>|host-route-only}		

Result: This configures FEC filtering policy.

7. To control locally distributed labels (incoming labels) to be distributed upstream by means of LDP, use **mpls ldp advertise-labels** [**for** <*prefix-access-list*> [**to** <*peer-access-list*>]] command in global configuration mode as shown in Table 327.

TABLE 327 MPLS ADVERTISE LABEL COMMAND

Command Format	Command Mode	Command Function
mpls ldp advertise-labels [**for** <*prefix-access-list*> [**to** <*peer-access-list*>]]	global config	This controls locally distributed labels (incoming labels) to be distributed upstream by means of LDP

Result: This controls locally distributed labels (incoming labels) to be distributed upstream by means of LDP.

8. To configure the interval for sending the LDP hello discovery message and the timeout time of the discovered LDP neighbor, use **mpls ldp discovery hello** {**holdtime** <*holdtime*>**|interval** <*interval*>} command in global configuration mode as shown in Table 328.

TABLE 328 MPLS LDP DISCOVERY COMMAND

Command Format	Command Mode	Command Function
mpls ldp discovery hello {holdtime <*holdtime*>|interval <*interval*>}	global config	This configures the interval for sending the LDP hello discovery message and the timeout time of the discovered LDP neighbor

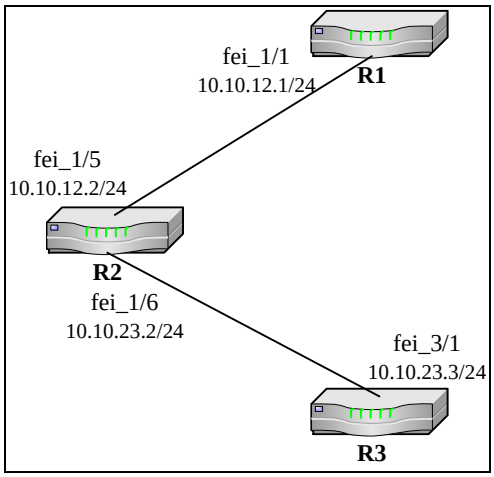
Result: This configures the interval for sending the LDP hello discovery message and the timeout time of the discovered LDP neighbor.

END OF STEPS

MPLS Configuration Example

Figure 106 shows a simple network where frame interfaces are used for MPLS forwarding.

FIGURE 106 MPLS CONFIGURATION EXAMPLE



Basic configuration tasks of three routers are to:

- Enable MPLS hop-by-hop forwarding on POS links between R1 and R2 and that between R2 and R3.
- Configure LDP label distribution between R1 and R2 and that between R2 and R3.
- Configure the IP address of a loopback interface to serve as the router ID of the LSR.

Configuration of R1:

```
ZXR10_R1(config)#mpls ip
ZXR10_R1(config)#interface Loopback1
ZXR10_R1(config-if)#ip address 10.10.1.1 255.255.255.255
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address 10.10.12.1 255.255.255.0
ZXR10_R1(config-if)#mpls ip
ZXR10_R1(config)#mpls ldp router-id loopback1
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 10.0.0.0 0.255.255.255
```

Configuration of R2:

```
ZXR10_R2(config)#mpls ip
ZXR10_R2(config)#interface Loopback1
ZXR10_R2(config-if)#ip address 10.10.2.2 255.255.255.255
ZXR10_R2(config)#interface fei_1/5
ZXR10_R2(config-if)#ip address 10.10.12.2 255.255.255.0
ZXR10_R2(config-if)#mpls ip
ZXR10_R2(config)#interface fei_1/6
```

```
ZXR10_R2(config-if)#ip address 10.10.23.2 255.255.255.0
ZXR10_R2(config-if)#mpls ip
ZXR10_R2(config)#mpls ldp router-id loopback1
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network 10.0.0.0 0.255.255.255.255
```

Configuration of R3:

```
ZXR10_R3(config)#mpls ip
ZXR10_R3(config)#interface Loopback1
ZXR10_R3(config-if)#ip address 10.10.3.3 255.255.255.255
ZXR10_R3(config)#interface fei_3/1
ZXR10_R3(config-if)#ip address 10.10.23.3 255.255.255.0
ZXR10_R3(config-if)#mpls ip
ZXR10_R3(config)#mpls ldp router-id loopback1
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network 10.0.0.0 0.255.255.255.255
```

In the above configuration, the OSPF dynamic routing protocol is run to advertise the Route-id of each LSR, that is, the route of the loopback interface address.

Note: Use of loopback interface address as router ID facilitates the stability of LDP id of a router, since status of loopback interface address does not change (unless the interface is disabled manually).

MPLS Maintenance and Diagnosis

Purpose Refer to below procedure for MPLS maintenance & diagnosis on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To display interfaces with MPLS enabled, use **show mpls interface** [<*interface-number*>] command in privileged mode as shown in Table 329.

TABLE 329 SHOW MPLS INTERFACE COMMAND

Command Format	Command Mode	Command Function
show mpls interface [<*interface-number*>]	Privileged	This displays MPLS interfaces

Result: This displays MPLS interfaces.

```
ZXR10 #show mpls interface
interface of LDP:
Interface            IP        Tunnel Operational
fei_1/5              Yes(ldp)   No     Yes
fei_1/6              Yes(ldp)   No     Yes
ZXR10#
```

2. To check MPLS LDP parameters, that is, LDP timer parameters use **show mpls ldp parameters** command in privileged mode as shown in Table 330.

TABLE 330 SHOW MPLS LDP PARAMETERS COMMAND

Command Format	Command Mode	Command Function
show mpls ldp parameters	Privileged	This check the current parameter information about LDP

Result: This check the current parameter information about LDP.

```
ZXR10 #show mpls ldp parameters
Protocol version: 1
Downstream label pool: min label: 16; max label:
1048575
Session hold time: 180 sec; keep alive interval: 60 sec
Discovery hello: holdtime: 15 sec; interval: 5 sec
Downstream on Demand max hop count: 255
LDP initial/maximum backoff: 15/120 sec
LDP loop detection: off
ZXR10#
```

3. To display LDP discovery information, use **show mpls ldp discovery** [detail] command in privileged mode as shown in Table 331.

TABLE 331 SHOW MPLS LDP DISCOVERY COMMAND

Command Format	Command Mode	Command Function
show mpls ldp discovery [detail]	Privileged	This displays LDP discovery information

Result: This displays LDP discovery information.

```
ZXR10#show mpls ldp discovery detail
Local LDP Identifier:
    10.10.2.2:0
Discovery Sources:
    Interfaces:
        fei_1/5 (ldp): xmit/recv
            LDP Id: 10.10.1.1:0
                Src IP addr: 10.10.12.1; Transport IP
addr: 10.10.12.1
        fei_1/6 (ldp): xmit/recv
            LDP Id: 10.10.3.3:0
                Src IP addr: 10.10.23.3; Transport IP
addr: 10.10.3.3
ZXR10 #
```

4. To display LDP session information, use **show mpls ldp neighbor** [*<interface-number>*] [**detail**] command in privileged mode, as shown in Table 332.

TABLE 332 SHOW MPLS LDP NEIGHBOR COMMAND

Command Format	Command Mode	Command Function
show mpls ldp neighbor [*<interface-number>*] [**detail**]	Privileged	This displays LDP session information

Result: This displays LDP session information.

```
ZXR10#show mpls ldp neighbor detail
Peer LDP Ident: 10.10.1.1:0; Local LDP Ident
10.10.2.2:0
        TCP connection: 10.10.12.1.1025 - 10.10.2.2.646
        state: Oper; Msgs sent/rcvd: 240/240;
Downstream
        Up Time: 03:52:25
        LDP discovery sources:
          fei_1/5; Src IP addr: 10.10.12.1
            holdtime: 15000 ms, hello interval: 5000 ms
        Addresses bound to peer LDP Ident:
          10.10.12.1  10.10.1.1
        Peer holdtime: 180000 ms; KA interval: 60000 ms
ZXR10#
```

5. To check label binding after the LDP session is set up normally, use **show mpls ldp bindings** command in privileged mode as shown in Table 333.

TABLE 333 SHOW MPLS LDP BINDINGS COMMAND

Command Format	Command Mode	Command Function
show mpls ldp bindings	Privileged	This displays the learned LDP label binding

Result: This displays the learned LDP label binding.

```
ZXR10 #show mpls ldp bindings
 10.10.1.1/255.255.255.255
        local binding:  label: 17
        remote binding: lsr: 10.10.3.3:0, label: 18
        remote binding: lsr: 10.10.1.1:0, label: imp-
null(inuse)
 10.10.2.2/255.255.255.255
        local binding:  label: imp-null
        remote binding: lsr: 10.10.3.3:0, label: 17
        remote binding: lsr: 10.10.1.1:0, label: 18
 10.10.3.3/255.255.255.255
        local binding:  label: 16
        remote binding: lsr: 10.10.3.3:0, label: imp-
null(inuse)
        remote binding: lsr: 10.10.1.1:0, label: 17
 10.10.12.0/255.255.255.0
        local binding:  label: imp-null
        remote binding: lsr: 10.10.3.3:0, label: 16
        remote binding: lsr: 10.10.1.1:0, label: imp-
null
 10.10.23.0/255.255.255.0
        local binding:  label: imp-null
        remote binding: lsr: 10.10.3.3:0, label: imp-
null
        remote binding: lsr: 10.10.1.1:0, label: 16:
ZXR10 #
```

6. For complicated troubleshooting, following debug commands may be used.

Command Format	Command Mode	Command Function
debug mpls ldp transport {**connections**|**events**}	Privileged	Monitors information discovered by LDP.
debug mpls ldp session {**io**|**state-machine**}	Privileged	Monitors LDP session activities.
debug mpls ldp messages	Privileged	Monitors messages from/to an LDP neighbor.

Command Format	Command Mode	Command Function
{**received**|**sent**}		
debug mpls ldp bindings	Privileged	Monitors the address and label advertised by an LDP neighbor.
debug mpls ldp advertisement	Privileged	Monitors the address and label advertised to an LDP neighbor

```
ZXR10#debug mpls ldp transport events
LDP transport events debugging is on
ZXR10#
ldp:     Send     ldp     hello;     fei_1/1,     scr/dst
10.10.12.1(0.0.0.0)/224.0.0.2, intf_id 257
ldp:      Rcvd      ldp      hello;      fei_1/1,      from
10.10.12.2(10.10.2.2:0), intf_id 257
ZXR10#debug mpls ldp transport connections
LDP transport connection debugging is on
ZXR10#
ldp: Hold timer expired for adj 0, will close adj
ldp: Closing ldp conn; 10.10.12.1:1025<-->10.10.2.2:646
ldp: Opening ldp conn; 10.10.12.1<-->10.10.2.2
ldp: Opening ldp conn; 10.10.12.1<-->10.10.2.2
ldp: ldp conn closed; 10.10.12.1:1026<-->10.10.2.2:646
ldp: ldp conn closed; 10.10.12.1:1027<-->10.10.2.2:646
ldp: Opening ldp conn; 10.10.12.1<-->10.10.2.2
ldp: ldp conn is up; 10.10.12.1:1028<-->10.10.2.2:646
ZXR10#
```

END OF STEPS

Chapter 20

MPLS VPN Configuration

Overview

Introduction This chapter describes the basic concepts of L3 MPLS VPN and the configuration and troubleshooting of MPLS VPN on ZTE ZXR10 GER router.

Contents This chapter covers the following contents:

TABLE 334 TOPICS IN CHAPTER 20

MPLS VPN Overview

Introduction MPLS VPN is an MPLS-based IP VPN, which is a routing method of applying the MPLS technology to networking routing and switching equipment to simplify core routers. MPLS VPN uses the label switching combined with traditional routing technologies to implement IP-based VPN. MPLS VPN can be used to construct broadband Intranet and Extranet and can meet multiple flexible service requirements.

Common Backbone MPLS VPN can utilize the powerful transmission capability of a common backbone network, reduce the construction costs of the

Intranet, greatly improve the operation and management flexibility of user's networks, and meanwhile can meet the requirements of users for secure, realtime, broadband and convenient information transmission.

Advantages of MPLS in IP-based Network

In an IP-based network, MPLS has following advantages:

Reduced Cost MPLS simplifies the integration technology of ATM and IP, efficiently combines the L2 and L3 technologies, reduces costs and protects user's investment at earlier stages.

Improved Resource Utilization Since label switching is used on the network, user's LANs at different points can use repeated IP addresses to improve the utilization of IP resources.

Improve Network Speed When label switching is used, address search time in each hop process is shortened. Transmission time of data on a network is reduced, and network speed is improved.

Improve Flexibility and Scalability Since MPLS uses AnyToAny connection, the network flexibility and scalability is improved. With respect to flexibility, special control policy can be customized to meet special requirements of different users and implement value-added services. The scalability covers the following two aspects:

- More VPNs on a network
- Easy user expansion in the same VPN.

User's Application Convienance MPLS technology will find wider application in networks of different carriers, so that an enterprise user can set up a global VPN conveniently.

Improve security MPLS serves as a channel mechanism to implement transparent packet transmission. LSPs of MPLS have high reliability and security similar to frame relay and ATMVCC (Virtual Channel Connection).

Enhance service A network can support the integration of data, audio and video services.

QoS ensurence of MPLS Related standards and drafts drawn by IETF for BGP/MPLS VPN:

- RFC 2547, BGP/MPLS VPN
- Draft RFC 2547bis, BGP/MPLS VPN
- RFC 2283, multi-protocol extension BGP4

Related Terms

A BGP/MPLS VPN network system covers the following types of network equipment.

PE (Provider Edge) A PE refers to a router connected to a CE in a client site on a carrier's network. A PE router supports VPN and labeling function (the labeling function can be provided by RSVP, LDP or CR-LDP). In a single VPN, a tunnel is used for connecting two PE routers, and the tunnel can be an MPLS LSP tunnel or an LDP tunnel.

P (Provider) Here, "P" refers a router in the core of a carrier's network, which is not connected to any router in any customer site, but is a part of the tunnel in a PE pair. "P" supports MPLS LSP or LDP, but does not need to support VPN.

CE (Customer Edge) CE refers to a router or switch connected to a carrier's network in a customer site. Normally, CE refers to an IP router.

VPN function is provided by a PE router, while P and CE routers do not have other VPN configuration requirements.

VPN-IPv4 Address and Route Distinguisher (RD)

L3 VPN L3 VPN may be connected to private networks via the Internet; these private networks can use public addresses or private addresses. When private networks use private addresses, addresses between different private networks may be repeated.

RFC 2547bis To avoid repetition of private addresses, public addresses can be used in network equipment to replace private addresses. A solution is provided in RFC2547bis, which uses an existing private network ID to generate a definite new address.

RD Definition New address is a part of VPN-IPv4 address cluster and is a BGP address cluster of the MP-BGP protocol. In a VPN-IPv4 address, there is a value used to differentiate different VPNs, called Route Distinguisher (RD).

Format of a VPN-IPv4 address is an eight-byte Router Distinguisher (RD) plus a four-byte IP address. RD is the eight-byte value used for VPN differentiation. An RD consists of the following domains:

- Type domain (two bytes): Determines the length of the other domains

  If value of the type domain is 0, administrator (ADM) domain is four bytes and the Assignment Number (AN) domain is two bytes.

  If value of the type domain is 1, administrator (ADM) domain is two bytes and the Assignment Number (AN) domain is four bytes.

- Administrator (ADM) domain: Identifies an administration assignment number

  If the value of the type domain is 0, administrator domain contains an IPv4 address. RFC2547bis recommends that IP address of a router (this address is normally configured as router ID) be used, and this address is a public address.

  If the type domain is 1, the administrator domain contains an AS ID. RFC2547bis recommends a public AS ID allocated by IANA be used (it is much better that the AS ID of the ISP or customer itself is used).

- Assignment Number (AN) domain: a number assigned by a network carrier

  If the type domain is 0, length of the AN domain is two bytes.

  If the type domain is 1, length of the AN domain is four bytes.

