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ESR Series Routers

ESR-100, ESR-200, ESR-1000, ESR-1200

Operation Manual, Firmware Ver. 1.2.0

Document version	Issue date	Revisions
Version 1.9	03.05.2017	Added chapters: - 7.19.2 Policy-based IPSec VPN configuration - 7.35 BRAS (Broadband Remote Access Server) configuration Edited chapters: - 2.3 Main specifications - 2.4 Design - 2.5 Delivery package - 3.3 ESR-1000,ESR-1200 power module installation - 5.1 ESR router factory settings
Version 1.8	14.12.2016	Added chapters: - 7.2 Q-in-Q termination configuration - 7.20 LT-tunnels configuration - 7.31 VRRP tracking configuration
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Version 1.6	24/02/2016	Added chapters: - 7.15.1 Configuring Route-map for BGP - 7.21 Configuring remote access to corporate network via OpenVPN protocol - 7.31 SNMP configuration Edited chapters: - 7.15 PBR routing policy configuration - 7.19 Configuring remote access to corporate network via PPTP protocol
Version 1.5	06/08/2015	Added description for ESR-100, ESR-200 Added chapters: - 2.4.2 ESR-100, ESR-200 design Edited chapters: - 2.4 Design - 2.5 Delivery package - 3 Installation and connection - 7.1 VLAN configuration - 7.6 Source NAT configuration - 7.16 L2TPv3 tunnel configuration - 7.24 Netflow configuration - 7.25 sFlow configuration - 7.26 LACP configuration
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		- 6.6 Bridge configuration - 6.7 RIP configuration - 6.8 OSPF configuration - 6.9 BGP configuration - 6.10 GRE tunnel configuration - 6.11 L2TPv3 tunnel configuration - 6.12 Route-based IPsec VPN configuration - 6.13 Configuring remote access to corporate network via PPTP protocol - 6.14 Configuring remote access to corporate network via L2TP/IPsec protocol - 7.1 Updating firmware via system resources - 7.2 Updating firmware via bootloader
Version 1.2	02/12/2014	Added chapters: - 6.6 Bridge configuration - 6.7 RIP configuration - 6.8 OSPF configuration - 6.9 BGP configuration - 6.10 L3 tunnel (GRE) configuration - 6.11 L2TPv3 tunnel (L2TPv3) configuration
Version 1.1	03/06/2014	Added: 6 Router configuration
Version 1.0	25/04/2014	First issue.
Firmware version	**1.2.0**	

CONTENTS

1 INTRODUCTION

1.1 Abstract

Today, large-scale communication network development projects are becoming increasingly common. One of the main tasks in implementation of large multiservice networks is the creation of reliable high-performance transport network that will serve as a backbone in multilayer architecture of next-generation networks.

ESR series routers could be used in large enterprise networks, SMB networks and operator's networks. Devices provide high performance and bandwidth, and feature protection of transmitted data.

This operation manual describes intended use, specifications, features, design, installation, first time setup, and firmware update guidelines for the ESR series router. (next, the device)

1.2 Target Audience

This user manual is intended for technical personnel that performs device installation, configuration and monitoring via command line interface (CLI) as well as the system maintenance and firmware update procedures. Qualified technical personnel should be familiar with the operation basics of TCP/IP protocol stacks and Ethernet networks design concepts.

1.3 Symbols

Symbol	Description
Calibri italic	Variables and parameters that should be replaced with the appropriate word or string are written in Calibri Italic.
Semibold font	Notes and warnings are written in semibold font.
<Semibold italic>	Keyboard keys are enclosed in angle brackets.
Courier New	Examples of command entry are written in Courier New semibold.
Courier New	Results of command execution are written in Courier New font in a frame with the shadow border.
[ ]	In the command line, optional parameters are shown in square brackets; when entered, they provide additional options.
{ }	In the command line, mandatory parameters are shown in curly braces. Choose one of the following:
|	In the description of the command, this sign means 'or'.

Notes and warnings

Notes contain important information, tips or recommendations on device operation and setup.

Warnings are used to inform the user about harmful situations for the device and the user alike, which could cause malfunction or data loss.

2 PRODUCT DESCRIPTION

2.1 Purpose

ESR series devices are the high performance multi-purpose network routers. Device combines traditional network features with a complex multi-tier approach to routing security, and ensures robust corporate environment protection.

Device has a built-in firewall that enables protection of your network environment and supports latest data security, encryption, authentication and anti-intrusion features.

Device contains software and hardware means of data processing. Top performance is achieved through optimal distribution of data processing tasks between different subsets of the device.

2.2 Functions

2.2.1 Interface functions

Table 2.1 lists interface functions of the device.

Table 2.1 – Device interface functions

Cable connection polarity detection (Auto MDI/MDIX)	Automatic cable type detection—crossed or straight. – MDI (Media-Dependent Interface—straight)—cable standard for connection of terminal devices – MDIX (Media-Dependent Interface with Crossover—crossed)—cable standard for connection of hubs and switches
Backpressure routing support (Back pressure)	The backpressure routing method is utilized in half-duplex connections for management of data streams, coming from the opposite devices, by means of collisions. This method allows to avoid buffer overruns and the loss of data.
Flow control (IEEE 802.3X)	Flow control allows to interconnect the low-speed and the high-speed devices. To avoid buffer overrun, the low-speed device gains the ability to send PAUSE packets, that will force the high-speed device to pause the packet transmission.
Link aggregation (LAG)	Link aggregation allows to increase the communication link bandwidth and robustness. Router supports static and dynamic link aggregation. For dynamic aggregation, link group management is performed via LACP protocol.

2.2.2 Functions for MAC address processing

Table 2.2 lists MAC address processing functions of the device

Table 2.2 —MAC address processing functions

MAC address table	MAC address table sets the correspondence between MAC addresses and device interfaces and is used for data packet routing. Routers support table capacity up to 16K of MAC addresses and reserve specific MAC addresses for the system use.
Learning mode	MAC address table may contain either static addresses or addresses learnt during data packet transition through the device. Learning involves registration of packet source MAC addresses with their binding to ports and VLANs. Afterwards, this data is used for incoming packet routing. Registered MAC address lifetime is limited. Administrator may adjust this setting. If destination MAC address specified in the packet that was received by the device is not listed in the table, this packet will be sent further as a broadcast packet within L2 segment of the network.

2.2.3 Second-layer functions of OSI model

Table 2.3 lists second-layer functions and special aspects (OSI Layer 2).

Table 2.3 —Second-layer functions description (OSI Layer 2)

VLAN support	VLAN (Virtual Local Area Network) is a solution used for splitting a network into separate segments on L2 level. VLAN utilization allows to increase the operation stability for large networks by splitting them into smaller networks, isolate diversified data traffic by type and solve many other tasks. Routers support various VLAN management methods: – VLAN based on data packet tagging according to IEEE802.1Q – VLAN based on device ports (port-based) – VLAN based on utilization of data classification policies (policy-based)
Spanning Tree Protocol (STP) [1]	The main task of Spanning Tree Protocol is to exclude redundant network links and convert network topology into the tree-like structure. Common areas of protocol application involve the prevention of network traffic loops and establishing of redundant communication links.

[1] In the current firmware version, this functionality is supported only by ESR-1000 router.

2.2.4 Third-layer functions of OSI model

Table 2.4 lists third-layer functions (OSI Layer 3).