  An RD is only used between PEs to differentiate IPv4 addresses of different VPNs. The ingress generates an RD and converts the received IPv4 route of the CE into a VPN-IPv4 address. Before advertising the route to the CE, the egress PE converts the VPN-IPv4 route into an IPv4 route.

Operational Principles of MPLS VPN

MPLS Operational Principles

Basic operation mode of MPLS VPN is the application of the L3 technologies. Each VPN has an independent VPN-ID, users of each VPN can only communicate with members in the same VPN and only VPN members can enter the VPN.

On MPLS-based VPNs, the service provider assigns a distinguisher to each VPN, called Route Distinguisher (RD). The distinguisher is unique in the network of the service provider.

Forwarding table

Forwarding table contains a unique address, called VPN-IP address, which is formed through the connection of the RD and the IP address of the user. The VPN-IP address is a unique one in the network. The address table is stored in the forwarding table.

BGP is a routing information distribution protocol, which uses multi-protocol extension and common attributes to define VPN connectivity. On MPLS-based VPNs, BGP only advertises information to members in the same VPN and provides basic security by means of traffic split.

Data is forwarded by using LSP. The LSP defines a special path that cannot be changed, to guarantee the security. Such a label-based mode can provide confidentiality as frame relay and ATM. The service provider relates a special VPN to an interface, and packet forwarding depends upon ingress labels.

VPN forwarding table

VPN forwarding table contains a label corresponding to the VPN-IP address. Label is used to send the data to the corresponding destination. Since the label is used instead of the IP address, a user can maintain its dedicated address structure, without the need of data transfer by means of Network Address Translation (NAT). According to the data ingress, the corresponding router will select a special VPN forwarding table that only contains a valid destination address in VPN.

CE advertises routing information on the user's network to the PE by means of static route, default route or routing protocols RIP, OSPF, IS-IS and BGP.

Multi-Protocol BGP

Meanwhile extended multi-protocol BGP is used between PEs to transfer VPN-IP information and the corresponding label (VPN label, called internal layer label hereinafter). Traditional IGP is used between PE and P to learn the routing information from each other, and the LDP is used for the binding of routing information and label (a label on the backbone network, called external layer label hereinafter).

PE

In this case, basic network topology and routing information of CE, PE and P routers have already been formed. A PE router has the routing information of the backbone network and the routing information of each VPN.

CE

When a CE user on a VPN enters the network, the system can identify to which VPN the CE belongs on the interface between the CE and the PE, and will further read the next-hop address information in the routing table of the VPN. In addition, forwarded packets will be marked with a VPN label (internal layer label).

External Layer Label

In this case, the next-hop address obtained is the address of a PE that is the peer of this PE. To reach the destination PE, routing information of backbone network should be read from source PE to obtain the address of the next P router, and meanwhile, forwarded user's packets will be tagged with a backbone network label (external layer label).

In the backbone network, all P routers after the source PE read the external layer label to determine the next hop. Therefore, only simple label switching is performed on the backbone network.

Destination

When a packet reaches the last P router before arriving at the destination PE, the external layer label will be cancelled. After the packet reaches the destination PE, the PE will read the internal layer label, find the next-hop CE in the corresponding VRF, send the packet to the related interface and further transfer the data to the CE network of the VPN.

MPLS-VPN Configuration

Purpose Refer to below procedure for MPLS-VPN configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To define a name of a VPN on PE or give a name of the forwarding table of a VPN, use **ip vrf <***vrf-name***>** command in Table 335.

TABLE 335 IP VRF COMMAND

Command Format	Command Mode	Command Function
ip vrf <*vrf-name*>	global config	This defines the name of a VPN

Result: This defines the name of a VPN.

The length of the name lasts one through sixteen characters. The name is only valid locally, which will be used when an interface is bound with the VPN.

2. To define the RD of the VRF and the Route Target (RT) import/export policy, use **rd** <*route-distinguisher*> command in vrf command mode as shown in Table 336.

TABLE 336 RD COMMAND

Command Format	Command Mode	Command Function
rd <route-distinguisher>	VRF	This defines the RD of the VRF
route-target [both|import|export] <*route-target-ext-community*>	VRF	This creates route-target extension community attribute related to the VRF

Result: This defines the RD of the VRF.

Result: This creates route-target extension community attribute related to the VRF.

3. To define the association of a designated interface with the VRF, use **ip vrf forwarding <***vrf-name***>** command in interface configuration mode as shown in Table 337.

TABLE 337 IP VRF FORWARDING COMMAND

Command Format	Command Mode	Command Function
ip vrf forwarding <*vrf-name*>	interface config	This defines an interface associated with the VRF

Result: This defines an interface associated with the VRF.

If the interface is configured with an IP address in advance, the original IP address will disappear, and address reconfiguration is needed.

4. To define VRF route

PE can define static routes or run dynamic routing protocols to implement automatic interaction with CE.

i. To designate the vrf in static route configuration, use **ip route** [**vrf <***vrf-name*>] <*prefix*> <*network-mask*> {<*forwarding-router's-address*> | <*interface-number*>} [<*distance-metric*>] [**tag** <*tag*>] command in global configuration mode as shown in Table 338.

TABLE 338 IP ROUTE VRF COMMAND

Command Format	Command Mode	Command Function
ip route [**vrf <**vrf-name>] <prefix> <network-mask> {<forwarding-router's-address> | <interface-number>} [<distance-metric>] [**tag** <tag>]	global config	This sets up a static route

Result: This sets up a static route.

ii. For different dynamic routing protocols, the configurations on PE are different. At present, the version supports four protocols: OSPF BGP, ISIS and RIP.

To run an OSPF protocol, PE should rerun the process by using the following command **router ospf <***process-id*> **vrf** <*vrf-name*> in global configuration mode as shown in Table 339.

TABLE 339 ROUTER OSPF –VRF COMMAND

Command Format	Command Mode	Command Function
router ospf <process-id> **vrf** <vrf-name>	global config	This enables OSPF VPN process

Result: This enables OSPF VPN process.

For this process, use the **network** command to define an interface connected to CE, and execute route redistribution from BGP to RIP. For example:

```
ZXR10(config)#router ospf 1
ZXR10(config-router)#network   10.0.0.0   0.255.255.255
area 0.0.0.0
ZXR10(config)#router ospf 2 vrf test1
ZXR10(config-router)#network  10.10.10.1  0.0.0.0  area
0.0.0.0
ZXR10(config-router)#redistribute bgp_int
```

For the BGP, it is only necessary to designate a CE peer in the address-family ipv4 vrf address of the BGP.

TABLE 340 ADDRESS FAMILY COMMAND

Command Format	Command Mode	Command Function
address-family ipv4 vrf <*vrf-name*>	Route	This enters BGP address mode

Result: This enters BGP address mode.

EBGP runs between PE and CE that belong to different ASs. In the current version, it is recommended that a directly-connected address be used as the link setup address, for example:

```
ZXR10(config)#router bgp 100
ZXR10(config-router)#neighbor 10.10.3.3 remote-as 100
ZXR10(config-router)#neighbor    10.10.3.3    update-source
loopback1
ZXR10(config-router)#address-family ipv4 vrf test1
ZXR10(config-router-af)#redistribute connected
ZXR10(config-router-af)#neighbor 10.1.1.2 remote-as 200
ZXR10(config-router-af)#exit-address-family
ZXR10(config-router)#address-family vpnv4
ZXR10(config-router-af)#neighbor 10.10.3.3 activate
ZXR10(config-router-af)#exit-address-family
```

5. To configure MPBGP, following steps are required:

After learning a VRF route from CE, the PE should advertise the route to other PEs. In this case, MPBGP should be configured in the following three steps:

i. In BGP route configuration mode, use the **neighbor** command to designate a PE peer.

ii. Enter the **address-familary vpnv4** address mode of the BGP and activate the peer.

Command Format	Command Mode	Command Function
address-family vpnv4	Route	This enables to enter into BGP address mode
neighbor *<ip-address>* activate	Address	This activates PE peer

Result: This enables to enter into BGP address mode.

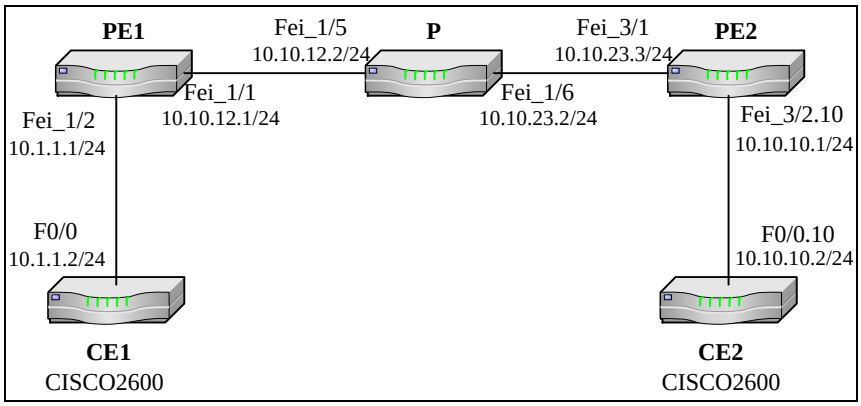
Result: This activates PE peer.

END OF STEPS

MPLS VPN Configuration Example

An MPLS VPN configuration example is given in Figure 107.

FIGURE 107 MPLS-VPN EXAMPLE



As shown in Figure 107, CE1 and CE2 belong to the same VPN. The loopback address of CE1 is 100.1.1.1/24, and that of CE2 is 200.1.1.1/24. Proper VPN configuration should be made so that CE1 and CE2 can learn the loopback routes from each other. The BGP runs between CE1 and PE1, while the OSPF protocol runs between CE2 and PE2.

Configuration of CE1:

```
CE1(config)#interface Loopback1
CE1(config-if)#ip address 100.1.1.1 255.255.255.0
CE1(config)#interface FastEthernet0/0
CE1(config-if)#ip address 10.1.1.2 255.255.255.0
CE1(config)#router bgp 200
CE1(config-router)#network 100.1.1.0 mask 255.255.255.0
```

```
CE1(config-router)#neighbor 10.1.1.1 remote-as 100
CE1(config-router)#no auto-summary
```

Configuration of PE1:

```
PE1(config)#ip vrf test1
PE1(config-vrf)#rd 100:1
PE1(config-vrf)#route-target import 100:1
PE1(config-vrf)#route-target export 100:1
PE1(config)#interface loopback1
PE1(config-if)#ip address 10.10.1.1 255.255.255.255
PE1(config)#interface fei_1/1
PE1(config-if)#ip address 10.10.12.1 255.255.255.0
PE1(config-if)#mpls ip
PE1(config-if)#mpls ldp discovery transport-address
interface
PE1(config)#interface fei_1/2
PE1(config-if)#ip vrf forwarding test1
PE1(config-if)#ip address 10.1.1.1 255.255.255.0
PE1(config)#router ospf 1
PE1(config-router)#router-id 10.10.1.1
PE1(config-router)#network 10.0.0.0 0.255.255.255 area
0.0.0.0
PE1(config)#router bgp 100
PE1(config-router)#neighbor 10.10.3.3 remote-as 100
PE1(config-router)#neighbor 10.10.3.3 update-source
loopback1
PE1(config-router)#address-family ipv4 vrf test1
PE1(config-router-af)#redistribute connected
PE1(config-router-af)#neighbor 10.1.1.2 remote-as 200
PE1(config-router-af)#exit-address-family
PE1(config-router)#address-family vpnv4
PE1(config-router-af)#neighbor 10.10.3.3 activate
PE1(config-router-af)#exit-address-family
PE1(config)#mpls ip
PE1(config)#mpls ldp router-id loopback1 force
```

An EBGP connection is set up between CE1 and PE1:

```
CE1#show ip bgp summary
BGP router identifier 10.1.1.2, local AS number 200
BGP table version is 8, main routing table version 8
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down
State/PfxRcd
10.1.1.1 4 100 156 157 8 0 0
```

```
   01:16:48        3
CE1#
```

The routing table of CE1 is as follows. Where, two BGP routes are VPN routes learned from CE1:

```
CE1#show ip route
Gateway of last resort is not set
     100.0.0.0/24 is subnetted, 1 subnets
C       100.1.1.0 is directly connected, Loopback1
B    200.1.1.0/24 [20/0] via 10.1.1.1, 00:01:17
     10.0.0.0/24 is subnetted, 2 subnets
B       10.10.10.0 [20/0] via 10.1.1.1, 00:02:02
C       10.1.1.0 is directly connected, FastEthernet0/0
CE1#
```

Configuration of P:

```
P(config)#interface fei_1/5
P(config-if)#ip address 10.10.12.2 255.255.255.0
P(config-if)#mpls ip
P(config-if)#mpls    ldp    discovery    transport-address
interface
P(config)#interface fei_1/6
P(config-if)#ip address  10.10.23.2 255.255.255.0
P(config-if)#mpls ip
P(config-if)#mpls    ldp    discovery    transport-address
interface
P(config)#interface loopback1
P(config-if)#ip address 10.10.2.2 255.255.255.255
P(config)#router ospf 1
P(config-router)#network   10.0.0.0   0.255.255.255   area
0.0.0.0
P(config)#mpls ip
P(config)#mpls ldp router-id loopback1 force
```

Configuration of PE2: Here, an Ethernet sub-interface is used for connection with CE2:

```
PE2(config)#ip vrf test1
PE2(config-vrf)#rd 100:1
PE2(config-vrf)#route-target import 100:1
PE2(config-vrf)#route-target export 100:1
PE2(config)#interface loopback1
PE2(config-if)#ip address 10.10.3.3 255.255.255.255
PE2(config)#interface fei_3/1
PE2(config-if)#ip address 10.10.23.3 255.255.255.0
```

```
PE2(config-if)#mpls ip
PE2(config-if)#mpls    ldp    discovery    transport-address
interface
PE2(config)#interface fei_3/2.10
PE2(config-if)#ip vrf forwarding test1
PE2(config-if)#encapsulation dot1q 10
PE2(config-if)#ip address 10.10.10.1 255.255.255.0
PE2(config)#router ospf 1
PE2(config-router)#network   10.0.0.0   0.255.255.255   area
0.0.0.0
PE2(config)#router ospf 2 vrf test1
PE2(config-router)#network 10.10.10.1 0.0.0.0 area 0.0.0.0
PE2(config-router)#redistribute bgp_int
PE2(config)#router bgp 100
PE2(config-router)#neighbor 10.10.1.1 remote-as 100
PE2(config-router)#neighbor     10.10.1.1     update-source
loopback1
PE2(config-router)#address-family ipv4 vrf test1
PE2(config-router-af)#redistribute ospf_int metric 10
PE2(config-router-af)#redistribute connected
PE2(config-router-af)#exit-address-family
PE2(config-router)#address-family vpnv4
PE2(config-router-af)#neighbor 10.10.1.1 activate
PE2(config-router-af)#exit-address-family
PE2(config)#mpls ip
PE2(config-if)#mpls ldp router-id loopback1 force
```

Configuration of CE2:

```
CE2(config)#interface Loopback1
CE2(config-if)#ip address 200.1.1.1 255.255.255.0
CE2(config-if)#ip ospf network point-to-point
CE2(config)#interface FastEthernet0/0.10
CE2(config-if)#encapsulation dot1Q 10
CE2(config-if)#ip address 10.10.10.2 255.255.255.0
CE2(config)#router ospf 1
CE2(config-router)#log-adjacency-changes
CE2(config-router)#network 10.10.10.2 0.0.0.0 area 0
CE2(config-router)#network 200.1.1.1 0.0.0.0 area 0
```

Routing table of CE2: Where, two OSPF routes are VPN routes learned from CE2:

```
CE2#sh ip route
Gateway of last resort is not set
     100.0.0.0/24 is subnetted, 1 subnets
O  E2       100.1.1.0  [110/1]  via  10.10.10.1,  00:07:21,
FastEthernet0/0.10
C    200.1.1.0/24 is directly connected, Loopback1
     10.0.0.0/24 is subnetted, 2 subnets
O  E2       10.1.1.0  [110/1]  via  10.10.10.1,  00:07:21,
FastEthernet0/0.10
C                  10.10.10.0   is   directly   connected,
FastEthernet0/0.10
CE2#
```

MPLS VPN Maintenance and Diagnosis

Purpose Refer to below procedure for MPLS-VPN maintenance and diagnosis on ZTE ZXR10 GER router.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To check network connectivity, use **ping vrf** <*vrf-name*> <*ip-address*> command in privileged mode, as shown in Table 341.