Table 2.4 —Third-layer functions description (OSI Layer 3)

Static IP routes	Administrator of the router can add or remove static records into/from the routing table.
Dynamic routing	With dynamic routing protocols, the device will be able to exchange the routing information with neighbouring routers and automatically create a routing table. Router supports the following protocols: RIP, OSPFv2, OSPFv3, BGP.
ARP table	ARP (Address Resolution Protocol) is a protocol used for resolution of the network and data-link layer addresses. ARP table contains information on the established correspondence. Correspondence is established on the basis of the network device response analysis; device addresses are requested with broadcast packets.
DHCP client	DHCP (Dynamic Host Configuration Protocol) protocol enables automation of the network device management process. DHCP client allows the router to obtain the network address and additional settings from the external DHCP server. As a rule, this method is used for obtaining network settings of a public network operator (WAN).
DHCP server	DHCP server enables automation and centralization of the network device configuration process. DHCP server allocated on a router allows for a complete solution for the local area network support. DHCP server integrated into the router assigns IP addresses to network devices and transfers additional network settings, e.g. server addresses, network gateway addresses and other necessary settings.
Network Address Translation (NAT)	Network address translation is a mechanism that translates IP addresses and port numbers for transit packets. NAT function allows to minimize the quantity of IP address used through translation of multiple internal network IP addresses into a single external public IP address. NAT conceals local area network internal structure and allows to enhance its security. Routers support the following NAT options: – Source NAT (SNAT)—the network address and the source port number will be replaced, when packet is transferred forth, and the destination address will be replaced in the response packet. – Destination NAT (DNAT)—external access is translated by the firewall to the user computer in LAN that has an internal address and thus directly inaccessible from outside the network.

2.2.5 Traffic tunnelling functions

Table 2.5 —Traffic tunnelling functions

Tunnelling protocols	Tunnelling is a method of packet conversion during their network transfer that involves the replacement, modification and addition of a new packet network header. This method may be used for negotiation of transport protocols when the data is transferred through the transit network as well as for creation of secured connections where tunnelled data is being encrypted. Routers support the following types of tunnels: – GRE—IP packet is encapsulated into another IP packet with GRE (General Routing Encapsulation) header – IPv4-IPv4—tunnel that encapsulates source IP packets into IP packets with alternative network parameters – L2TPv3—tunnel for L2 traffic transmission using IP packets – IPsec—tunnel with the encryption of transmitted data – L2TP, PPTP—tunnels used for establishing a remote 'client-sever' access

2.2.6 Management and configuration functions

Table 2.6 —Basic management and configuration functions

Configuration file download and upload	Device parameters are saved into the configuration file that contains configuration data for the specific device ports as well as for the whole system. The following protocols may be used for file transfers: TFTP, FTP, and SCP.
Command line interface (CLI)	CLI management is performed locally via serial port RS-232, or remotely via Telnet, SSH. Console command line interface (CLI) is the industrial standard. CLI interpreter contains the list of commands and keywords that will help the user and reduce the amount of input data.
Syslog	Syslog protocol is designed for transmission of system event messages and event logging.
Network utilities: ping, traceroute	*ping and traceroute utilities* allow you to check the availability of network devices and identify data transfer routes in IP networks.
Controlled access management— privilege levels	Routers support system access level management for users. Access levels enable responsibility areas management for device administrators. Access levels are numbered from 1 to 15; Level 15 stands for full access to device management features.
Authentication	Authentication is a user identity check procedure. Routers support the following authentication methods: – local—local user database stored on the device is used for authentication – group—user database is located on the authentication server RADIUS and TACACS protocols are user for server interactions.
SSH server ***Telnet server***	SSH and Telnet server features allow you to establish connection to the device and perform device management.
Automatic configuration restore	Device features automatic configuration restore system designed to prevent remote access loss after re-configuration. If the configuration change is not confirmed in the defined time, configuration will be rolled back to the last known state.

2.2.7 Network security functions

The table lists network security functions of the device.

Table 2.7 —Network security functions

Security zones	All router interfaces are distributed by security areas. For each zone pair, you can set the rules that define the possibility of data transmission between zones, data traffic filtering rules.
Data filtering	For each zone pair, you can define the rule set that manages the filtering process for data transmitted through the router. Device command interface provides appropriate means for detailed configuration of the traffic classification rules and to apply the resulting solution for traffic transmission.

2.3 Main specifications

Table 2.8 lists main specifications of the router.

Table 2.8 —Main specifications

General parameters		
Packet processor	ESR-1200 ESR-1000	Broadcom XLP316L
	ESR-200	Broadcom XLP204
	ESR-100	Broadcom XLP104
Interfaces	ESR-1200	12 x Ethernet 10/100/1000Base-T 4 x Ethernet 10/100/1000Base-T/1000Base-X Combo 8 x 10GBase-R/1000Base-X (SFP+/SFP)
	ESR-1000	24 x Ethernet 10/100/1000Base-T 2 x 10G Base Base-R/1000Base-X (SFP+/SFP)
	ESR-200	x Ethernet 10/100/1000Base-T / 1000 Base-X Combo 4 x Ethernet 10/100/1000Base-T
	ESR-100	x Ethernet 10/100/1000Base-T / 1000 Base-X Combo
Types of optical transceivers	ESR-1200 ESR-1000	1000BASE-X SFP, 10GBASE-R SFP+
	ESR-100 ESR-200	1000BASE-X SFP
Duplex or half-duplex interface modes		- duplex and half-duplex modes for electric ports - duplex mode for optical ports
ESR-1000 router maximum bandwidth (hardware switching)		88Gbps
Integrated switch buffer memory (for ESR-1000)		12Mb
Data transfer rate	ESR-1200 ESR-1000	- electric interfaces 10/100/1000Mbps - optical interfaces 1/10Gbps
	ESR-100 ESR-200	- electric interfaces 10/100/1000Mbps - optical interfaces 1Gbps
MAC address table (for ESR-1000)		16K records
VLAN support		up to 4K active VLANs according to 802.1Q
Quantity of L3 interfaces		up to 2K
Quantity of BGP routes	ESR-1200 ESR-1000	2,6M
	ESR-100 ESR-200	1,2M

Quantity of OSPF routes	ESR-1200 ESR-1000	500K
	ESR-100 ESR-200	300K
Quantity of RIP routes		10K
Quantity of static routes		11K
FIB size	ESR-1200 ESR-1000	1,7M
	ESR-100 ESR-200	550K
Compliance		IEEE 802.3 10BASE-T Ethernet IEEE 802.3u 100BASE-T Fast Ethernet IEEE 802.3ab 1000BASE-T Gigabit Ethernet IEEE 802.3z Fiber Gigabit Ethernet ANSI/IEEE 802.3 Speed autodetection IEEE 802.3x Data flow control IEEE 802.3ad LACP link aggregation IEEE 802.1q VLAN virtual local networks IEEE 802.1v IEEE 802.3ac IEEE 802.3ae IEEE 802.1D IEEE 802.1w IEEE 802.1s
Control		
Local control		CLI
Remote control		TELNET, SSH
Physical specifications and ambient conditions		
Power supply	ESR-1200 ESR-1000	AC: 220V+-20%, 50Hz DC: -36 .. - 72V Power options: - Single AC or DC power supply - Two AC or DC power supplies with hot swapping
	ESR-100 ESR-200	AC: 220V+-20%, 50Hz
Maximum power consumption:	ESR-1200	85W
	ESR-1000	75W
	ESR-100	20W
	ESR-200	25W
Weight	ESR-1200	5.5kg max.
	ESR-1000	3.6kg max.
	ESR-100 ESR-200	2.5kg max.
Dimensions	ESR-1200 ESR-1000	430x352x44mm
	ESR-100 ESR-200	310x240x44mm
Operating temperature range		-10 to +45°C
Storage temperature range		-40 to +70°C
Operation relative humidity (non-condensing)		up to 80%
Storage relative humidity (non-condensing)		from 10% to 95%
Average lifetime		20 years

2.4 Design

This section describes the design of the device. Depicted front, rear, and side panels of the device, connectors, LED indicators and controls.