TABLE 341 PING VRF COMMAND

Command Format	Command Mode	Command Function
ping vrf <vrf-name> <ip-address>	Privileged	This checks the VPN network connectivity

Result: This checks the VPN network connectivity.

In the following example, to **ping** the address of CE1. VRF must be designated:

```
PE1#ping vrf test1 10.1.1.2
sending 5,100-byte ICMP echos to 10.1.1.2,timeout is 2
seconds.
!!!!!
Success    rate    is    100    percent(5/5),round-trip
min/avg/max= 0/4/20 ms.
PE1#
```

2. To display some configuration information about VRF, use **show ip vrf** command in privileged mode as shown in Table 342.

TABLE 342 SHOW IP VRF COMMAND

Command Format	Command Mode	Command Function
show ip vrf	Privileged	This displays some configuration information about VRF

Result: This displays some configuration information about VRF.

View the VRF information on PE1:

```
PE1#show ip vrf
* Being deleted
    Name              Default RD            Interfaces
    test1               100:1                 fei_1/2
PE1#
```

3. To display the status of and information about the VRF interface, use **show ip vrf interfaces** command in privileged mode as shown in Table 343.

TABLE 343 SHOW IP VRF INTERFACES COMMAND

Command Format	Command Mode	Command Function
show ip vrf interfaces	User, Privileged	This displays the status/information about the VRF interface

Result: This displays the status/information about the VRF interface.

View the status of and information about the VRF interface on PE1:

```
PE1#show ip vrf interfaces
interface                     IP-Address           VRF
Protocol
fei_1/2              10.1.1.1        test1           up
PE1#
```

4. To check the VRF routing table to see whether there is any correct route on PE, use **show ip route vrf** *<vrf-name>* command in privileged mode as shown in Table 344.

TABLE 344 SHOW IP ROUTE VRF COMMAND

Command Format	Command Mode	Command Function
show ip route vrf *<vrf-name>*	Privileged	This displays VRF routing table

Result: This displays VRF routing table.

Check the VRF routing table on PE1:

```
PE1#show ip route vrf test1
IPv4 Routing Table:
  Dest              Mask            Gw        Interface
Owner  pri  metric
10.1.1.0      255.255.255.0      10.1.1.1         fei_1/2
direct   0   0
10.1.1.1       255.255.255.255    10.1.1.1         fei_1/2
address  0   0
100.1.1.1      255.255.255.255    10.1.1.1         fei_1/2
bgp   20     0
10.10.10.0   255.255.255.0   10.10.3.3      fei_1/1   bgp
200 4294967295
200.1.1.1   255.255.255.255   10.10.3.3     fei_1/1   bgp
200 4294967295
PE1#
```

The VRF routing table contains directly connected network sections, routes advertised by CE1 and routes advertised by PE2.

Whether the peer can enter VRF depends upon whether the import/export target route attribute (route-target import/export) of both parties match each other.

5. To check whether the internal layer labels of VPN on PEs are correct and consistent; use **show ip protocol routing vrf** *<vrf-name>* command in privileged mode as shown in Table 345.

TABLE 345 SHOW IP PROTOCOL ROUTING VRF COMMAND

Command Format	Command Mode	Command Function
show ip protocol routing vrf *<vrf-name>*	Privileged	This checks internal layer labels of VPN

Result: This checks internal layer labels of VPN.

Check the internal layer label that PE1 assigns to VPN routes:

```
PE1#show ip protocol routing vrf test1

Routes of vpn:
status codes: *valid, >best
     Dest              NextHop            Intag    Outtag
RtPrf  Protocol
*>    10.1.1.0/24     10.1.1.0           153       notag
0   connected
*>    10.1.1.1/32     10.1.1.1           152       notag
0   connected
*>     10.10.10.0/24   10.10.3.3            22        17
200 bgp_int
*>    100.1.1.0/24    10.1.1.2           20        notag
20  bgp_ext
*>     200.1.1.0/24    10.10.3.3            21         27
200 bgp_int
PE1#
```

ZTE ZXR10 GER router provides debug commands for tracing routes advertised by MPBGP. When using the debugging commands, the reset command can be used to reset BGP sessions.

Command Format	Command Mode	Command Function
debug ip bgp updates	Privileged	This traces and displays update packets transmitted/received by a BGP connection and also displays route processing in packets.
reset ip bgp [neighbor <*addr*>]	Privileged	Resets BGP session by software. The commands has the function of “enable” for a neighbor already in non-BGP session stop status

Trace and display updates packets transmitted/received by a BGP connection and also displays route processing in packets:

```
ZXR10#debug ip bgp updates
ZXR10(config)#reset ip bgp neighbor 10.10.3.3
ZXR10(config)#
1d4h: BGP: 100.1.1.1/32 deleted from BGP routable
1d4h: BGP: 100.1.1.1/32 deleted from IP routable
1d4h: BGP: 10.10.1.1/32 deleted from BGP routable
1d4h: BGP: 10.10.1.1/32 deleted from IP routable
ZXR10(config)#
1d4h: BGP:  10.10.3.3 send UPDATE w/ attr: origin i as-
```

```
path metric 0 localpref 254 route target 100:1 mp nlri
afi:1 safi:128 next-hop:10.10.1.1 nlri 0131 100:1
10.1.1.0/24
1d4h: BGP: 10.10.3.3 rcv UPDATE w/ attr: origin i as-
path metric 0 localpref 144 route target 100:1 mp nlri
afi:1 safi:128 next-hop:10.10.3.3 nlri 0181 100:1
100.1.1.1/32 nlri 0171 100:1 10.10.1.1/32
ZXR10(config)#
```

Chapter 21

VPWS Configuration

Overview

Introduction This chapter describes the VPWS protocol and its related configuration on the ZXR10 GER.

Contents This chapter covers the following topics:

TABLE 346 TOPICS IN CHAPTER 21

VPWS

Introduction Virtual Private Wire Services (VPWS) or Pseudo Wire Emulation Edge to Edge (PWE3) provide point-to-point connectivity between customer sites, where the service provider network emulates a set of wires between the customer's sites over the underlying MPLS tunnel.

This is particularly useful in the case where a customer is currently using a set of ATM or Frame Relay connections between their different sites, as the VPWS can emulate the existing links. Customer can keep the same layer 2 connections to the service provider, but instead of data being carried natively over an ATM or Frame Relay service, the traffic is encapsulated and routed over the provider's MPLS backbone.

IP/MPLS Cloud VPWS makes the convergence of Layer 2 and Layer 3 services possible over an IP/MPLS cloud. VPWS lets service providers deploy point-to-point circuits with Ethernet as an attachment circuit, allowing high-speed LAN connectivity. Mostly two

pseudowire technologies are available in all major vendor products:

- AToM for MPLS networks
- L2TPv3 for native IP networks

Both AToM and L2TPv3 support the transport of Frame Relay, ATM, HDLC, and Ethernet traffic over an IP or MPLS core.

IP Network

VPWS is generating interest among service providers that wish to migrate existing Layer 2 networks to their packet MPLS or IP network (Figure 4), or for service providers that wish to use the packet infrastructure to extend Layer 2 service offerings in new markets. VPWS provides a common framework to encapsulate and transport supported Layer 2 traffic types over an MPLS network core. Service providers can use a single MPLS network infrastructure to offer connectivity for supported Layer 2 traffic and for IP traffic in Layer 3 VPNs.

Configuring VPWS

Background

VPWS (Virtual Private Wire Service) technology was the first to be introduced to deal with transport of Layer 2 Ethernet traffic over an IP/MPLS backbone.

Purpose

This below procedure describes how to do VPWS configuration on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

For the configuration of VPWS, perform the following steps:

1. To configure LDP neighbor, use the following command, as shown in Table 347.

TABLE 347 MPLS LDP COMMAND

Command Format	Command Mode	Command Function
mpls ldp target-session neighbor-id	Global	This configures LDP neighbor

Result: This configures LDP neighbor.

2. To enable the VPWS in interface, use the following command, as shown in Table 348.

TABLE 348 MPLS XCONNECT COMMAND

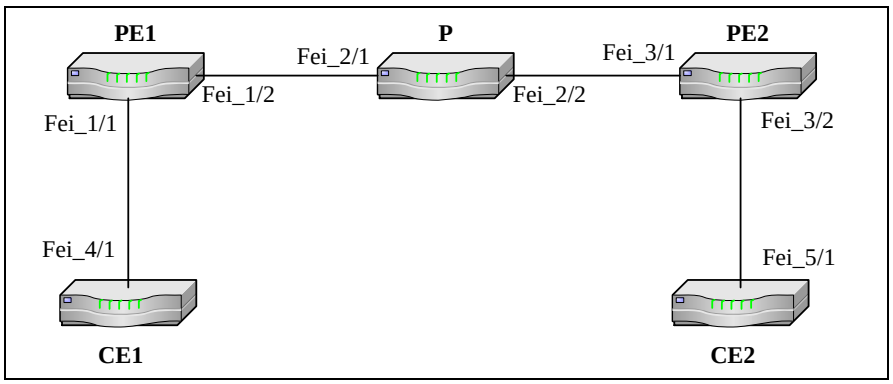
Command Format	Command Mode	Command Function
mpls xconnect neighbor-id vcid	interface	This enables the VPWS

Result: This enables the VPWS.

END OF STEPS

Example: As shown in Figure 108, configuration of interface address and loopback interface is in PE1、P、PE2. Run IGP protocol such as OSPF protocol between PE1、P and PE2. Configuration of MPLS is in PE1、P、PE2 and configuration of router id is configured for mpls ldp. Configuration is done for target session in PE1、PE2，make PE1 and PE2 to became the neigbhour to each other. Configure the mpls xconnect command in the interface which is connected to the CE in PE1 and PE2.

FIGURE 108 VPWS SERVICE



PE1 configuration:

```
PE1(config)#interface loopback10
PE1(config-if)#ip address 1.1.1.1 255.255.255.255
PE1(config)# interface fei_1/1
PE1(config-if)#mpls xconnect 1.1.1.3 100
PE1(config)#interface fei_1/2
PE1(config-if)#ip address 175.1.1.1 255.255.255.0
PE1(config-if)#mpls ip
PE1(config)#mpls ip
PE1(config)#mpls ldp router-id loopback10 force
PE1(config)#mpls ldp target-session 1.1.1.3
PE1(config)#router ospf 1
```

```
PE1(config-router)#network 1.1.1.1 0.0.0.0 area 0.0.0.0
PE1(config-router)#network    175.1.1.0    0.0.0.255    area
0.0.0.0
```

P configuration:

```
P(config)#interface loopback10
P(config-if)#ip address 1.1.1.2 255.255.255.255
P(config)#interface fei_2/1
P(config-if)#ip address 175.1.1.2 255.255.255.0
P(config-if)#mpls ip
P(config)#interface fei_2/2
P(config-if)#ip address  148.1.1.2 255.255.255.0
P(config-if)#mpls ip
P(config)#mpls ip
P(config)#mpls ldp router-id loopback10 force
P(config)#router ospf 1
P(config-router)#network 1.1.1.2 0.0.0.0 area 0.0.0.0
P(config-router)#network 148.1.1.0 0.0.0.255 area 0.0.0.0
P(config-router)#network 175.1.1.0 0.0.0.255 area 0.0.0.0
```

PE2 configuration:

```
PE2(config)#interface loopback10
PE2(config-if)#ip address 1.1.1.3 255.255.255.255
PE2(config)#interface fei_3/1
PE2(config-if)#ip address 148.1.1.3 255.255.255.0
PE2(config-if)#mpls ip
PE2(config)#interface fei_3/2
PE2(config-if)#mpls xconnect 1.1.1.1 100
PE2(config)#mpls ip
PE2(config)#mpls ldp router-id loopback10 force
PE2(config)#mpls ldp target-session 1.1.1.1
PE2(config)#router ospf 1
PE2(config-router)#network 1.1.1.3 0.0.0.0 area 0.0.0.0
PE2(config-router)#network    148.1.1.0    0.0.0.255    area
0.0.0.0
```

VPWS Maintenance and Diagnosis

Purpose This procedure describes how to do VPWS configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To check VC is established, use **show mpls l2transport vc** command in privilged mode, as shown in Table 349.

TABLE 349 SHOW MPLS L2 TRANSPORT COMMAND

Command Format	Command Mode	Command Function
show mpls l2transport vc	Privilged	This enables to check VC is established

Result: This enables to check VC is established.

2. To check VC binding information, use **show mpls l2transport binding** command in privilged mode, as shown in Table 350.

TABLE 350 SHOW MPLS L2 TRANSPORT BINDING COMMAND

Command Format	Command Mode	Command Function
show mpls l2transport vc	Privilged	This enables to check VC binding information

Result: This enables to check VC binding information.

3. To monitor VPWS message sending and receiving, use debug **mpls ldp l2vpn event** command in privilged mode, as shown in Table 351.

TABLE 351 DEBUG MPLS LDP L2VPN EVENT COMMAND

Command Format	Command Mode	Command Function
debug mpls ldp l2vpn event	Privilged	This enables to monitor VPWS message sending and receiving

Result: This enables to monitor VPWS message sending and receiving.

4. To monitor the state machine of the VPWS, use **debug mpls ldp l2vpn fsm** command in privilged mode, as shown in Table 352.

TABLE 352 DEBUG L2VPN FSM COMMAND

Command Format	Command Mode	Command Function
debug mpls ldp l2vpn fsm	Privilged	This enables to monitor the state machine of the VPWS

Result: This enables to monitor the state machine of the VPWS.

5. To view the debug information, use **debug mpls ldp l2vpn** command in privilged mode, as shown in Table 353.

TABLE 353 DEBUG MPLS L2VPN COMMAND

Command Format	Command Mode	Command Function
debug mpls ldp l2vpn	Privilged	This enables to view the debug information

Result: This enables to view the debug information.

END OF STEPS

Chapter 22

VPLS Configuration

Overview

Introduction This chapter describes VPLS. Both VPLS and VPWS are technologies for implementing MPLS VPN on Layer 2 of the network.

Contents This chapter covers the following topics:

TABLE 354 TOPICS IN CHAPTER 22

VPLS

Introduction VPLS builds on the VPWS point-to-point pseudowire model, adding packet replication and the ability to learn source-based MAC addresses for multipoint Layer 2 capabilities. It is an attractive option for service providers because it uses a Layer 2 architecture to offer multipoint Ethernet VPNs that connect multiple sites within a MAN or over a WAN.

Using VPLS, service providers can create a Layer 2 "virtual switch" over an MPLS core. Enterprises with large, distributed ERP applications and VoIP can benefit from these multipoint services.

Benefits Users benefit from performance and connectivity that are on par with a direct connection to a switch. This architecture for providing geographically dispersed Ethernet Multipoint Service (EMS) adheres to Metropolitan Ethernet Forum standards. Each customer edge device or node communicates directly with all other customer edge nodes in the EMS.

This is a significant improvement over hub-and-spoke architectures used by Frame Relay and other technologies. Hub-and-spoke architectures require the end user to designate one customer edge node as the "hub" that is connected to all "spoke" sites. All communication between sites first must go through the spoke site, leading to potential bottlenecks and other performance problems.

With VPLS, each customer edge device only requires a single connection to the provider edge, and the provider edge provides full multipoint connectivity. A VPLS consists of a collection of customer sites connected to provider edge devices that are implementing the emulated LAN service.