The device has a metal housing available for 19” form-factor rack mount; housing size is 1U.

2.4.1 ESR-1000, ESR-1200 design

2.4.1.1 ESR-1200 front panel

The front panel of ESR-1200 is depicted in Fig. 2.1.

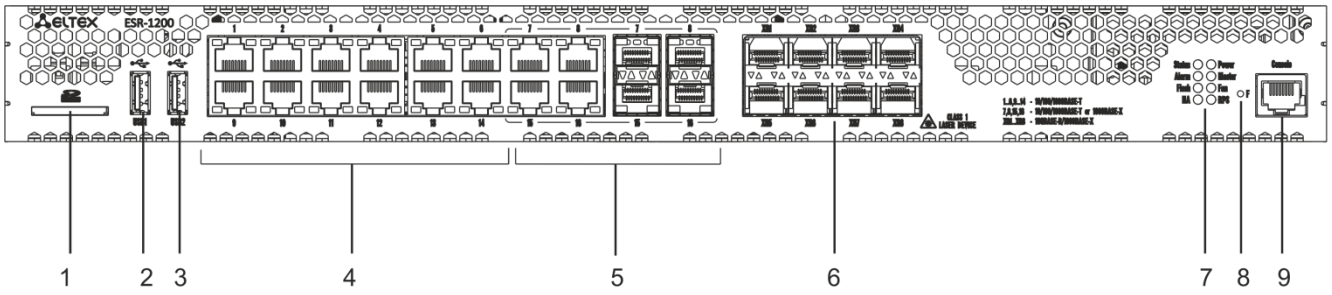


Fig. 2.1 - Front panel of ESR-1200

The list of connectors, light indicators and controls located on the front panel of ESR-1200 lists in Table 2.9

Table 2.9 - Description of connectors, indicators and controls located on the front panel of ESR-1200

№	Front panel element	Description
1	SD	SD-card connector.
2	USB1	USB-device port.
3	USB2	USB-device port.
4	[1 .. 12]	12 x Gigabit Ethernet 10/100/1000Base-T (RJ-45) ports.
5	Combo Ports	4 x Gigabit Ethernet 10/100/1000Base-X (SFP) ports.
6	XG1 - XG8	10G SFP+/ 1G SFP transceiver installation slots.
7	Status	Indicator of device's current state.
	Alarm	indicator of alarm existence and emergency level.
	HA	HA operation mode indicator.
	Flash	Activity indicator of exchange with data storages (SD-card or USB Flash).
	Power	Device power indicator.
	Master	Indicator of failover modes operation.
	Fan	Fan alarm indicator.
	RPS	Backup power source indicator.
8	F	Functional key that reboots the device and resets it to factory settings: – Pressing the key for less than 10 seconds reboots the device; – Pressing the key for more than 10 seconds resets the

		terminal to factory settings.
9	Console	Console port RS-232 for local management of the device.

2.4.1.2 ESR-1000 front panel

The front panel layout of the device is depicted in Fig. 2.2.

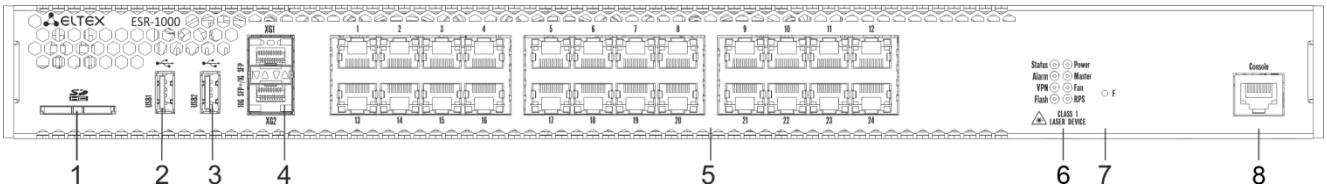


Fig. 2.2 —ESR-1000 front panel

Table 2.10 lists sizes, LEDs, and controls located on the front panel of the device.

Table 2.10 —Description of connectors, LEDs, and controls located on the front panel

No.	Front panel element	Description
1	SD	SD memory card installation slot.
2	USB1	USB-enabled devices connection port.
3	USB2	USB-enabled devices connection port.
4	XG1, XG2	10G SFP+/ 1G SFP transceivers installation slots.
5	[1 .. 24]	24 x Gigabit Ethernet 10/100/1000 Base-T (RJ-45) ports.
6	Status	Current device status indicator.
	Alarm	Device alarm presence and level indicator.
	VPN	Active VPN sessions indicator.
	Flash	Data storage activity indicator—SD card or USB Flash
	Power	Device power indicator.
	Master	Device failover mode operation indicator.
	Fan	Fan alarm indicator.
	RPS	Backup power supply indicator.
7	F	Functional key that reboots the device and resets it to factory settings: – Pressing the key for less than 10 seconds reboots the device. – Pressing the key for more than 10 seconds resets the device to factory settings.
8	Console	RS-232 console port for local control of the device.

2.4.1.3 ESR-1000, ESR-1200 rear panel

The rear panel layout of ESR-1000, ESR-1200 is depicted in Fig. 2.3[1].

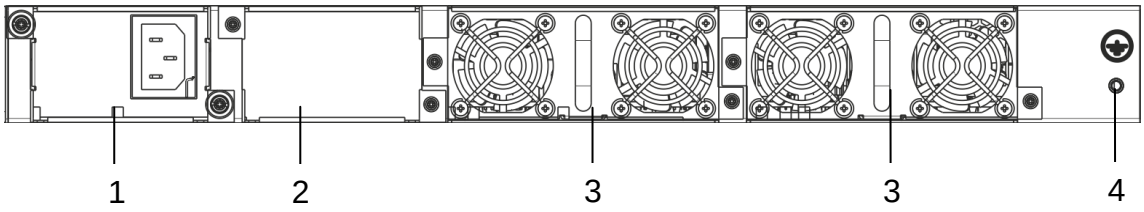


Fig. 2.3 —ESR-1000, ESR-1200 rear panel

Table 2.11 lists rear panel connectors of the router.

Table 2.11 —Description of rear panel connectors of the router

No.	Description
1	Main power supply.
2	Backup power supply installation position.
3	Removable ventilation modules with hot-swapping.
4	Earth bonding point of the device.

2.4.1.4 Side panels of the device

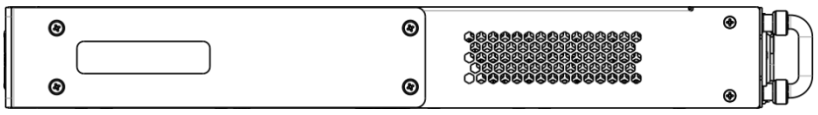


Fig. 2.4 —The right-side panel of ESR-1000, ESR-1200 routers

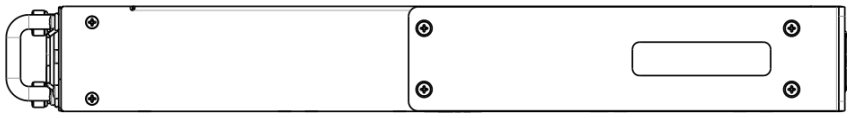


Fig. 2.5—The left-side panel of ESR-1000, ESR-1200 routers

Side panels of the device have air vents for heat removal. Do not block air vents. This may cause components overheating which may result in terminal malfunction. For recommendations on device installation, see section 'Installation and connection'.

[1] The figure shows the router delivery package with a single AC power supply.

2.4.2 ESR-100, ESR-200 design

2.4.2.1 ESR-100, ESR-200 front panel

The front panel layout of ESR-100 is depicted in Fig. 2.6.

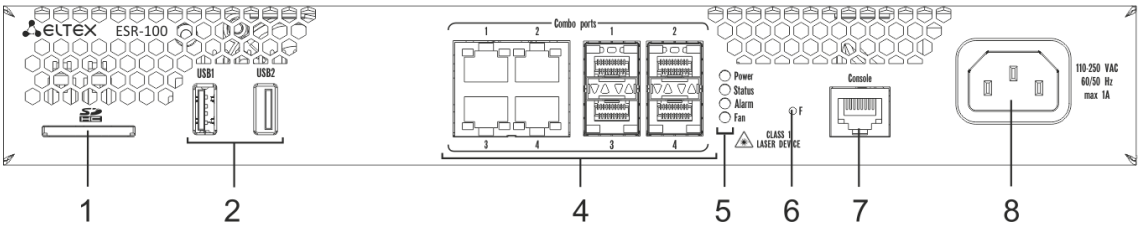


Fig. 2.6 —ESR-100 front panel

The front panel layout of ESR-200 is depicted in Fig. 2.7.

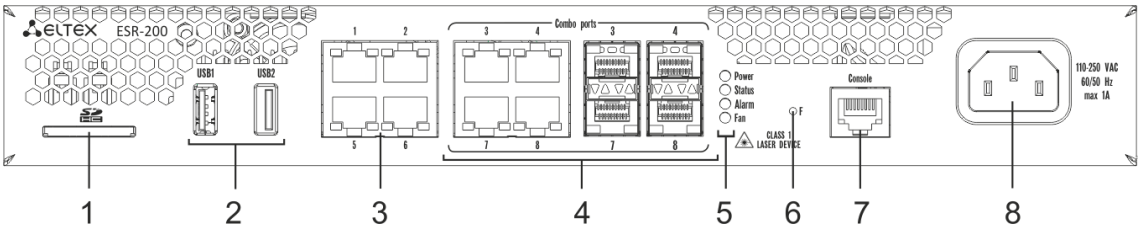


Fig. 2.7 —ESR-200 front panel

Table 2.12 lists sizes, LEDs, and controls located on the front panel of ESR-100 and ESR-200 routers.

Table 2.12 —Description of connectors, LEDs, and controls located on the front panel

No.	Front panel element	Description
1	SD	SD memory card installation slot.
2	USB1, USB2	2 x USB-enabled devices connection port.
3	[1 .. 4]	4 x Gigabit Ethernet 10/100/1000 Base-T (RJ-45) ports.
4	Combo Ports	4 x Gigabit Ethernet 10/100/1000 Base-X (SFP) ports
5	Power	Device power indicator.
	Status	Current device status indicator.
	Alarm	Device alarm presence and level indicator.
	Fan	Fan alarm indicator.
6	F	Functional key that reboots the device and resets it to factory settings: – Pressing the key for less than 10 seconds reboots the device. – Pressing the key for more than 10 seconds resets the device to factory settings.
7	Console	RS-232 console port for local control of the device.
8	110-250VAC 60/50Hz max 1A	Power supply

2.4.2.2 ESR-100, ESR-200 rear panel

The rear panel layout of ESR-100 and ESR-200 routers is depicted in Fig. 2.8[1].

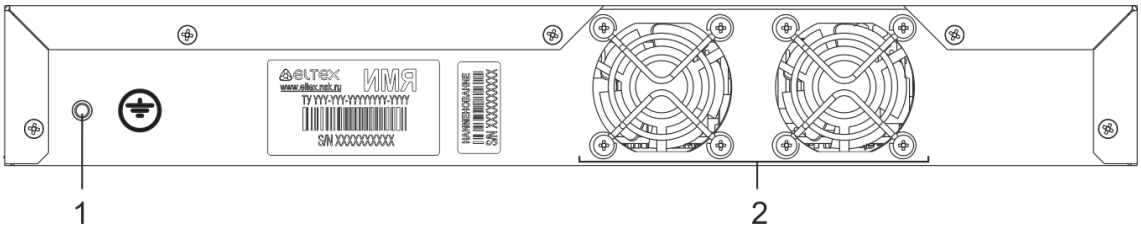


Fig. 2.8 —ESR-1000, rear panel

Table 2.13 lists rear panel connectors of the router.

Table 2.13 —Description of rear panel connectors of the router

No.	Description
1	Earth bonding point of the device.
2	Ventilation module.

2.4.2.3 ESR-100, ESR-200 side panels

Fig. 2.9 —The right-side panel of ESR-100 and ESR-200 routers

Fig. 2.10—The left-side panel of ESR-100 and ESR200 routers

[1] The figure shows the router delivery package with a single AC power supply.

2.4.3 Light Indication

2.4.3.1 ESR-1000, ESR-1200 light indication

Gigabit Ethernet copper interface status is represented by two LEDs—green *LINK/ACT* LED and amber *SPEED* LED. Location of the copper interface LEDs is depicted in Fig. 2.11. SFP interface status is is represented by two LEDs—RX/ACT and TX/ACT—depicted in Fig. 2.12. For light indication meaning, see Tables 2.14 and 2.15.

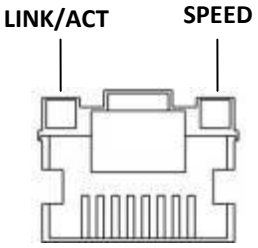


Fig. 2.11 —Location of RJ-45 port indicators

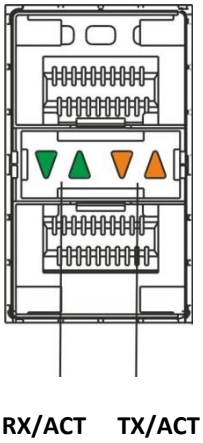


Fig. 2.12 —Location of optical interface indicators

Table 2.14 —Light indication of copper interface status

SPEED indicator is lit	LINK/ACT indicator is lit	Ethernet interface state
Off	Off	Port is disabled or connection is not established
Off	Solid on	10Mbps or 100Mbps connection is established
Solid on	Solid on	1000Mbps connection is established
X	Flashes	Data transfer is in progress

Table 2.15 —Light indication of SFP/SFP+ interface status

RX/ACT indicator is lit	TX/ACT indicator is lit	Ethernet interface state
Off	Off	Port is disabled or connection is not established

Solid on	Solid on	Connection established
Flashes	X	Data reception in progress
X	Flashes	Data transfer in progress

The following table lists description of system indicator statuses and meanings.