Virtual Switching Instance (VSI)

A virtual switching instance (VSI) is used at each VPLS provider edge router to implement the forwarding decisions of each VPLS. The provider edge devices make the forwarding decisions between sites and encapsulate the Ethernet frames across a packet-switched network using an Ethernet pseudowire. Provider edge routers use a full mesh of pseudo-wires to forward the Ethernet frames between provider edge nodes.

In a VPLS, each device can communicate directly with its peers, which is efficient for applications that must be propagated quickly throughout the network, such as broadcast and distributed ERP. Scalability and manageability are limited, however-the amount of overhead increases exponentially because packets sent to all devices in a broadcast, for example, must be replicated for the number of devices receiving them. Depending on the type of VPLS application, MAC address learning and broadcast packet replication can become problematic.

VPLS Service Configuration

Background

The latest breakthrough in MPLS development is called Virtual Private LAN Service (VPLS), paying due respect to Ethernet technology.

Main idea is using IP/MPLS routing protocols instead of conventional Spanning Tree algorithm and its known shortcomings, and the use of MPLS labels to replace now “traditional” VLAN Ids. Ethernet frames are switched on basis of their Layer 2 (MAC) address. The major advantage here is the possibility of a point-to-multipoint interconnection, just as in the case of a local network (Bridged or Switched LAN).

In the MPLS/IP core transport network, VPLS support Ethernet transmission service in layer2.

Purpose

This procedure describes how to do VPLS configuration on ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. To create VFI, use command **vfi**<vfi-name> in global configuration mode. This is shown in Table 355.

TABLE 355 VFI COMMAND

Command Format	Command Mode	Command Function
vfi<vfi-name>	global config	This creates VFI

Result: This creates VFI.

2. To enable MPLS, use command **mpls ip** in global configuration mode. This is shown in Table 356.

TABLE 356 MPLS ID COMMAND

Command Format	Command Mode	Command Function
mpls ip	global config	This enables MPLS

Result: This enables MPLS.

3. To create VCID, use command **vcid** <vcid-number> in VFI configuration mode. This is shown in Table 357.

TABLE 357 VCID COMMAND

Command Format	Command Mode	Command Function
vcid <vcid-number>	VFI	This creates VCID

Result: This creates VCID.

4. To configure PWTYPE, use command **pwtype** <ethernet|ethernet-vlan> in VFI configuration mode. This is shown in Table 358.

TABLE 358 PWTYPE COMMAND

Command Format	Command Mode	Command Function
pwtype <ethernet|ethernet-vlan>	VFI	This configures PWTYPE

Result: This configures PWTYPE.

5. To create peer, use command **peer** {<peer-router-id> <-1024>|**spoke** <1-1024}> in VFI configuration mode. This is shown in Table 359.

TABLE 359 PEER COMMAND

Command Format	Command Mode	Command Function
peer {<peer-router-id> <-1024>|**spoke** <1-1024}>	VFI	This creates peer

Result: This creates Peer.

6. To set the max number of MAC address, use command **maxmac** in VFI configuration mode. This is shown in Table 360.

TABLE 360 MAXMAX COMMAND

Command Format	Command Mode	Command Function
maxmac	VFI	This sets the max number of MAC address

Result: This sets the max number of MAC address.

7. To configure ldp neighbor, use command **mpls ldp target-session** <ip-address> in global configuration mode. This is shown in Table 361.

TABLE 361 MPLS LDP TARGET COMMAND

Command Format	Command Mode	Command Function
mpls ldp target-session <ip-address>	global config	This configures ldp neighbor

Result: This configures ldp neighbor.

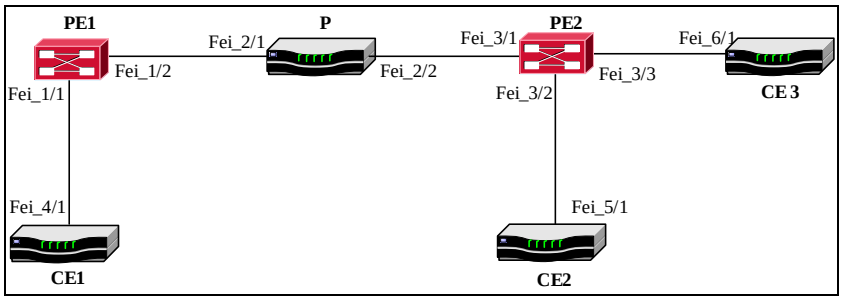
END OF STEPS

Example:

Create VFI，and configure the parameters such as vcid 、pwtype and peer. Configure the loopback at PE1、P and PE2. Run the IGP protocol such as OSPF protocol between PE1、P and PE2. Enable mpls in the global configuration mode, this also needs to enable on interface such as fei_1/2 at PE1, fei_2/1 and fei_2/2 at P, fei_3/1 at PE2.

Configure target-session in PE1 and PE2，make PE1 and PE2 became neighbor. Enable the vpls service in the interface fei_1/1 at PE1, fei_3/2 and fei_3/3 at PE2. This is shown in Figure 109.

FIGURE 109 VPLS SERVICE



PE1 configuration:

```
PE1(config)#vfi vpls_a
PE1(config-vfi)#vcid 100
PE1(config-vfi)#pwtype Ethernet
ZXUAS(config-vfi)#mac-timeout 180
PE1(config-vfi)#peer 1.1.1.3
PE1(config-vfi)#maxmac 1000
PE1(config-vfi)#exit
PE1(config)#bras
ZXUAS(config-bras)#vfi account-group 100   /*configure VFI
account*/
PE1(config)#interface loopback10
PE1(config-if)#ip address  1.1.1.1 255.255.255.255
PE1(config)#interface fei_1/1
PE1(config-if)#xconnect vfi vpls_a
PE1(config-if)#mac-limit 100     /* set the max munber of
MAC address */
PE1(config)#interface fei_1/2
PE1(config-if)#ip address  175.1.1.1 255.255.255.0
PE1(config-if)#mpls ip
PE1(config-if)#client-interface      /* Set the interface
worked at client mode in hub-spoke network */
PE1(config)#mpls ip
PE1(config)#mpls ldp router-id loopback10 force
PE1(config)#mpls ldp target-session 1.1.1.3
PE1(config)#router ospf 1
PE1(config-router)#network 1.1.1.1 0.0.0.0 area 0.0.0.0
PE1(config-router)#network   175.1.1.0   0.0.0.255   area
0.0.0.0
```

P configuration:

```
P(config)#interface loopback10
P(config-if)#ip address  1.1.1.2 255.255.255.255
```

```
P(config)#interface fei_2/1
P(config-if)#ip address  175.1.1.2 255.255.255.0
P(config-if)#mpls ip
P(config)#interface fei_2/2
P(config-if)#ip address  148.1.1.2 255.255.255.0
P(config-if)#mpls ip
P(config)#mpls ip
P(config)#mpls ldp router-id loopback10 force
P(config)#router ospf 1
P(config-router)#network 1.1.1.2 0.0.0.0 area 0.0.0.0
P(config-router)#network 148.1.1.0 0.0.0.255 area 0.0.0.0
P(config-router)#network 175.1.1.0 0.0.0.255 area 0.0.0.0
```

PE2 configuration:

```
PE2(config)#vfi vpls_a
PE2(config-vfi)#vcid 100
PE2(config-vfi)#pwtype ethernet
ZXUAS(config-vfi)#mac-timeout 180
PE1(config-vfi)#peer 1.1.1.1
PE1(config-vfi)#maxmac 1000
PE1(config-vfi)#exit
PE1(config)#bras
ZXUAS(config-bras)#vfi account-group 100
PE2(config)#interface loopback10
PE2(config-if)#ip address  1.1.1.3 255.255.255.255
PE2(config)#interface fei_3/1
PE2(config-if)#ip address  148.1.1.3 255.255.255.0
PE2(config-if)#mpls ip
PE2(config)#interface fei_3/2
PE2(config-if)#xconnect vfi vpls_a
PE2(config)#interface fei_3/3
PE2(config-if)#xconnect vfi vpls_a
PE2(config)#mpls ip
PE2(config)#mpls ldp router-id loopback10 force
PE2(config)#mpls ldp target-session 1.1.1.1
PE2(config)#router ospf 1
PE2(config-router)#network 1.1.1.3 0.0.0.0 area 0.0.0.0
PE2(config-router)#network    148.1.1.0    0.0.0.255    area
0.0.0.0
```

VPLS Diagnosis and Maintenance

Purpose This procedure describes how to diagnose and maintain the VPLS configuration on ZTE ZXR10 GER.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To show the relevant configuration of VPLS, use show **vfi** command in privilged mode, as shown in Table 362.

TABLE 362 SHOW VFI COMMAND

Command Format	Command Mode	Command Function
show mpls l2transport vc	Privilged	This shows the relevant configuration of VPLS

Result: This shows the relevant configuration of VPLS.

2. To show the successfully established PW, use **show mpls l2transport vc vpls** command in privilged mode, as shown in Table 363**.**

TABLE 363 SHOW MPLS L2TRANSPORT VC VPLS COMMAND

Command Format	Command Mode	Command Function
show mpls l2transport vc vpls	Privilged	This show the successfully established PW

Result: This show the successfully established PW.

3. To view the MAC forwarding table of VPLS instances, use **show mac-table vfi** command in privilged mode, as shown in Table 364.

TABLE 364 SHOW MAC TABLE VFI COMMAND

Command Format	Command Mode	Command Function
show mac-table vfi	Privilged	This shows the MAC forwarding table of VPLS instances

Result: This shows the MAC forwarding table of VPLS instances.

4. Open the VPLS debug information. Following command is used. **debug mpls ldp l2vpn.**

END OF STEPS

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Chapter 23

Traffic Engineering Configuration

Overview

Introduction This chapter gives the basic concepts of layer-3 MPLS TE and the relevant configuration on the ZXR10 GER router.

Contents This chapter covers the following topics.

TABLE 365 TOPICS IN CHAPTER 23

Overview

Definition Multiprotocol Label Switching (MPLS) traffic engineering software enables an MPLS backbone to replicate and expand upon the traffic engineering capabilities of Layer 2 ATM and Frame Relay networks.

Traffic Engineering Traffic engineering is essential for service provider and Internet service provider (ISP) backbones. Such backbones must support a high use of transmission capacity, and the networks must be very resilient, so that they can withstand link or node failures.

MPLS Traffic Engineering MPLS traffic engineering provides an integrated approach to traffic engineering. With MPLS, traffic engineering capabilities are integrated into Layer 3, which optimizes the routing of IP

traffic, given the constraints imposed by backbone capacity and topology.

MPLS traffic engineering:

- Enhances standard IGPs, such as IS-IS or OSPF, to automatically map packets onto the appropriate traffic flows.
- Transports traffic flows across a network using MPLS forwarding.
- Determines the routes for traffic flows across a network based on the resources the traffic flow requires and the resources available in the network.
- Employs "constraint-based routing," in which the path for a traffic flow is the shortest path that meets the resource requirements (constraints) of the traffic flow. In MPLS traffic engineering, the traffic flow has bandwidth requirements, media requirements, a priority versus other flows, and so on.
- Recovers to link or node failures that change the topology of the backbone by adapting to a new set of constraints.

The IETF has the following RFCs related to the MPLS TE:

- RFC3209: RSVP-TE: Extensions to RSVP for LSP Tunnels
- RFC3630: Traffic Engineering (TE) Extensions to OSPF Version 2

MPLS Engineering Working

One-Tier Network

MPLS is an integration of Layer 2 and Layer 3 technologies. By making traditional Layer 2 features available to Layer 3, MPLS enables traffic engineering. Thus, you can offer in a one-tier network what now can be achieved only by overlaying a Layer 3 network on a Layer 2 network.

RSVP

MPLS traffic engineering automatically establishes and maintains the tunnel across the backbone, using RSVP. The path used by a given tunnel at any point in time is determined based on the tunnel resource requirements and network resources, such as bandwidth.

Available resources are flooded via extensions to a link-state based Interior Protocol Gateway (IPG).

Tunnel Paths

Tunnel paths are calculated at the tunnel head based on a fit between required and available resources (constraint-based routing). The IGP automatically routes the traffic into these tunnels. Typically, a packet crossing the MPLS traffic engineering backbone travels on a single tunnel that connects the ingress point to the egress point.

MPLS traffic engineering is built on the following IOS mechanisms:

- Label-switched path (LSP) tunnels, which are signaled through RSVP, with traffic engineering extensions. LSP tunnels are represented as IOS tunnel interfaces, have a configured destination, and are unidirectional.
- A link-state IGP (such as IS-IS) with extensions for the global flooding of resource information, and extensions for the automatic routing of traffic onto LSP tunnels as appropriate.
- An MPLS traffic engineering path calculation module that determines paths to use for LSP tunnels.
- An MPLS traffic engineering link management module that does link admission and bookkeeping of the resource information to be flooded.
- Label switching forwarding, which provides routers with a Layer 2-like ability to direct traffic across multiple hops as directed by the resource-based routing algorithm.

Tunnels Mesh

One approach to engineer a backbone is to define a mesh of tunnels from every ingress device to every egress device. The IGP, operating at an ingress device, determines which traffic should go to which egress device, and steers that traffic into the tunnel from ingress to egress. The MPLS traffic engineering path calculation and signaling modules determine the path taken by the LSP tunnel, subject to resource availability and the dynamic state of the network. For each tunnel, counts of packets and bytes sent are kept.

Sometimes, a flow is so large that it cannot fit over a single link, so it cannot be carried by a single tunnel. In this case multiple tunnels between a given ingress and egress can be configured, and the flow is load shared among them.

MPLS Basic Configuration

Purpose

Below procedure gives information about MPLS basic configuration.

Prerequisite

Router CLI (Privileged Mode) has been accessed.

Steps

1. To configure device for enabling MPLS TE signaling use **mpls traffic-eng tunnels** in global configuration mode as shown in Table 366.

TABLE 366 MPLS TRAFFIC COMMAND

Command Format	Command Mode	Command Function
mpls traffic-eng tunnels	Global config	This enables MPLS TE

Result: This configures MPLS TE signaling.

2. To set interface for support RSVP signaling, use **mpls traffic-eng tunnels** in interface configuration mode as shown in Table 367.

TABLE 367 MPLS TRAFFIC INTERFACE COMMAND

Command Format	Command Mode	Command Function
mpls traffic-eng tunnels	Interface config	This enables MPLS TE on an interface

Result: This configures MPLS TE signaling on an interface.

Note: RSVP is supported on GER Ethernet and Pos interfaces.

3. To configure the maximum available bandwidth of traffic engineering and LSP of an interface, use **ip rsvp bandwidth** <max-bandwidth> [<flow-bandwidth>] in interface configuration mode as shown in Table 368.

TABLE 368 IP-RSVP COMMAND

Command Format	Command Mode	Command Function
ip rsvp bandwidth <max-bandwidth> [<flow-bandwidth>]	Interface config	This sets the parameter for maximum available bandwidth

Result: This configures the available bandwidth for traffic engineering of an interface.

4. To configure the IGP to support TE, following commands are used:

   i. To define the Router of the TE, use **mpls traffic-eng router-id** <interface-name> command in OSPF configuration as shown in Table 369.

   ii. To configure TE-enabled areas, use **mpls traffic-eng area** <area-id> command in OSPF config mode as shown in Table 369.

   iii. To enable opaque feature of the OSPF, use command **capability opaque** in OSPF config mode as shown in Table 369.

TABLE 369 IGP TE CONFIG COMMAND

Command Format	Command Mode	Command Function
mpls traffic-eng router-id <interface-name>	OSPF config	This sets the router id for TE signaling
mpls traffic-eng area <area-id>	OSPF config	This sets an area for TE signaling
capability opaque	OSPF config	This sets the OSPF opaque feature

Result: This configures an IGP protocol to transmit TE.