Table 2.16 —Status of system indicators

Indicator name	Indicator function	LED State	Device State
Status	Current device status indicator.	Green	Device is in normal operation state.
		Orange	Device is booting up the software.
Alarm	Device alarm presence and level indicator.	-	-
VPN	Active VPN sessions indicator.	-	-
Flash	Data storage activity indicator: SD card or USB Flash.	Orange	Read/write operation execution with 'copy' command
Power	Device power indicator.	Green	Device power is OK. Main power supply, if installed, is operational.
		Orange	Main power supply failure or fault, or the primary main is missing.
		Off	Device internal power supply failure.
Master	Device failover mode operation indicator.	-	-
Fan	Cooling fan status.	Off	All fans are operational.
		Red	One or more fans has failed. Possible cause of failure: at least one of the fans has stopped or is working at lower rpm.
RPS	Backup power supply operation mode.	Green	Backup power supply is installed and operational.
		Off	Backup power supply is not installed.
		Red	Backup power supply is missing or failed.

2.4.3.2 ESR-100/ESR-200 light indication

Gigabit Ethernet copper interface and SFP interface statuses are represented by two LEDs—green LINK/ACT LED and amber SPEED LED. Location of the copper interface LEDs is depicted in Fig. 2.11. SFP interface status is depicted in Fig. 2.13. For light indication meaning, see Table 2.17.

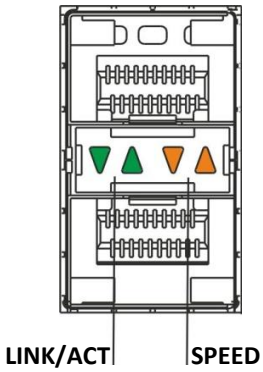


Fig. 2.13 —Location of optical interface indicators

Table 2.17 —Light indication of copper and SFP interface status

SPEED indicator is lit	LINK/ACT indicator is lit	Ethernet interface state
Off	Off	Port is disabled or connection is not established
Off	Solid on	10Mbps or 100Mbps connection is established
Solid on	Solid on	1000Mbps connection is established
X	Flashes	Data transfer in progress

The following table lists description of system indicator statuses and meanings.

Table 2.18 —Status of system indicators

Indicator name	Indicator function	LED State	Device State
Status	Current device status indicator.	Green	Device is in normal operation state.
		Orange	Device is booting up the software.
Alarm	Device alarm presence and level indicator. [1]	-	-
Power	Device power indicator.	Green	Device power is OK. Main power supply, if installed, is operational.
		Orange	Main power supply failure or fault, or the primary main is missing.
		Off	Device internal power supply failure.
Fan	Cooling fan status.	Off	All fans are operational.
		Red	One or more fans has failed. Possible cause of failure: at least one of the fans has stopped or is working at lower rpm.

2.5 Delivery Package

ESR-100 standard delivery package includes:

- ESR-100 router
- Power cable
- Console port connection cable (RJ-45 – DB9F)
- 19’’ rack mounting kit
- Documentation

ESR-200 standard delivery package includes:

- ESR-200 router
- Power cable
- Console port connection cable (RJ-45 – DB9F)
- 19’’ rack mounting kit
- Documentation

[1] Not supported in the current firmware version.

ESR-1000 standard delivery package includes:

- ESR-1000 router
- Power cable
- Console port connection cable (RJ-45 – DB9F)
- 19” rack mounting kit
- Documentation

ESR-1200 standard delivery package includes:

- ESR-1200 router;
- power cable;
- Console port connection cable (RJ-45 – DB9F);
- 19” rack mounting kit;
- Documentation.

Power module (PM-160-220/12 or PM-75-48/12) may be included in the ESR-1000 delivery package on the customer's request.

SFP/SFP+ transceivers may be included in the delivery package on the customer's request.

3 INSTALLATION AND CONNECTION

This section describes installation of the device into a rack and connection to a power supply.

3.1 Support brackets mounting

The delivery package includes support brackets for rack installation and mounting screws to fix the device case on the brackets. To install the support brackets:

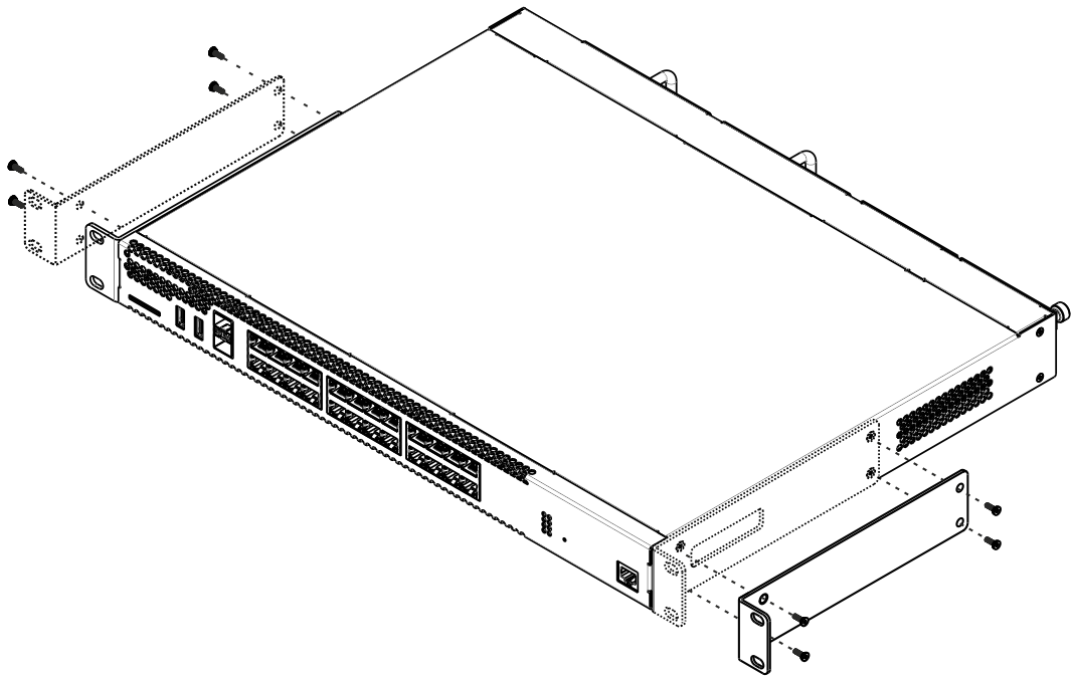


Fig. 3.1 —Support brackets mounting

1. Align four mounting holes in the support bracket with the corresponding holes in the side panel of the device.
2. Use a screwdriver to screw the support bracket to the case.
3. Repeat steps 1 and 2 for the second support bracket.

3.2 Device rack installation

To install the device to the rack:

1. Attach the device to the vertical guides of the rack.
2. Align mounting holes in the support bracket with the corresponding holes in the rack guides. Use the holes of the same level on both sides of the guides to ensure the device horizontal installation.
3. Use a screwdriver to screw the router to the rack.

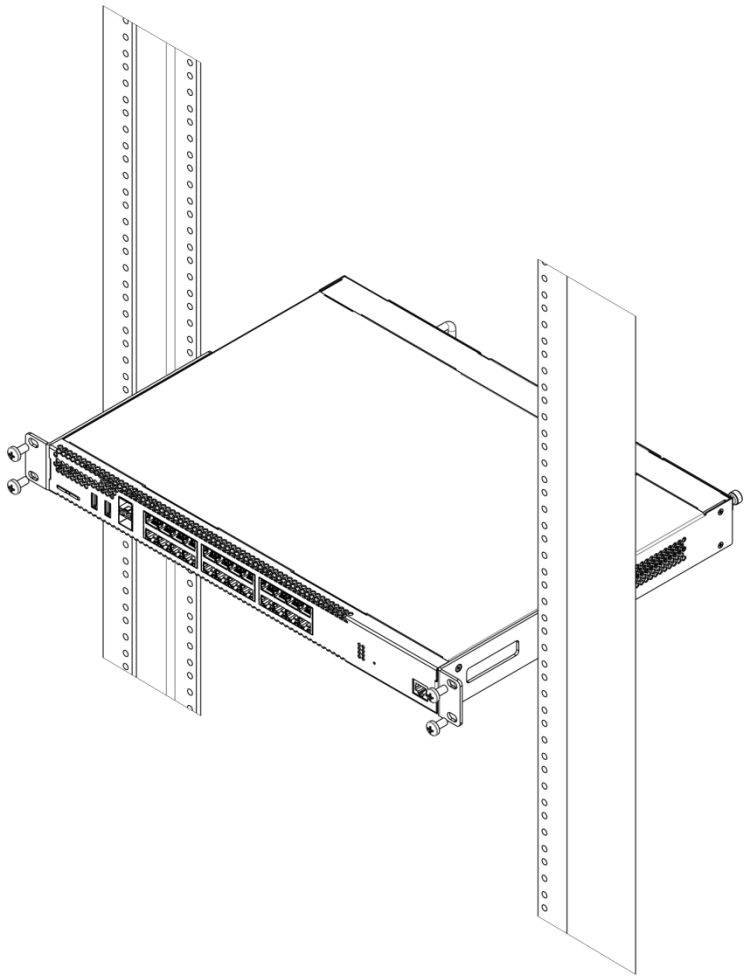


Fig. 3.2 —Device rack installation

Device ventilation system is implemented using 'front-rear' layout. Vents are located on the front and side panels of the device; ventilation modules are located at the rear. Do not block air inlet and outlet vents to avoid components overheating and subsequent device malfunction.

3.3 ESR-1000, ESR-1200 power module installation

ESR-1000 router can operate with one or two power modules. The second power module installation is necessary when the device operates under strict reliability requirements.

From the electric point of view, both places for power module installation are identical. In the context of device operation, the power module located closer to the edge is considered as the main module, and the one closer to the centre—as the backup module. Power modules can be inserted and removed without powering the device off. When additional power module is inserted or removed, the router continues operation without reboot.

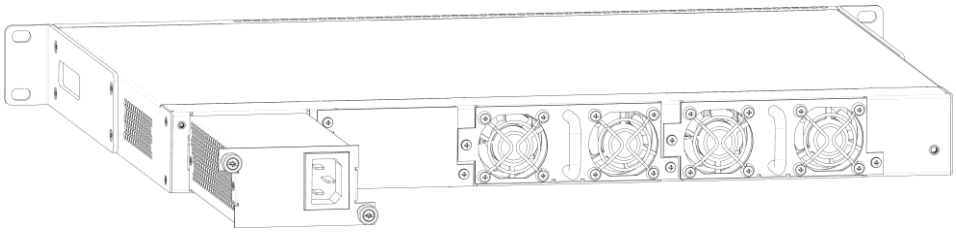


Fig. 3.3 —Power module installation

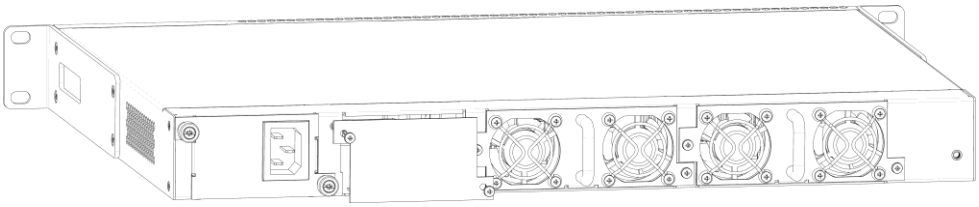


Fig. 3.4 —Cover installation

Power module fault indication may be caused not only by the module failure, but also by the absence of the primary power supply.

You can check the state of power modules by the indication on the front panel of the router (see Section 2.4.3) or by diagnostics, available through the router management interfaces.

3.4 Connection to Power Supply

1. Ground the case of the device prior to connecting it to the power supply. An insulated multiconductor wire should be used for earthing. The device grounding and the earthing wire cross-section should comply with Electric Installation Code.
2. If a PC or another device is supposed to be connected to the router console port, the device should be also securely grounded.
3. Connect the power supply cable to the device. Depending on the delivery package, the device can be powered by AC or DC electrical network. To connect the device to AC power supply, use the cable from the delivery package. To connect the device to DC power supply, use the cable with cross-section not less than 1mm^2.
4. Turn the device on and check the front panel LEDs to make sure the terminal is in normal operating conditions.

3.5 SFP transceiver installation and removal

Optical modules can be installed when the terminal is turned on or off.

Transceiver installation

1. Insert the top SFP module into a slot with its open side down, and the bottom SFP module with its open side up.

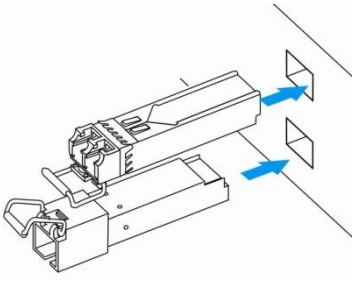


Fig. 3.5 —SFP transceiver installation

2. Push the module into the device housing until the it is secured with a clicking sound.

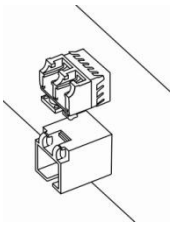


Fig. 3.6 —Installed SFP transceivers

Transceiver removal

1. Flip the module handle to unlock the latch.

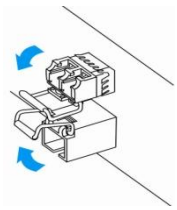


Fig. 3.7 —Opening the Latch of SFP Transceivers

2. Remove the module from the slot.

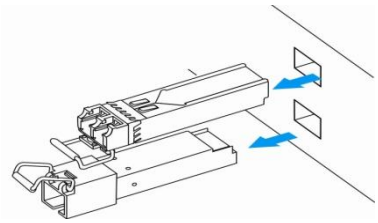


Fig. 3.8 —SFP transceiver removal

4 MANAGEMENT INTERFACES

You may use various management interfaces in order to control and monitor the device.

To access the device, you may use network connection via Telnet or SSH as well as direct connection via RS-232 compliant console port. For Telnet, SSH or console port connections, the command line interface is used for device management.

Factory settings contain trusted zone description and IP address for device management access—192.168.1.1/24.

Trusted zone includes the following interfaces:
For ESR-100: GigabitEthernet 1/0/2-4;
For ESR-200: GigabitEthernet 1/0/2-8;
For ESR-1000: GigabitEthernet 1/0/2-24;
For ESR-1200: GigabitEthernet 1/0/2-16, TengigabitEthernet 1/0/3-8

By default, the user 'admin' with the password 'password' is defined in factory settings.

For each management interface provided, there are unified configuration operating principles. When modifying and applying the configuration, you should follow the specific sequence described herein that is intended to protect the device from misconfiguration.

4.1 Command line interface (CLI)

Command Line Interface (CLI) allows to perform the device management and monitor its operation and status. You will require the PC application supporting Telnet or SSH protocol operation or direct connection via the console port (e.g. HyperTerminal).

Command line interface enables user authorization and restricts access to commands depending on their access level, provided by the administrator.

You can create as many users as you like, access rights will be assigned individually to each user.

To ensure command line interface security, all commands are divided into 2 categories—privileged and unprivileged. Privileged commands basically include configuration commands. Unprivileged commands include monitoring commands.

The system allows multiple users to connect to the device simultaneously.