5. To configure the tunnel interface for TE, use the following commands:

   i. To enter into tunnel interface mode, use **interface tunnel** <1-64> command in global configuration mode as shown in Table 370.

   ii. To set the tunnel mode into mpls, use **tunnel mode mpls traffic-eng** command in tunnel interface configuration mode as shown in Table 370.

   iii. To define the IP address of the tunnel destination router, use **tunnel destination** {ipv4 | ipv6} <ip-address> command in Table 370.

   iv. To set the bandwidth reserved for tunnel use **tunnel mpls traffic-eng bandwidth** <bandwidth> command in tunnel interface configuration mode as shown in Table 370.

   v. To configure ERO in order to obtain dynamic selection or static configuration of an explicit path, use **tunnel mpls traffic-eng path-option** <number> {dynamic | explicit {name <path-name> | identifier <id>}} in tunnel interface configuration mode as shown in Table 370.

   vi. To record the routes used by tunnel, use **tunnel mpls traffic-eng record-route** command in tunnel interface configuration mode as shown in Table 370.

TABLE 370 TUNNEL CONFIG COMMAND

Command Format	Command Mode	Command Function
interface tunnel<1-64>	Global config	This configures tunnel interface
tunnel mode mpls traffic	Tunnel interface config	This sets the tunnel for MPLS TE

Command Format	Command Mode	Command Function
tunnel destination {ipv4 | ipv6} <ip-address>	Tunnel interface config	This sets an ip address for the tunnel destination router
tunnel mpls traffic-eng bandwidth <bandwidth>	Tunnel interface config	This sets the parameter for maximum available bandwidth
tunnel mpls traffic-eng path-option <number> {dynamic | explicit {name <path-name> | identifier <id> }}	Tunnel interface config	This sets an ERO for MPLS TE
tunnel mpls traffic-eng record-route	Tunnel interface config	This record the routes used by tunnel
ip explicit-path{name <name> | identifier <identifier>}next-address < A.B.C.D> { loose | strict }	Global config	This configures an IP explicit path

Result: This configures the tunnel with all the necessary attributes.

END OF STEPS.

MPLS TE Maintenance & Diagnosis

Purpose This procedure describes how to diagnose and maintain MPLS configuration.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To check the network connectivity, use command **ping <**ip address**>** in Privileged mode as shown in Table 371.

TABLE 371 PING COMMAND

Command Format	Command Mode	Command Function
ping <ip addre**>**	Privileged	This verifies the network connectivity

Result: This verifies the network connectivity.

2. To view MPLS TE enabled nodes interfaces, use **show mpls** [<interface_id>] command in Privileged mode as shown in Table 372.

TABLE 372 SHOW MPLS TRAFFIC COMMAND

Command Format	Command Mode	Command Function
show mpls interface [<interface_id>]	Privileged	This display the MPLS TE enabled interfaces

Result: This display the MPLS TE enabled interfaces.

3. To view MPLS TE information at a node, use **show mpls traffic-eng tunnels summary** command in Privileged mode as shown in Table 373.

TABLE 373 SHOW MPLS TRAFFIC-ENG COMMAND

Command Format	Command Mode	Command Function
show mpls traffic-eng tunnels summary	Privileged	This display the MPLS TE tunnels information

Result: This shows the MPLS TE tunnels information.

4. To view MPLS TE information for a specific tunnel at a node, use **show mpls traffic-eng tunnels** <tunnel_id>command in Privileged mode as shown in Table 374.

TABLE 374 SHOW MPLS TUNNEL COMMAND

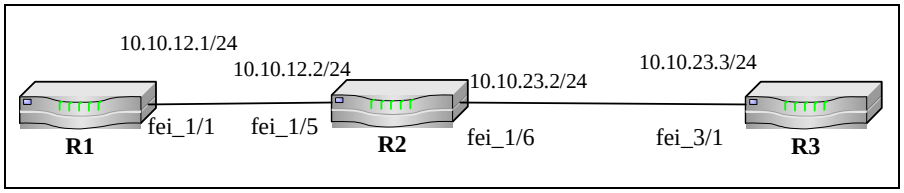
Command Format	Command Mode	Command Function
show mpls traffic-eng tunnels <tunnel_id>	Privileged	This display the MPLS TE specific tunnel information

Result: This shows the MPLS TE specific tunnel information.

END OF STEPS

MPLS TE Example

FIGURE 110 MPLS TE EXAMPLE



The three routers as shown in above figure assume the following tasks respectively:

Router	Loopback	Task	Tunnel
R1	100.1.1.1	End node	Tunnel1, destination address 100.1.1.3
R2	100.1.1.2	Middle node	
R3	100.1.1.3	End node	Tunnel3, destination address 100.1.1.1

R1 configuration:

```
R1(config)#interface fei_1/1
R1(config-if)#ip address 10.10.12.1 255.255.255.0
R1(config-if)#ip rsvp bandwidth 30000 10000
R1(config-if)#mpls traffic-eng tunnels
R1(config-if)#exit
R1(config)#interface loopback1
R1(config-if)#ip address 100.1.1.1
255.255.255.255
R1(config-if)#exit

R1(config)#mpls traffic-eng tunnels
R1(config)#
R1(config)#router ospf 1
R1(config-router)#mpls traffic-eng area 0
R1(config-router)#mpls traffic-eng router-id
loopback1
R1(config-router)#network 100.1.1.1 0.0.0.0 area
0
R1(config-router)#network 10.10.12.1 0.0.0.255
area 0
R1(config-router)#exit
R1(config)#
```

R2 configuration:

```
R2(config)#interface fei_1/5
R2(config-if)#ip address 10.10.12.2 255.255.255.0
R2(config-if)#mpls traffic-eng tunnels
R2(config-if)#ip rsvp bandwidth 30000 10000
R2(config-if)#exit
R2(config)#
R2(config)#interface fei_1/6
R2(config-if)#ip address 10.10.23.2 255.255.255.0
R2(config-if)#mpls traffic-eng tunnels
R2(config-if)#ip rsvp bandwidth 30000 10000
R2(config-if)#exit
R2(config)#
R2(config)#interface loopback1
```

```
R2(config-if)#ip address 100.1.1.2 255.255.255.255
R2(config-if)#exit
R2(config)#


R2(config)#mpls traffic-eng tunnels
R2(config)#router ospf 2
R2(config-router)#mpls traffic-eng router-id loopback1
R2(config-router)#mpls traffic-eng area 0
R2(config-router)#network 10.10.12.0 0.0.0.255 area 0
R2(config-router)#network 100.1.1.2 0.0.0.0 area 0
R2(config-router)#network 10.10.23.0 0.0.0.255 area 0
R2(config-router)#exit
R2(config)#
```

R3 configuration:

```
R3(config)#int fei_3/1
R3(config-if)#ip address 10.10.23.3 255.255.255.0
R3(config-if)#mpls traffic-eng tunnels
R3(config-if)#ip rsvp bandwidth 30000 10000
R3(config-if)#mpls traffic-eng tunnels
R3(config-if)#exit
R3(config)#
R3(config)#interface loopback1
R3(config-if)#ip address 100.1.1.3 255.255.255.255
R3(config-if)#exit
R3(config)#router ospf 3
R3(config-router)#mpls traffic-eng router-id loopback1
R3(config-router)#mpls traffic-eng area 0
R3(config-router)#network 100.1.1.3 0.0.0.0 area 0
R3(config-router)#network 10.10.23.0 0.0.0.255 area 0
R3(config-router)#exit
R3(config)#
```

Configure the explicit path Tunnel on R1:

```
R1(config)#interface tunnel21
R1(config-if)#tunnel mode mpls traffic-eng
R1(config-if)#ip address 1.1.21.1 255.255.255.0
R1(config-if)#tunnel destination ipv4 100.1.1.3
R1(config-if)#tunnel mpls traffic-eng path-option
1 explicit-path identifier 21
R1(config-if)#exit
R1(config)#
R1(config)#ip explicit-path identifier 21 next-
address 100.1.1.2 loose
R1(config)#ip explicit-path identifier 21 next-
address 100.1.1.3 loose
R1(config)#interface tunnel22
R1(config-if)#tunnel mode mpls traffic-eng
R1(config-if)#ip address 1.1.22.1 255.255.255.0
R1(config-if)#tunnel destination ipv4 100.1.1.3
R1(config-if)#tunnel mpls traffic-eng path-option
1 explicit-path identifier 22
R1(config-if)#exit
R1(config)#
R1(config)#ip explicit-path identifier 22 next-
address 10.10.12.2 strict
R1(config)#ip explicit-path identifier 22 next-
address 10.10.23.3 strict
```

Chapter 24

Multicast Routing Configuration

Overview

Introduction This chapter describes multicast routing and the relevant configuration on the ZXR10 GER router.

Contents This chapter covers the following topics.

TABLE 375 TOPICS IN CHAPTER 24

Overview

Multicast Address

In a multicast network, the sender sends a packet to multiple receivers in a multicast mode. In such a situation, the sender is called the multicast source. Multiple receivers for the same packet are identified by same ID. This is called the multicast group address. In the IP address allocation scheme, class D IP address, 224.0.0.0-239.255.255.255, is just the multicast address. The 224.0.0.0-224.0.0.255 and the 239.0.0.0-239.255.255.255 are used for the purpose of research and management.

IGMP

If a host expects to receive multicast packets sent to a specific group, it should intercept all the packets sent to the specific group. When a host begins to receive multicast packet as a local member of a certain group, the multicast router will sent queryig message periodically to check if there is any local member still in this multicast group.

If the router receives no Membership Reports in response, it assumes that the multicast group has no local members and does not forward any multicast packets addressed to this group.

Multicast Usage

The Internet group management protocol (IGMP) is used in multicasts to complete this task. In this way, multicast routers can know the members of multicast groups over networks and there out determine whether to forward multicast packets to their networks. When a multicast router receives a multicast packet, it checks the multicast destination address of the packet and will forward the packet only when its interface has members of that group.

IGMP provides information that is required when packets are forwarding to the destination (the last stage). Multicast routers and the hosts that receive multicast data exchange information mutually, is collected from the group members of the hosts that directly connect to multicast routers.

Multicast Group Members

IGMP is the protocol that is used by multicast routers to know about information about multicast group members. Generally, it employs two kinds of packets: group member enquiry packets and group member report packets.

A multicast router periodically sends query messages of group members to all hosts to know which specific group members exist in the connected networks. The mainframe returns a report

message of group members, reporting the multicast group which they belong to. When a host joins a new group, it will send a join message immediately rather than wait for an enquiry for cases where the host is the first member of that group.

When a host starts to receive messages as a member of a group, the multicast router will check whether members of the group take part in the process by periodically querying the group. The multicast router will continue to forward data as long as a host is still taking part in the process.

Leave Message

When the host leaves the group, the multicast router will receive a leave-message and then it will immediately query whether there are still active group members in the group. If yes, the multicast router will continue to forward data. If not, it will not forward data any longer.

Two Versions

There are two versions available in the current actual applications: the IGMP V1 and the IGMP V2. The IGMP V2 has more enhanced features than the IGMP V1. It finishes exchanging information between hosts and routers by means of four types of messages.

- Group member query
- V2 member report
- Leave report
- V1 member report

The V1 member report is used for the compatibility with the IGMP V1.

Multicast Tree

Path Selection

To realize the multicast communication in the TCP/IP network, the possession of the multicast source, the receiver, and of the multicast packet path is essential. For path selection, the most common method is to construct tree routes. The reasons are that the tree route has two following advantages:

- The packet reaches different receivers along branches in a parallel mode.
- A packet copy only occurs in the branch position, which keeps the packets sent over network to minimum.

Definition

A multicast tree is a set which is composed of a series of input interfaces and output interfaces of routes. It determines an unique forwarding path between the subnet where the multicast source lies and the subnets containing group members.

There are two basic ways to construct multicast trees: source-based multicast tree and shared multicast tree.

- Source-based multicast trees

Spanning Tree

Source-based multicast tree is also called the source shortest path tree, which constructs a spanning tree toward all receivers for each source. The spanning tree, with the subnet of the source as a root node, extends to the subnet where receivers exist. A multicast group may have many multicast sources, each of them, or each pair (S, G) of them corresponding to a multicast tree.

Reverse Path Forwarding

The method to construct the source-based multicast trees is the reverse route forwarding (RPF). Each router can find the shortest path toward the source and the corresponding output interface according to a unicast route. When receiving a multicast packet, a router checks whether the input interface reached is the output interface of the shortest unicast path from itself to source. If yes, the router copies and forwards the packet to other interfaces. If not, the router discards the multicast packet.

The input interface receiving multicast packets in the router is called the parent link. The output interface sending multicast packets is called the sub-link.

- Shared multicast tree

The share multicast tree constructs for each multicast group. This tree is shared by all members of a group. Namely, a shared multicast tree is shared by (*, G) instead of being constructed for each pair (S, G). Each device wanting to receive the multicast packets of the group must explicitly join the shared multicast tree.

Unicast Mode First

The shared multicast tree uses a router or a group of routers as the center of the multicast tree. All sources of the group send multicast packets to receivers by sending them to the center in a unicast mode first, and then forward them from the center along the shared multicast tree in a multicast mode.

Multicast Routing Protocol

Definition

Multicast routing protocol is responsible for create multicast trees by exchanging information between routers. Different multicast routing protocols feature different usages. Multicast routing protocols are divided into two categories based on the distribution of multicast users in networks: dense mode and sparse mode.

Dense mode

Multicast routing protocol dense mode is based on dense distribution of multicast users in networks and redundant bandwidth. It periodically floods multicast packets to the entire network to create and maintain multicast trees. That is, routers that run multicast routing protocol flood the received multicast packets to all the other interfaces.

Pruning

When a neighbor router at an interface reports no existence of a group, this interface will be deleted from the multicast tree of

this group, which is called pruning. When the neighbor router reports that a receiver of this group occurs again, this interface will be added to the multicast tree of this group accordingly, which is called graft.

Multicast routing protocol dense mode contains the following:

- Distance Vector Multicast Routing Protocol (DVMRP)
- Multicast Open Shortest Path First (MOSPF)
- Protocol Independent Multicast Dense Mode (PIM-DM)

Sparse mode

Multicast routing protocol sparse mode is applicable to the sparse distribution of multicast receivers in networks, where the bandwidth will be greatly wasted if multicast routing trees are constructed in the same way used in the dense mode – flooding. In the sparse mode, if a network device wants to receive multicast packets, it must first apply to join a multicast routing tree.

Multicast routing protocol sparse mode contains the following:

- Core-Based Trees(CBT)
- Protocol Independent Multicast Sparse Mode(PIM-SM)

ZXR10 GER Router supported PIM-SM.

PIM-SM

The PIM-SM sends multicast packets by using a shared multicast tree. A shared multicast tree has a center point that is responsible for sending packets to all the source-sending ends of a multicast group. Each source-sending end sends packets to the center point along the shortest path, and then takes the center point as the root point to distribute packets to various receiving ends of the group.

Rendezvous Point (RP)

The group center point of the PIM-SM is called the Rendezvous Point (RP). A network may have multiple RPs, whereas a multicast group has only one RP.

A router can obtain the location of the RP by three methods.

- Configure RPs manually and statically on the various routers running the PIM-SM.
- PIM-SM V1 obtains such locations through automatic RPs (Auto-RP) dynamically.
- PIM-SM V2 obtains such locations through the candidate-RP (RP) notification. The RPs with higher priority will become formal RPs.

Candidate BSRs

The PIM-SM V2 manually configures some routers running PIM-SM as candidate-BSRs (BootStrap Router), and selects the candidate-BSR with the highest priority as the formal BSR.

The BSR is responsible for collecting the candidate-RP information of each multicast router to find out what candidate-RPs is in the multicast domain, and notify them to all the PIM routers in the PIM domain in a unified way. Each PIM router, according to the similar Hash rules, selects the one with the highest priority as the formal RP from the same candidate-RP set.

Candidate RPs The candidate-RPs is manually configured. The routers running PIM-SM find each other and maintain the adjacency relation by exchanging Hello messages. In the multi-across network, Hello messages also contain the priority information of routers. According to the parameter, select the designate router (DR).