5 INITIAL ROUTER CONFIGURATION

5.1 ESR router factory settings

The device is shipped to the consumer with the factory configuration installed which includes essential basic settings. Factory configuration allows you to use the router as a gateway with SNAT without applying any additional settings. Also, factory configuration contains settings that allow you to obtain network access to the device for advanced configuration.

Description of factory settings

To establish network connection, the configuration features 2 security zones named 'Trusted' for local area network and 'Untrusted' for public network. All interfaces are divided between two security zones:

1. 'Untrusted' zone is meant for a public network (WAN) connection. In this zone, DHCP ports are open in order to obtain dynamic IP address from the provider. All incoming connections from this zone to the router are blocked.

This security zone includes the following interfaces:

- For ESR-100 and ESR-200: GigabitEthernet 1/0/1;
- For ESR-1000 and ESR-1200: GigabitEthernet1/0/1, TengigabitEthernet1/0/1, TengigabitEthernet1/0/2.

Zone interfaces are grouped into a single L2 segment via *Bridge 2* network bridge.

2. 'Trusted' zone is meant for a local area network (LAN) connection. In this zone, the following ports are open: Telnet and SSH ports for remote access, ICMP ports for router availability test, DHCP ports for clients obtaining IP addresses from the router. Outgoing connections from this zone into the Untrusted zone are allowed.

This security zone includes the following interfaces:

- For ESR-100: GigabitEthernet 1/0/2-4;
- For ESR-200: GigabitEthernet1/0/2-8;
- For ESR-1000: GigabitEthernet1/0/2-24;
- For ESR-1200: GigabitEthernet1/0/2-16, TengigabitEthernet1/0/3-8;

Zone interfaces are grouped into a single L2 segment via *Bridge 1* network bridge.

On the *Bridge 2* interface, DHCP client is enabled to obtain dynamic IP address from the provider. On *Bridge 1* interface, static IP address 192.168.1.1/24 is configured. Created IP address acts as a gateway for LAN clients. For LAN clients, DHCP address pool 192.168.1.2-192.168.1.254 is configured with the mask 255.255.255.0. For clients in order to access the Internet, the router should have Source NAT service enabled.

Security zone policies have the following configuration:

Table 5.1 —Security zone policy description

Traffic origin zone	Traffic destination zone	Traffic type	Action
Trusted	Untrusted	TCP, UDP, ICMP	enabled
Trusted	Trusted	TCP, UDP, ICMP	enabled
Trusted	self	TCP/23(Telnet), TCP/22(SSH), ICMP, UDP/67(DHCP Server), UDP/123(NTP)	enabled
Untrusted	self	UDP/68(DHCP Client),	enabled

To enable device configuration on the first startup, 'admin' account has been created in the router configuration. We strongly recommend to change administrator password during the initial configuration of the router.

To enable network access to the router on the first startup, static IP address 192.168.1.1/24 has been configured on Bridge 1 interface.

5.2 Router connection and configuration

ESR series routers are intended to perform border gateway functions and securing the user network when it is connected to public data networks.

Basic router configuration should include:

- Assigning IP addresses (static or dynamic) to the interfaces that participate in data routing
- Creation of security zones and distribution of interfaces between these zones
- Creation of policies governing data transfer through these zones
- Configuration of services that accompany the data routing (NAT, Firewall, etc.)

Advanced settings depend on the requirements of the specific device application pattern and may be easily added or modified with the existing management interfaces.

5.2.1 Connection to the router

There are several device connection options:

5.2.1.1 Ethernet LAN connection

Upon the initial startup, the router starts with the factory configuration. For factory configuration description, see Section 5.1 of this Manual.

Connect the network data cable (patch cord) to any port within the ***'Trusted'*** zone and to the PC intended for management tasks.

In the router factory configuration, DHCP server is enabled with IP address pool in **192.168.1.0/24** subnet.

When network interface is connected to the management computer, the latter should obtain the network address from the server.

If IP address is not obtained for some reason, assign the interface address manually using any address except for 192.168.1.1 in 192.168.1.0/24 subnet.

5.2.1.2 RS-232 console port connection

Using RJ-45/DBF9 cable included into device delivery package, connect the router **'Console'** port to the computer RS-232 port.

Launch terminal application (e.g. HyperTerminal or Minicom) and create a new connection. VT100 terminal emulation mode should be used.

Specify the following settings for RS-232 interface:

- Bit rate: 115200bps
- Data bits: 8bit
- Parity: no
- Stop bits: 1
- Flow control: none

5.2.2 Basic router configuration

Upon the first startup, the router configuration procedure includes the following steps:

- Changing password for "admin" user.
- Creation of new users.
- Assigning device name (Hostname).
- Setting parameters for public network connection in accordance with the provider requirements.
- Configuring remote connection to router.
- Applying basic settings.

5.2.2.1 Changing password for "admin" user

To ensure the secure system access, you should change the password for the privileged 'admin' user.

- 'techsupport' account ('eltex' up to version 1.0.7) is required for service center specialist remote access.
- 'remote' account — RADIUS, TACACS+, LDAP authentication.
- 'admin', 'techsupport', 'remote' users cannot be deleted. You may only change passwords and a privilege level**.**

Username and password are required for login during the device administration sessions.

To change 'admin' password, use the following commands:

```
esr# configure
esr(config)# username admin
esr(config-user)# password <new-password>
esr(config-user)# exit
```

5.2.2.2 Creation of new users

Use the following commands to create a new system user or configure the username, password, or privilege level:

```
esr(config)# username <name>
esr(config-user)# password <password>
esr(config-user)# privilege <privilege>
esr(config-user)# exit
```

Privilege levels 1–9 allow you to access the device and view its operation status, but the device configuration is disabled. Privilege levels 10–14 allow both the access to the device and configuration of majority of its functions. Privilege level 15 allows both the access to the device and configuration of all its functions.

- Example of commands, that allow you to create user **'fedor'** with password **'12345678'** and privilege level **15** and create user **'ivan'** with password **'password'** and privilege level '**1**:'

```
esr# configure
esr(config)# username fedor
esr(config-user)# password 12345678
esr(config-user)# privilege 15
esr(config-user)# exit
esr(config)# username ivan
esr(config-user)# password password
esr(config-user)# privilege 1
esr(config-user)# exit
```

5.2.2.3 Assigning device name

To assign the device name, use the following commands:

```
esr# configure
esr(config)# hostname <new-name>
```

When a new configuration is applied, command prompt will change to the value specified by **<new-name>** parameter.

5.2.2.4 Configuration of public network parameters

To configure router network interface in the public network, you should assign parameters defined by the network provider—default IP address, subnet mask and gateway address—to the device.

- Example of static IP address configuration commands for **GigabitEthernet 1/0/2.150** sub-interface used for obtaining access to the router via **VLAN 150**.

  Interface parameters:

  - IP address: **192.168.16.144**;
  - Subnet mask: **255.255.255.0**;
  - Default gateway IP address: **192.168.16.1**.

```
esr# configure
esr(config)# interface gigabitethernet 1/0/2.150
esr(config-subif)# ip address 192.168.16.144/24
esr(config-subif)# exit
esr(config)# ip route 0.0.0.0/0 192.168.16.1
```

To ensure the correct IP address assigning for the interface, enter the following command when the configuration is applied:

```
esr# show ip interfaces
```

```
IP address            Interface                          Type
-------------------   --------------------------------   -------
192.168.16.144/24     gigabitethernet 1/0/2.150          static
```

Provider may use dynamically assigned addresses in their network. If the there is DHCP server in the network, you can obtain the IP address via DHCP protocol.