Unicast Router The multicast source or the first hop router (DR directly connected with the source) encapsulates packets in a registration message, and sends it to the RP through a unicast router. When receiving the registration message, the RP de-encapsulates and takes out the packets, and sends them to the receiver of the group along the shared multicast tree.

Member Report Message Each host acting as a receiver joins the multicast group through the member report message of the IGMP. The last hop router (or the DP in the multi-access network) sends the received joining message to the RP for registration level by level. After receiving the joining message, the intermediary router checks whether it has already had the router of the group. If yes, the intermediary router adds the downstream request router to the shared multicast tree as a branch. If not, it continues to send the joining message to the RP.

When the RP or the multicast router is directly connected with the receiver, it can switch to the source-based shortest path tree from the shared multicast tree. When the RP receives the registration message sent from a new multicast source, the RP returns a joining message to the DR directly connected with the multicast source. Thus, the shortest path tree from the source to the RP is established.

Pruning Message After a DR or a router directly connected with multicast members receives the first multicast packet from the multicast group or the received packets reaches a threshold, it can switch to the source-based shortest path tree from the shared multicast tree. Once switchover occurs, the router will send a pruning message to the upstream neighbor, requiring to leave the shared tree.

MSDP Multicast Source Discovery Protocol (MSDP): This is a mechanism used to connect multiple PIMSM domains. It works over the transmission control protocol (TCP) and provides existence of multicast sources out of the PIM domain for the PIM-SM.

Multicast Common Configurations

Purpose Below procedure gives information about multicast common configurations.

Prerequisite Router Command Line Interface has been accessed.

Steps Multicast common configuration is used to start the configuration shared by the multicast group management protocol and the

multicast routing protocol, including multicast configuration, showing multicast routing table and multicast forwarding table.

1. To start the multicast protocol, use **ip multicast-routing** command in global configuration mode as shown in Table 376.

TABLE 376 IP MULTICAST ROUTING COMMAND

Command Format	Command Mode	Command Function
ip multicast-routing	Global config	This starts the multicast protocol

Result: This starts the multicast protocol.

2. To clear multicast routing, use **clear ip mroute** command in Privileged mode as shown in Table 377.

TABLE 377 CLEAR IP MROUTE COMMAND

Command Format	Command Mode	Command Function
clear ip mroute	Global config	This clears multicast routing table.

Result: This clears multicast routing table.

END OF STEPS

Configuring IGMP

Purpose Below procedure gives information about configuring IGMP.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To start IGMP for different version according to the actual conditions, use **access-group** **<**access-list-number**>** command in interface configuration mode as shown in Table 378.

TABLE 378 IP IGMP VERSION COMMAND

Command Format	Command Mode	Command Function
ip igmp version <version>	Interface config	This starts IGMP for different version according to the actual conditions

Result: This starts IGMP for different version according to the actual conditions.

2. To configure the group range allowing the IGMP to join, use **ip igmp access-group** <access-list-number> command in interface configuration mode as shown in Table 379.

TABLE 379 IP IGMP ACCESS-GROUP COMMAND

Command Format	Command Mode	Command Function
ip igmp version <version>	Interface config	This configures the group range allowing the IGMP to join

Result: This configures the group range allowing the IGMP to join.

When running the IGMP on the interface, receive all multicast groups by default. Set the receiving group range. Discard the joining request when the joining request from the host does not fall into this range.

Example: Only receive the group 239.10.10.10 allowed by the acl 10 at an interface.

```
ZXR10(config)#access-list       10       permit
239.10.10.10 0.0.0.0
ZXR10(config)#int fei_1/1
ZXR10(config-if)#ip igmp access-group 10
```

3. To configure the static group member on the IGMP interface, use **ip igmp static-group** <group-address> command in interface configuration mode as shown in Table 380.

TABLE 380 IP IGMP STATIC-GROUP COMMAND

Command Format	Command Mode	Command Function
ip igmp static-group	Interface config	This configures the static group member on the IGMP interface

Result: This configures the static group member on the IGMP interface.

Statically bind the group address to an interface. Namely, supposing there are always members of the group at the interface.

Example: Configure the static group 239.10.10.10 at an interface.

```
ZXR10(config)#int fei_1/1
ZXR10(config-if)#ip igmp static-group
239.10.10.10
```

4. To configure the group range allowing the IGMP to leave immediately, use **ip igmp immediate-leave** [group-list

<access-list-number>] command in interface configuration mode as shown in Table 381.

TABLE 381 IP IGMP IMMEDIATE

Command Format	Command Mode	Command Function
ip igmp immediate-leave [group-list <access-list-number>]	Interface config	This configuration removes a group immediately when that group falls into the group allowing range.

Result: This configuration removes a group immediately when that group falls into the group allowing range. ..

END OF STEPS

Configuring IGMP Timer

Introduction After booting the IGMP on the multicast router interface connected with the shared network segment, select the optimum one as the Querier of the network segment, responsible for sending the query message to obtain the information of group members.

Query Messages After sending query messages, the Querier will wait for the member report of the receiving host for some time. The duration is the max response time value carried when sending query messages. The default value is 10 seconds.

Maximum Response Time Upon receiving query messages, the host member on the network segment will reduce a random deviation value based on the maximum response time, and take the result as its own response time. During the period, if the report of another host member is received, the host member will cancel it; if not, the host member will send the host report at the right time. Therefore, prolonging the max response time will accordingly increase the waiting chances for the group members of the network segment, and spare down the burst rate of multiple host reports on the network segment.

According to the actual network conditions, appropriately adjust parameter values of several timers related to the Querier.

Purpose Below procedure gives information about configuring IGMP timer.

Prerequisite Router Command Line Interface has been accessed.

Steps

1. To configure the IGMP query time interval, use **ip igmp query-interval** <seconds> command in interface configuration mode as shown in Table 382.

TABLE 382 IP IGMP QUERY INTERVAL COMMAND

Command Format	Command Mode	Command Function
ip igmp query-interval <seconds>	Interface config	This configures the IGMP query time interval

Result: This configures the IGMP query time interval.

2. To configure the maximum response time value carried by query messages when they are sent by the IGMP, use **ip igmp query-max-response-time** <seconds> command in interface configuration mode as shown in Table 383.

TABLE 383 IP IGMP QUERY-MAX COMMAND

Command Format	Command Mode	Command Function
ip igmp query-interval <seconds>	Interface config	This configures the maximum response time value carried by query messages when they are sent by the IGMP

Result: This configures the maximum response time value carried by query messages when they are sent by the IGMP.

3. To configure the timeout length of the IGMP querier, use **ip igmp querier-timeout** <seconds> command in interface configuration mode as shown in Table 384.

TABLE 384 IP IGMP-QUERIER COMMAND

Command Format	Command Mode	Command Function
ip igmp querier-timeout <seconds>	Interface config	This configures the timeout of the IGMP querier. This timer is related to the frequency of the re-elected for querier in a network.

Result: This configures the timeout of the IGMP querier. This timer is related to the frequency of the re-elected for querier in a network.

4. To configure the query interval of a specific IGMP group, use **ip igmp last-member-query-interval** <seconds> command in interface configuration mode as shown in Table 385.

TABLE 385 IP-IGMP LAST MEMBER COMMAND

Command Format	Command Mode	Command Function
ip igmp querier-	Interface config	This configures the query interval of a specific IGMP

Command Format	Command Mode	Command Function
timeout <seconds>		group

Result: This configures the query interval of a specific IGMP group.

END OF STEPS

Configuring PIM-SM

Basic PIM-SM Configuration

PIM-SM configuration covers the following contents:

Purpose

This topic describes how to configure PIM-SM in ZTE ZXR10 GER.

Prerequisite

Router Command Line Interface has been accessed.

Steps

1. To enable the PIM-SM, use **router pimsm** command in global configuration mode as shown in Table 386.

TABLE 386 ROUTER PIMSM COMMAND

Command Format	Command Mode	Command Function
router pimsm	Global config	This enables the PIM-SM

Result: This enables the PIM-SM.

2. To add an interface running the PIM-SM, use **ip pim sm** command in interface configuration mode, as shown in Table 387

TABLE 387 IP PIM SM COMMAND

Command Format	Command Mode	Command Function
ip pim sm	Interface config	This adds an interface running the PIM-SM

Result: This adds an interface running the PIM-SM.

3. To configure the static RP, use **static-rp** <ip-address> [group-list <access-list-number>] [priority <priority>] command in pimsm configuration mode, as shown in Table 388.

TABLE 388 STATIC-RP COMMAND

Command Format	Command Mode	Command Function
static-rp <ip-	Pimsm	This configures the

Command Format	Command Mode	Command Function
address> [group-list <access-list-number>] [priority <priority>]	configuration	static RP

Result: This configures the static RP.

Configure a static RP for a or multiple specific groups, and configure the same static RPs for the group on all PIM-SM multicast routers in the multicast domain.

The RP address should be reachable from other routers. Usually, the loopback interface address is used to reduce the network vibration caused by the up/down of a physical interface. After the static RP is configured, the candidate-RP is not needed to be configured for the group.

Example: Configure the static RP 10.1.1.1 for all the groups.

```
ZXR10(config-router)#static-rp 10.1.1.1
```

Example: Configure the static RP 10.1.1.1 for the multicast 239.132.10.100 allowed by the acl 10.

```
ZXR10(config-router)#static-rp 10.1.1.1 group-
list 10
ZXR10(config)#access-list 10 permit
239.132.10.100 0.0.0.0
```

4. To configure the candidate-BSR, use **bsr-candidate** <interface-name> [<hash-mask-length>] [<priority>] command in pimsm configuration mode as shown in Table 389.

TABLE 389 BSR-CANDIDATE COMMAND

Command Format	Command Mode	Command Function
bsr-candidate <interface-name> [<hash-mask-length>] [<priority>]	Pimsm configuration	This configures the candidate-BSR

Result: This configures the candidate-BSR.

Static RP Mechanism

If the static RP mechanism is not used, every multicast domain must be configured with the candidate-BSR on more than one multicast routers, and a BSR should be selected.

The BSR periodically sends booting (BSR) messages to advertise the RP information. The router running the PIM-SM updates the RP state according to the latest advertising messages. The bootstrap message sent by the BSR is also used to select the formal BSR from the candidate-BSRs.

Default Priority

The default priority of the candidate-BSR is 0. The candidate-BSRs with higher priority become the formal BSRs. If the BSR

priorities of multiple routers are similar, the IP addresses should be compared. The candidate-BSR with greater address will become the formal BSR.

5. To Configure candidate-RPs, use **rp-candidate** <interface-name> [group-list <access-list-number>] [priority <priority>] command in pimsm configuration mode, as shown in Table 390.

TABLE 390 RP-CANDIDATE COMMAND

Command Format	Command Mode	Command Function
rp-candidate <interface-name> [group-list <access-list-number>] [priority <priority>]	Pimsm configuration	This configures candidate-RPs

Result: This configures candidate-RPs.

In the PIM-SM, the RP is a root of the shared multicast tree. It is responsible for sending multicast packets to the receiving member of the group in the downstream along the shared tree. Each multicast group has only one formal RP.

The default priority of the candidate-RP is 0. The candidate-RP with greater priority value has greater priority.

END OF STEPS

Setting PIM-SM Global Parameters

Introduction When PIM-SM is running, different parameters have different default value. These parameters can be set to optimize networks.

Purpose This topic describes how to set PIM-SM global parameters

Prerequisites Router Command Line Interface has been accessed.

Steps

1. To configure the thresold for RPT switch to SPT, use **spt-threshold infinity** [group-list <access-list-number>] command in pimsm configuration mode as shown in Table 391.

TABLE 391 SPT-THRESHOLD INFINITY COMMAND

Command Format	Command Mode	Command Function
spt-threshold infinity [group-list <access-list-number>]	Pimsm configuration	This configures the thresold for RPT switch to SPT

Result: This configures the thresold for RPT switch to SPT

Only the last hop DP and the RP can actively switch over to the source shortest path tree. By default, when the RP receives the first registration information, it will start the switchover. For the last hop DR, configure the switchover threshold strategy of the source shortest path tree, with the unicast group as control granularity. If the switchover threshold is set to infinity, switchover does not occur. By default, switchover must take place if traffic exists.

2. To set the DR priority, use **ip pim dr-priority** <priority> command in interface configuration mode as shown in Table 392.

TABLE 392 IP PIM DR-PRIORITY COMMAND

Command Format	Command Mode	Command Function
ip pim dr-priority <priority>	interface configuration	This sets the DR priority

Result: This sets the DR priority.

DR Selection

A DR must be selected in a shared (or Multi-Access) network segment. The router with the highest priority will win the selection. If the priorities are identical, the router with the greatest IP address will be selected.

In the shared network segment connected with the multicast data source, only the DR can send the registration information to the RP. In the shared network segment connected with the receiver, only the DR can respond to IGMP joining/leaving messages, and send PIM joining/pruning messages to upstream.

The priority of a router is contained in the Hello message exchanged with neighbors. The default value is 0.

3. To configure an interface to be the PIM domain border, use **ip pim bsr-border** command in interface configuration mode as shown in Table 393.

TABLE 393 IP-PIM BSR BORDER COMMAND

Command Format	Command Mode	Command Function
ip pim bsr-border	interface configuration	This configures an interface to be the PIM domain border

Result: This configures an interface to be the PIM domain border.

4. To enable/disable reporting of the multicast packet count, use **packet-count** {begin|end} command in pimsm configuration mode as shown in Table 394.

TABLE 394 PACKET-COUNT COMMAND

Command Format	Command Mode	Command Function
packet-count {begin|end}	Pimsm configuration	This enables/disables reporting of the multicast packet count

Result: This enables/disables reporting of the multicast packet count.

5. To set the interval of sending the Hello message, use **ip pim query-interval** <seconds> command in interface configuration mode as shown in Table 395.

TABLE 395 IP PIM QUERY INTERVAL COMMAND

Command Format	Command Mode	Command Function
ip pim query-interval <seconds>	interface configuration	This sets the interval of sending the Hello message

Result: This sets the interval of sending the Hello message.

According to the actual network conditions, appropriately adjust the time interval of the Hello message sent by the PIM-SM neighbors. The default value is 30 seconds.

6. To limit PIM-SM neighbors, use **accept-register <**access-list-number**>** command in interface configuration mode as shown in Table 396.

TABLE 396 IP PIM NEIGHBOR FILTER COMMAND

Command Format	Command Mode	Command Function
accept-register <access-list-number**>**	interface configuration	This limits PIM-SM neighbors

Result: This limits PIM-SM neighbors.

With the view of security, the PIM-SM limits some routers to be neighbors at the interface.

Example: On fei_1/1 interface, forbid the router restricted by acl 10 to become the PIM neighbor.

```
ZXR10(config)#access-list 10 deny 10.1.1.1
0.0.0.0
ZXR10(config)#interface fei_1/1
ZXR10(config-if)#ip pim neighbor-filter 10
```

END OF STEPS

PIM SM Policy Control

Purpose This topic describes how to control PIM-SM policy.

Prerequisites Router Command Line Interface has been accessed.

Steps

1. To filter the multicast packets encapsulated in the received register packet, use **accept-register** <access-list-number> command in pimsm configuration mode as shown in Table 397.

TABLE 397 IP PIM NEIGHBOR FILTER COMMAND

Command Format	Command Mode	Command Function
ip pim neighbor-filter <access-list-number>	Pimsm configuration	This filters the multicast packets encapsulated in the received register packet

Result: This filters the multicast packets encapsulated in the received register packet.

Filter the source addresses of the multicast packets encapsulated in the register packets according to the rules defined in the ACL.

2. To filter the candidate RP addresses advertised in the BSR message, use **accept-rp** <access-list-number> command in pimsm configuration mode as shown in Table 398.

TABLE 398 ACCEPT-RP COMMAND

Command Format	Command Mode	Command Function
accept-rp <access-list-number>	Pimsm configuration	This filter the candidate RP addresses advertised in the BSR message

Result: This filter the candidate RP addresses advertised in the BSR message.

3. To limit PIM-SM neighbors, use **ip pim neighbor-filter** <access-list-number> command in interface configuration mode as shown in Table 399.

TABLE 399 IP PIM NEIGHBOR FILTER COMMAND

Command Format	Command Mode	Command Function
ip pim neighbor-	Interface configuration	This limits the PIM-SM neighbors

Command Format	Command Mode	Command Function
filter		

Result: This limits the PIM-SM neighbors.

With the view of security, the PIM-SM limits some routers to be neighbors at the interface.

Example: On the fei_1/1 interface, forbid the router restricted by acl 10 to become the PIM neighbor.

```
ZXR10(config)#access-list 10 deny 10.1.1.1
0.0.0.0
ZXR10(config)#interface fei_1/1
ZXR10(config-if)#ip pim neighbor-filter 10
```

Configuring MSDP

Purpose This topic describes how to configure MSDP.

Prerequisite Router Command Line Interface has been accessed

Steps

1. To enable the MSDP PEER to configure a MSDP neighbor, use **ip msdp peer** <peer-address> **connect-source** <interface-name> command in global configuration mode as shown in Table 400.

TABLE 400 IP MSDP PEER COMMAND

Command Format	Command Mode	Command Function
ip pim neighbor-filter	Global configuration	This enables the MSDP PEER to configure a MSDP neighbor

Result: This enables the MSDP PEER to configure a MSDP neighbor.

2. To enable the MSDP DEFAULT-PEER to define a default MSDP neighbor, use **ip msdp default-peer** <peer-address> [list <acl-number>] command in global configuration mode, as shown in Table 401.

TABLE 401 IP MSDP DEFAULT PEER COMMAND

Command Format	Command Mode	Command Function
ip pim neighbor-filter	Global configuration	This enables the MSDP DEFAULT-PEER to define a default MSDP neighbor

Result: This enables the MSDP DEFAULT-PEER to define a default MSDP neighbor.

END OF STEPS

MSDP Extended Configuration

Purpose This topic describes how to configure MSDP in an extended way

Prerequisites Router CLI (Privileged Mode) has been accessed.

Steps

1. To add illustrative description to MSDP neighbors, use **ip msdp description** <peer-address> <desc-text> command in global configuration mode as shown in Table 402.

TABLE 402 IP MSDP DESCRIPTION COMMAND

Command Format	Command Mode	Command Function
ip msdp description <peer-address> <desc-text>	Global configuration	This adds illustrative description to MSDP neighbors

Result: This adds illustrative description to MSDP neighbors.

Note: Mesh Group consists of MSDP speakers, where every two of them are connected by the MDSP. When the SA packet of the MSDP neighbor from the same Mesh Group is received, it will not be forwarded to the other MSDP neighbors of the same Mesh Group.

2. To take the IP address of a designated interface as the RP address of the SA message, use **ip msdp originator-id** <interface-name> command in global configuration mode as shown in Table 403.

TABLE 403 IP MSDP ORIGINATOR COMMAND

Command Format	Command Mode	Command Function
ip msdp originator-id <interface-name>	Global configuration	This takes the IP address of a designated interface as the RP address of the SA message

Result: This takes the IP address of a designated interface as the RP address of the SA message.

3. To limit the number of SA messages from the designated MSDP neighbor in the SA cache table, use **ip msdp sa-limit** <peer-address> <sa-limit> command in global configuration mode as shown in Table 404.

TABLE 404 IP MSDP SA-LIMIT COMMAND

Command Format	Command Mode	Command Function
ip msdp originator-id <interface-name>	Global configuration	This limits the number of SA messages from the designated MSDP neighbor in the SA cache table

Result: This limits the number of SA messages from the designated MSDP neighbor in the SA cache table.

4. To limit the scope of the MSDP neighbor to which the multicast packets encapsulated into the SA packets to be sent, use **ip msdp ttl-threshold** <peer-address> <ttl-value> command in global configuration mode as shown in Table 405.

TABLE 405 IP MSDP TTL-THRESHOLD COMMAND

Command Format	Command Mode	Command Function
ip msdp ttl-threshold <peer-address> <ttl-value>	Global configuration	This limits the scope of the MSDP neighbor to which the multicast packets encapsulated into the SA packets to be sent

Result: This limits the scope of the MSDP neighbor to which the multicast packets encapsulated into the SA packets to be sent.

MSDP Policy Configuration

Purpose This topic describes how to configure MSDP policy.

Prerequisites Router CLI (Privileged Mode) has been accessed.

Steps

1. To limit generation of the SA message, use **ip msdp sa-filter in** <peer-address> [list <acl-number>] command in global configuration mode as shown in Table 406.

TABLE 406 IP MSDP REDISTRIBUTE COMMAND

Command Format	Command Mode	Command Function
ip msdp sa-filter in <peer-address> [list <acl-number>]	Global configuration	This limits generation of the SA message

Result: This limits generation of the SA message.

According to the configured ACL rules, only the (S, G) multicast routing entries that meet such rules can occur in the SA message generated by a MSDP neighbor.

2. To set to filter the SA message from a designated MSDP neighbor, use **ip msdp sa-filter in** <peer-address> [list <acl-number>] command in global configuration mode as shown in Table 407.

TABLE 407 IP MSDP SA-FILTER IN COMMAND

Command Format	Command Mode	Command Function
ip msdp redistribute [list <acl-number>]	Global configuration	This sets to filter the SA message from a designated MSDP neighbor

Result: This sets to filter the SA message from a designated MSDP neighbor.

3. To set filter the SA message sent to a designated MSDP neighbor, use **clear ip msdp peer [<peer-address>]** command in global configuration mode as shown in Table 408.

TABLE 408 IP MSDP SA-FILTER OUT COMMAND

Command Format	Command Mode	Command Function
clear ip msdp peer [<peer-address>]	Global configuration	This set filter the SA message sent to a designated MSDP neighbor

Result: This set filter the SA message sent to a designated MSDP neighbor.

END OF STEPS

Clearing the MSDP Status

Purpose This topic describes how to clear the MSDP status

Prerequisites Router CLI (Privileged Mode) has been accessed.

Steps

1. To clear the TCP connection with all/designated MSDP neighbors, use **clear ip msdp sa-cache** [<group-address>] command in Priviliged mode as shown in Table 409.

TABLE 409 CLEAR IP MSDP PEER COMMAND

Command Format	Command Mode	Command Function
clear ip msdp sa-cache [<group-address>]	Priviliged	This clears the TCP connection with all/designated MSDP neighbors

Result: This clears the TCP connection with all/designated MSDP neighbors.

2. To clear the MSDP SA cache entry, use **clear ip msdp statistics** [<peer-address>] command in Priviliged mode as shown in Table 410.

TABLE 410 CLEAR IP MSDP SA-CACHE COMMAND

Command Format	Command Mode	Command Function
clear ip msdp statistics [<peer-address>]	Priviliged	This clears the MSDP SA cache entry

Result: This clears the MSDP SA cache entry.

3. To clear the statistics of the MSDP neighbor, use **clear ip msdp statistics** [<peer-address>] command in Priviliged mode as shown in Table 411.

TABLE 411 CLEAR IP MSDP STATISTICS COMMAND

Command Format	Command Mode	Command Function
ip msdp sa-filter out <peer-address> [list <acl-number>]	Priviliged	This clears the statistics of the MSDP neighbor

Result: This clears the statistics of the MSDP neighbor.

END OF STEPS

Static Multicast Configuration

Purpose This topic describes how to configure static multicast route.

Prerequisite Router CLI (Privileged Mode) has been accessed.

Steps

1. To do static multicast configuration, use **show ip mroute** [group <group-address>] [source <source-address>] [summary] command in global configuration mode as shown in Table 412.

TABLE 412 IP MROUTE COMMAND

Command Format	Command Mode	Command Function
show ip mroute [group <group-address>] [source <source-address>] [summary]	Global configuration	This do static multicast configuration

Result: This do static multicast configuration.

END OF STEPS

Multicast Maintenance and Diagnosis

Purpose Below procedure gives information about multicast maintenance & diagnosis.

Prerequisite Router CLI (Privileged Mode) has been accessed.

Steps

1. To view multicast routing tables, use **show ip igmp interface** [<interface-name>] command in Priviliged mode, as shown in Table 413.

TABLE 413 SHOW IP MROUTE COMMAND

Command Format	Command Mode	Command Function
show ip igmp interface [<interface-name>]	Priviliged	This shows multicast routing tables.

Result: This shows multicast routing tables.

2. To view multicast forwarding routing tables, use **show ip forwarding mroute group-address** <group-address> [source-address <source-address>] command in Priviliged mode as shown in Table 414.

TABLE 414 SHOW IP MROUTE FORWARDING COMMAND

Command Format	Command Mode	Command Function
show ip forwarding mroute group-address <group-address> [source-address <source-address>]	Privileged	This shows multicast forwarding routing tables

Result: This shows multicast forwarding routing tables.

3. To show the information about the multicast reverse path forwarding (RPF), use **show ip rpf** <source-address> command in Priviliged mode as shown in Table 415.

TABLE 415 SHOW IP RPF COMMAND

Command Format	Command Mode	Command Function
show ip rpf <source-address>	Privileged	This shows the information about the multicast reverse path forwarding (RPF)

Result: This shows the information about the multicast reverse path forwarding (RPF).

END OF STEPS.

IGMP Maintenance and Diagnosis

Purpose Below procedure gives information about IGMP maintenance & diagnosis.

Prerequisites Router CLI (Privileged Mode) has been accessed.

ZXR10 1800/2800/3800 Router provides some commands to show the IGMP status. The following are some common commands:

Steps

1. To view the IGMP information on an interface, use **show ip igmp interface** [<interface-name>] command in Priviliged mode as shown in Table 416.

TABLE 416 SHOW IP IGMP INTERFACE COMMAND

Command Format	Command Mode	Command Function
show ip rpf <source-address>	Privileged	This shows the IGMP information on an interface

Result: This shows the IGMP information on an interface.

Example: This shows the IGMP information of the fei_1/1 interface.

```
ZXR10#show ip igmp interface fei_1/1
fei_1/1
  Internet address is 131.1.1.45, subnet mask is
255.255.255.0
  IGMP is enabled on interface
  Current IGMP version is 2
  IGMP query interval is 125 seconds
  IGMP last member query interval is 1 seconds
  IGMP query max response time is 10 seconds
IGMP querier timeout period is 251 seconds
  IGMP querier is 131.1.1.45, never expire
  Inbound IGMP access group is not set
  IGMP immediate leave control is not set
```

2. To view the joining information about the IGMP group on an interface, use **show ip igmp groups** [<interface-name>] command in Priviliged mode as shown in Table 417.

TABLE 417 SHOW IP IGMP GROUPS COMMAND

Command Format	Command Mode	Command Function
show ip igmp groups	Privileged	This shows the joining information about the IGMP group on an interface

Result: This shows the joining information about the IGMP group on an interface.

Example: This shows the group member information at the fei_3/1 interface.

```
ZXR10#show ip igmp groups fei_3/1
IGMP Connected Group Membership
Group addr       Interface      Present
Expire       Last Reporter
233.1.1.4        fei_3/1          01:07:49
never        30.1.1.43
233.1.1.147      fei_3/1          01:07:49
00:03:05     30.1.1.42
233.1.4.21       fei_3/1          01:07:49
00:03:05     30.1.1.42
```

END OF STEPS

PIM-SM Maintenance and Diagnosis

Purpose This topic describes how to diagnose and maintain PIM-SM.

Prerequisites Router CLI (Privileged Mode) has been accessed.

ZXR10 1800/2800/3800 Router provides some commands to view the PIM-SM state. The following are some common commands:

Steps

1. To show multicast routing, use **show ip mroute** [group <group-address>] [source <source-address>] [summary] command in Priviliged mode, as shown in Table 418.

TABLE 418 SHOW IP MROUTE COMMAND

Command Format	Command Mode	Command Function
show ip mroute [group <group-address>] [source <source-address>] [summary]	Priviliged	This shows multicast routing

Result: This shows multicast routing.

Example: This shows the contents of the current IP multicast routing table.

```
ZXR10#show ip mrout
IP Multicast Routing Table
Flags:D -Dense,S -Sparse,C -Connected,L -Local,P
-Pruned
      R -RP-bit set,F -Register flag,T -SPT-bit
set,J -Join SPT
      U -Up Send,N -No Used,X -Proxy Join Timer
Running
      * -Assert flag
Timers:Uptime/Expires
Interface state:Interface,Next-Hop or
VCD,State/Mode

(*, 233.1.1.3), 00:00:41/00:02:49, RP
43.43.43.43 , 0/0, flags: S
  Incoming interface: tunnel22, RPF nbr
22.22.22.43
  Outgoing interface list:
    pos3_5/1, Forward/Sparse, 00:00:41/00:02:49

(*, 233.1.1.4), 00:13:52/00:03:30, RP
43.43.43.43 , 1/1, flags: SC
  Incoming interface: tunnel22, RPF nbr
22.22.22.43
  Outgoing interface list:
    fei_3/1, Forward/Sparse, 00:13:52/00:03:30 C

(*, 233.1.1.5), 00:00:28/00:03:02, RP
43.43.43.43 , 0/0, flags: SC
  Incoming interface: tunnel22, RPF nbr
22.22.22.43
```

```
  Outgoing interface list:
    fei_3/1, Forward/Sparse, 00:00:28/00:03:02
C
(*, 233.1.1.6), 00:00:28/00:03:02, RP
43.43.43.43 , 0/0, flags: SC
  Incoming interface: tunnel22, RPF nbr
22.22.22.43
  Outgoing interface list:
    fei_3/1, Forward/Sparse, 00:00:28/00:03:02
C
```

2. To show information about the PIM-SM interface, use **show ip pimsm interface** [<interface-name>] command in Priviliged mode as shown in Table 419.

TABLE 419 SHOW IP PIMSM INTERFACE COMMAND

Command Format	Command Mode	Command Function
show ip pimsm interface [<interface-name>]	Priviliged	This shows information about the PIM-SM interface

Result: This shows information about the PIM-SM interface.

Example: show the configured PIM-SM interfaces.

```
ZXR10#show ip pimsm interface
Address         Interface     state Nbr    Query
DR              DR

Count Intvl                 Prior
131.1.1.45      pos3_5/1       Up      1      30
131.1.1.91      1
30.1.1.43       fei_3/1        Up      0      30
30.1.1.43       1
22.22.22.45     tunnel22       Up      1      30
22.22.22.45     1
```

3. To show information about the PIM-SM neighbor, use **show ip pim bsr** command in Priviliged mode as shown in Table 420.

TABLE 420 SHOW IP PIMSM NEIGHBOR COMMAND

Command Format	Command Mode	Command Function
show ip pim bsr	Priviliged	This shows information about the PIM-SM neighbor

Result: This shows information about the PIM-SM neighbor.

Example: This shows neighbors of the PIM-SM interface.

```
ZXR10#show ip pimsm neighbor
Neighbor Address  Interface        DR Prio
Uptime    Expires
131.1.1.91          pos3_5/1          30000
00:19:34  00:01:29
22.22.22.43         tunnel22         1
03:21:25  00:01:16
```

4. To show the BSR information, use **show ip pim bsr** command in Priviliged mode as shown in Table 421.

TABLE 421 SHOW IP PIM BSR COMMAND

Command Format	Command Mode	Command Function
show ip pimsm neighbor [<interface-name>]	Priviliged	This shows the BSR information

Result: This shows the BSR information.

```
ZXR10#show ip pim bsr
PIMSM Bootstrap information
BSR address: 131.1.1.45(?)---
Uptime: 00:01:06, BSR Priority :200, Hash mask
length:30
Expires:00:00:55
This system is a candidate BSR
  candidate BSR address: 131.1.1.45, priority:
200, hash mask length:30
This System is Candidate_RP:
  candidate             RP             address:
55.1.1.45(fei_3/1),priority:100, Group acl:1
  candidate             RP             address:
43.43.43.43(static),priority:0
```

5. To show the RP set information advertised by the BSR, use **show ip pim rp mapping** command in Priviliged mode as shown in Table 422.

TABLE 422 SHOW IP PIM RP MAPPING COMMAND

Command Format	Command Mode	Command Function
show ip pim rp mapping	Priviliged	This shows the RP set information advertised by the BSR

Result: This shows the RP set information advertised by the BSR.

```
ZXR10#show ip pim rp mapping
Group                RP                      uptime
expires
226.1.0.0            17.93.8.3           01:24:57
00:00:49
226.4.0.0            17.93.8.3           01:24:57
00:00:49
```

MSDP Maintenance and Diagnosis

Purpose This topic describes how to diagnose and maintain MSDP procedure gives information about MSDP maintenance & diagnosis.

Prerequisite Router CLI (Privilged Mode) has been accessed.

Steps

1. To show the detailed information of MSDP neighbors, use **show ip msdp sa-cache** [<group-address> [<source-address>]] command in Priviliged mode, as shown in Table 423.

TABLE 423 SHOW IP MSDP PEER COMMAND

Command Format	Command Mode	Command Function
show ip msdp sa-cache [<group-address> [<source-address>]]	Priviliged	This shows the detailed information of MSDP neighbors

Result: This shows the detailed information of MSDP neighbors.

Example: This shows the detailed information of MSDP neighbors.

```
ZXR10#show ip msdp peer
 MSDP Peer 55.1.1.42

Description:
Connection status:

State: Up, Resets: 0, Connection source: fei_1/5
(55.1.1.41)

Uptime(Downtime):        00:20:07,        Messages
sent/received: 21/21

Connection and counters cleared 00:24:09 ago

SA Filtering:
```

```
Input (S,G) filter: none

Output (S,G) filter: none

Peer ttl threshold: 0

SAs learned from this peer: 0
```

2. To show the (S, G) state of every MSDP neighbor, use **debug ip msdp message-recv** command in Priviliged mode as shown in Table 424.

TABLE 424 SHOW IP MSDP SA-CACHE COMMAND

Command Format	Command Mode	Command Function
debug ip msdp message-recv	Priviliged	This shows the (S, G) state of every MSDP neighbor

Result: This shows the (S, G) state of every MSDP neighbor.

Example: This shows the (S, G) state of every MSDP neighbor.

```
ZXR10#show ip msdp sa-cache
MSDP Source-Active Cache - 4 entries
(101.101.101.101, 224.1.1.1), RP 49.4.4.4,
00:21:45/ 00:05:57
(101.101.101.101, 224.1.1.2), RP 49.4.4.4,
00:21:45/ 00:05:57
(101.101.101.101, 226.1.1.1), RP 50.4.4.4,
00:09:04/ 00:04:57
(101.101.101.101, 226.1.1.2), RP 50.4.4.4,
00:09:04/ 00:04:57
```

3. To show all the information received by MSDP, use **debug ip msdp message-recv** command in Priviliged mode as shown in Table 425.

TABLE 425 DEBUG IP MSDP MESSAGE-RECV COMMAND

Command Format	Command Mode	Command Function
show ip msdp peer [<peer-address>]	Priviliged	This shows all the information received by MSDP

Result: This shows all the information received by MSDP.

Example: This shows all the information received by the MSDP.

```
ZXR10# debug ip msdp message-recv
MSDP: 105.2.2.2: Received 56-byte msg 2372
from peer
MSDP: 105.2.2.2: SA TLV, len: 56, ec: 4, RP:
103.4.4.4
MSDP: 105.2.2.2: Peer RPF check failed for
103.4.4.4, we are RP
```

4. To show all the information about the MSDP, use **debug ip msdp** command in Priviliged mode as shown in Table 426.

TABLE 426 DEBUG IP MSDP COMMAND

Command Format	Command Mode	Command Function
debug ip msdp	Priviliged	This shows all the information about the MSDP

Result: This shows all the information about the MSDP.

Example: This shows all the information about the MSDP.

```
ZXR10# debug ip msdp
MSDP: Session to peer 102.2.2.2 going down
MSDP: 102.2.2.2: Peer reset, own IP address is
changed
MSDP: Session to peer 142.3.3.3 going down
MSDP: 142.3.3.3: Peer reset, other side down
MSDP: 105.2.2.2: Received 56-byte msg 2372
from peer
MSDP: 105.2.2.2: SA TLV, len: 56, ec: 4, RP:
103.4.4.4
MSDP: 105.2.2.2: Peer RPF check failed for
103.4.4.4, we are RP
```

END OF STEPS

Static Multicast Maintenance and Diagnosis

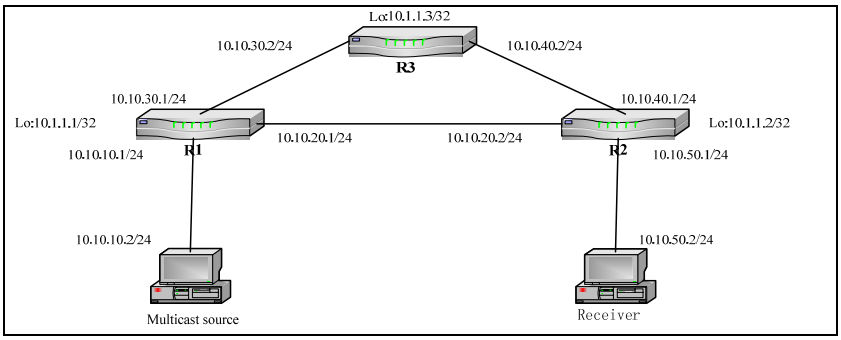
Use the **show ip route multicast** command to show static multicast routing information.

Multicast Configuration Example

PIM-SM Configuration Example

The following is an example of the PIM-SM configuration. See Figure 111 for network topology.

FIGURE 111 MULTICAST CONFIGURATION EXAMPLE



R1 configuration:

```
ZXR10_R1(config)#interface loopback1
ZXR10_R1(config-if)#ip address  10.1.1.1
255.255.255.255
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip address  10.10.10.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config)#interface fei_1/2
ZXR10_R1(config-if)#ip address  10.10.20.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config)#interface fei_1/3
ZXR10_R1(config-if)#ip address  10.10.30.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network 10.0.0.0
255.255.255.0 area 0.0.0.0
ZXR10_R1(config)#ip multicast-routing
ZXR10_R1(config)#router pimsm
ZXR10_R1(config-router)#rp-candidate loopback1
priority 10
ZXR10_R1(config-router)#bsr-candidate loopback1
10 10
```

R2 configuration:

```
ZXR10_R2(config)#interface loopback1
ZXR10_R2(config-if)#ip    address         10.1.1.2
255.255.255.255
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip    address       10.10.20.2
255.255.255.0
ZXR10_R2(config-if)#ip pim sm
ZXR10_R2(config)#interface fei_1/2
```

```
ZXR10_R2(config-if)#ip    address       10.10.40.1
255.255.255.0
ZXR10_R2(config-if)#ip pim sm
ZXR10_R2(config)#interface fei_1/3
ZXR10_R2(config-if)#ip    address       10.10.50.1
255.255.255.0
ZXR10_R2(config-if)#ip igmp access-group 10
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network          10.0.0.0
255.0.0.0 area 0.0.0.0
ZXR10_R2(config)#ip multicast-routing
ZXR10_R2(config)#router pimsm
ZXR10_R2(config-router)#rp-candidate    loopback1
priority 20
ZXR10_R2(config-router)#bsr-candidate   loopback1
10 20
ZXR10_R2(config)#access-list 10 permit any
```

R3 configuration:

```
ZXR10_R3(config)#interface loopback1
ZXR10_R3(config-if)#ip    address        10.1.1.3
255.255.255.255
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip    address       10.10.30.2
255.255.255.0
ZXR10_R3(config-if)#ip pim sm
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip    address       10.10.40.2
255.255.255.0
ZXR10_R3(config-if)#ip pim sm
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network          10.0.0.0
255.255.255.0 area 0.0.0.0
ZXR10_R3(config)#ip multicast-routing
ZXR10_R3(config)#router pimsm
ZXR10_R3(config-router)#rp-candidate    loopback1
priority 30
ZXR10_R3(config-router)#bsr-candidate   loopback1
10 30
```

MSDP Configuration Example

Assign R1 and R3 as a PIMS-SM domain and R2 as another PIMS-SM domain, and then enable the multicast data streams of the two PIMS-SM domains to inter-work through the MSDP.

R1 configuration:

```
ZXR10_R1(config)#interface loopback1
ZXR10_R1(config-if)#ip    address         10.1.1.1
255.255.255.255
ZXR10_R1(config)#interface fei_1/1
ZXR10_R1(config-if)#ip    address       10.10.10.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config)#interface fei_1/2
ZXR10_R1(config-if)#ip    address       10.10.20.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config-if)#ip pim bsr-border
ZXR10_R1(config)#interface fei_1/3
ZXR10_R1(config-if)#ip    address       10.10.30.1
255.255.255.0
ZXR10_R1(config-if)#ip pim sm
ZXR10_R1(config)#router ospf 1
ZXR10_R1(config-router)#network           10.0.0.0
0.0.0.255 area 0.0.0.0
ZXR10_R1(config)#ip multicast-routing
ZXR10_R1(config)#router pimsm
ZXR10_R1(config-router)#rp-candidate    loopback1
priority 10
ZXR10_R1(config-router)#bsr-candidate   loopback1
10 10
ZXR10_R1(config)#ip msdp peer 10.10.20.2 connect-
source fei_1/2
ZXR10_R1(config)#ip msdp peer 10.10.30.2 connect-
source fei_1/3
```

R2 configuration:

```
ZXR10_R2(config)#interface loopback1
ZXR10_R2(config-if)#ip    address         10.1.1.2
255.255.255.255
ZXR10_R2(config)#interface fei_1/1
ZXR10_R2(config-if)#ip    address       10.10.20.2
255.255.255.0
ZXR10_R2(config-if)#ip pim sm
ZXR10_R2(config)#interface fei_1/2
ZXR10_R2(config-if)#ip    address       10.10.40.1
255.255.255.0
ZXR10_R2(config-if)#ip pim sm
```

```
ZXR10_R2(config)#interface fei_1/3
ZXR10_R2(config-if)#ip    address       10.10.50.1
255.255.255.0
ZXR10_R2(config-if)#ip igmp access-group 10
ZXR10_R2(config)#router ospf 1
ZXR10_R2(config-router)#network          10.0.0.0
0.0.0.255 area 0.0.0.0
ZXR10_R2(config)#ip multicast-routing
ZXR10_R2(config)#router pimsm
ZXR10_R2(config-router)#rp-candidate    loopback1
priority 20
ZXR10_R2(config-router)#bsr-candidate   loopback1
10 20
ZXR10_R2(config)#access-list 10 permit any
ZXR10_R2(config)#ip msdp peer 10.10.20.1 connect-
source fei_1/1
ZXR10_R2(config)#ip msdp peer 10.10.40.2 connect-
source fei_1/2
ZXR10_R2(config)#ip msdp default-peer 10.10.20.1
```

R3 configuration:

```
ZXR10_R3(config)#interface loopback1
ZXR10_R3(config-if)#ip    address        10.1.1.3
255.255.255.255
ZXR10_R3(config)#interface fei_1/1
ZXR10_R3(config-if)#ip    address       10.10.30.2
255.255.255.0
ZXR10_R3(config-if)#ip pim sm
ZXR10_R3(config)#interface fei_1/2
ZXR10_R3(config-if)#ip    address       10.10.40.2
255.255.255.0
ZXR10_R3(config-if)#ip pim sm
ZXR10_R3(config-if)#ip pim bsr-border
ZXR10_R3(config)#router ospf 1
ZXR10_R3(config-router)#network          10.0.0.0
0.0.0.255 area 0.0.0.0
ZXR10_R3(config)#ip multicast-routing
ZXR10_R3(config)#router pimsm
ZXR10_R3(config-router)#rp-candidate    loopback1
priority 30
ZXR10_R3(config-router)#bsr-candidate   loopback1
10 30
ZXR10_R3(config)#ip msdp peer 10.10.40.1 connect-
source fei_1/2
```

```
ZXR10_R3(config)#ip msdp peer 10.10.30.1 connect-
source fei_1/1
```

Glossary

Acronyms and Abbreviations

Abbreviation	Full Name
ABR	Area Border Router
ACL	Access Control List
AD	Administrative Distance
API	Application Programming Interface
ARP	Address ResolutionProtocol
AS	Autonomous System
ASBR	Autonomous System Border Router
ASN	Abstract Syntax Notation
ATM	Asynchronous Transfer Mode
BGP	Border Gateway Protocol
BOOTP	BOOTstrap Protocol
BDR	Backup Designate Router
CHAP	Challenge Handshake Authentication Protocol
CIDR	Classless Inter-Domain Routing
CLNP	ConnectionLess Network Protocol
CLNS	ConnectionLess Network Sevice
COS	Class of Service
CRC	Cyclic Redundancy Check
CRLDP	Constraint based Routing Label Distribution Protocol
CSN	Cryptographic Sequence Number
CSU	Channel Service Unit
DDN	Digit Data Network
DHCP	Dynamic Host Configuration Protocol
DIS	Designate IS
DNS	Domain Name System
DR	Designate Router
DSU	Data Service Unit

EBGP	External Border Gateway Protocol
EGP	External Gateway Protocol
ES	End System
FDDI	Fiber Distributed Data Interface
GER	General Excellent Router
FEC	Forwarding Equivalence Class
FIFO	First In and First Out
FPGA	Field Programmable Gate Array
FSM	Finite State Machine
FTP	File Transfer Protocol
GBIC	Gigabit Interface Converter
GRE	General Routing Encapsulation
ICMP	Internet Control Message Protocol
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IP	Internet Protocol
ISO	International Organization for Standardization
ISP	Internet Service Provider
LAN	Local Area Network
LAPB	Link Access Procedure Balanced
LCP	Link Control Protocol
LDP	Label Distribution Protocol
LLC	Logical Link Control
LSA	Link State Advertisement
LSP	Link State PDU
LSR	Label Switch Router
MAC	Media Access Control
MD5	Message Digest 5
MED	MULTI_EXIT_DISC
MIB	Management Information Base
MPLS	Multi-Protocol Label Switching
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NBMA	Non-Broadcast Multiple Access
NCP	Network Control Protocol
NIC	Network Information Center
NLRI	Network Layer Reachable Information

NMS	Network Management System
NSAP	Network Service Access Point
NSP	Network Service Provider
NTP	Network Time Protocol
NVT	Network Virtual Terminal
OAM	Operation And Management
OID	Object ID
OSI	Open Systems Interconnection
OSPF	Open Shortest Path First
PAP	Password Authentication Protocol
PAT	Port Address Translation
PCB	Process Control Block
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
POS	Packet over SDH
PPP	Point-to-Point Protocol
PSNP	Partial Sequence Num PDU
PRT	Process Registry Table
QOS	Quality of Service
RARP	Reverse Address Resolution Protocol
RADIUS	Remote Authentication Dial In User Service
RFC	Request For Comments
RIP	Routing Information Protocol
RLE	Route lookup engine
RMON	Remote Monitoring
ROS	Router Operation System
RSVP	Resource Reservation Protocol
SDH	Synchronous Digital Hierarchy
SDLC	Synchronous Data Link Control
SMP	Security Main Processor
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SNP	Sequence Num PDU
SPF	Shortest Path First
TCP	Transmission Control Protocol
TFTP	Trivial File Transfer Protocol
TOS	Type Of Service
TELNET	Telecommunication Network Protocol

TTL	Time To Live
UDP	User Datagram Protocol
VLSM	Variable Length Subnet Mask
VPN	Virtual Private Network
VRF	Virtual Routing Forwarding
VRRP	Virtual Router Redundancy Protocol
WAN	Wide Area Network
WWW	World Wide Web

Figures

Tables

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