- Configuration example for obtaining dynamic IP address from DHCP server on **GigabitEthernet 1/0/10** interface:

```
esr# configure
esr(config)# interface gigabitethernet 1/0/10
esr(config-if)# ip address dhcp enable
esr(config-if)# exit
```

To ensure the correct IP address assigning for the interface, enter the following command when the configuration is applied:

```
esr# show ip interfaces
```

```
IP address            Interface                          Type
-------------------   --------------------------------   -------
192.168.11.5/25       gigabitethernet 1/0/10             DHCP
```

5.2.2.5 Configuring remote connection to router

In the factory configuration, remote access to the router may be established via Telnet or SSH from the **'trusted'** zone. To enable remote access to the router from other zones, e.g. from the public network, you should create the respective rules in the firewall.

When configuring access to the router, rules should be created for the following pair of zones:

- **source-zone**—zone that the remote access will originate from
- **self**—zone which includes router management interface

Use the following commands to create the allowing rule:

```
esr# configure
esr(config)# security zone-pair <source-zone> self
esr(config-zone-pair)# rule <number>
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol tcp
esr(config-zone-rule)# match source-address <network object-group>
esr(config-zone-rule)# match destination-address <network object-group>
esr(config-zone-rule)# match source-port any
esr(config-zone-rule)# match destination-port <service object-group>
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

- Example of commands that allow users from '**untrusted**' zone with IP addresses in range **132.16.0.5-132.16.0.10** to connect to the router with IP address **40.13.1.22** via SSH:

```
esr# configure
esr(config)# object-group network clients
esr(config-addr-set)# ip address-range 132.16.0.5-132.16.0.10
esr(config-addr-set)# exit
esr(config)# object-group network gateway
esr(config-addr-set)# ip address-range 40.13.1.22
esr(config-addr-set)# exit
esr(config)# object-group service ssh
esr(config-port-set)# port-range 22
esr(config-port-set)# exit
esr(config)# security zone-pair untrusted self
esr(config-zone-pair)# rule 10
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol tcp
esr(config-zone-rule)# match source-address clients
esr(config-zone-rule)# match destination-address gateway
esr(config-zone-rule)# match source-port any
esr(config-zone-rule)# match destination-port ssh
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

5.2.2.6 Applying basic settings

To apply performed router configuration changes, you should enter the following commands from the root section of the command interface.

```
esr# commit
esr# confirm
```

If during configuration device was accessed remotely and the management interface network settings have changed, when you execute **commit** command the connection to the device may be lost. Use new network settings defined in configuration to connect to the device and execute **confirm** command.

If you are not able to execute **confirm** command, upon the expiration of the confirmation timer device configuration will revert to the state prior the **commit** command execution.

6 FIRMWARE UPDATE

6.1 Updating firmware via system resources

To update the firmware, use any of the following servers: TFTP, FTP, SCP. Router firmware files obtained from the manufacturer should be allocated on the server.

The router stores two copies of the firmware. To ensure the reliability of the firmware update procedure, only the copy that was not used for the last device startup is available for the update.

Update via system resources is available in version 1.0.3.69 and later. You may update the firmware from the earlier versions using the instructions located in Section 6.2.

To update the firmware for the device running the operating system, follow procedure described below.

1. Prepare the selected server for operation. You should know the server address; also firmware distributive file should be loaded onto the server.
2. The router should be prepared for operation according to the documentary requirements. Router configuration should allow for data exchange with the server via TFTP/FTP/SCP and ICMP protocols. At that, you should take into account the server inherence to the router security zones.
3. Connect to the router locally via Console port or remotely via Telnet or SSH.

   Check the server availability for the router using *ping* command on the router. If the server is not available, check the router settings and the status of the server network interfaces.

4. To update the router firmware, enter the following command. Specify IP address of the server being used as *<server>* parameter. For updates that utilize FTP or SCP server, you should enter a username (*<user>* parameter) and a password (*<password>* parameter). Specify the name of the firmware file loaded onto the server as *<file_name>* parameter. When the command is executed, router will copy the file into its internal memory, perform data integrity check and save it into non-volatile memory.

   – TFTP:

   ```
   esr# copy tftp://<server>:/<file_name> system:firmware
   ```

   – FTP:

   ```
   esr# copy ftp://[<user>[:<password>]@]<server>:/<file_name>
   system:firmware
   ```

   – SCP:

   ```
   esr# copy scp://[<user>[:<password>]@]<server>://<folder>/<file_name>
   system:firmware
   ```

   For example, let's update basic firmware via SCP:

   ```
   esr# copy scp://adm:password123@192.168.16.168://home/tftp/firmware
   system:firmware
   ```

5. To start the device with the new firmware version, you have to switch the active image. With *show bootvar* command, locate the image number, containing updated firmware.

```
esr# show bootvar
```

Image	Version	Date	Status	After reboot
1	1.0.4 build 94[f812808]	date 18/02/2015 time 16:12:54	Active	*
2	1.0.4 build 94[f812808]	date 18/02/2015 time 16:12:54	Not Active	

Use the following command to select the image:

```
esr# boot system image-[1|2]
```

6. To update the secondary bootloader (U-Boot), enter the following command: Specify IP address of the server being used as *<server>* parameter. For updates that utilize FTP or SCP server, you should enter a username (*<user>* parameter) and a password (*<password>* parameter). Specify the name of the secondary bootloader onto the server as *<file_name>* parameter. When the command is executed, router will copy the file into its internal memory, perform data integrity check and save it into non-volatile memory.

   – TFTP:
   ```
   esr# copy tftp://<server>:/<file_name> system:boot
   ```
   – FTP:
   ```
   esr# copy ftp://<server>:/<file_name> system:boot
   ```
   – SCP:
   ```
   esr# copy scp://[<user>[:<password>]@]<server>://<folder>/<file_name>
   system:boot
   ```

6.2 Updating firmware via bootloader

Router firmware may be updated via the bootloader as follows:

1. When U-Boot finishes the router initialization, break the device startup with the **<Esc>** key.

```
Configuring PoE...
distribution 1 dest_threshold 0xa drop_timer 0x0
Configuring POE in bypass mode
NAE configuration done!
initializing port 0, type 2.
initializing port 1, type 2.
SMC Endian Test:b81fb81f
nae-0, nae-1
  =======Skip: Load SYS UCORE for old 8xxB1/3xxB0 revision on default.
Hit any key to stop autoboot:  2
```

2. Specify TFTP server address:

```
BRCM.XLP316Lite Rev B0.u-boot# setenv serverip 10.100.100.1
```

3. Specify router IP address:

```
BRCM.XLP316Lite Rev B0.u-boot# setenv ipaddr 10.100.100.2
```

4. You may save the environment using 'saveenv' command for future updates.

5. Launch firmware update procedure:

   – `BRCM.XLP316Lite Rev B0.u-boot# run tftp_update_image1`
   – `BRCM.XLP316Lite Rev B0.u-boot# run set_bootpart_1`

```
Using nae-0-3 device
TFTP from server 10.100.100.1; our IP address is 10.100.100.2
Filename 'esr1000/firmware'.
Load address: 0xa800000060000000
Loading: TftpStart:TftpTimeoutMsecs = 10000, TftpTimeoutCountMax = 6
#################################################################
    #################################################################
#################################################################
         ########################
    ##################################
done
Bytes transferred = 64453909 (3d77d15 hex)
Device 0: MT29F8G08ABBCAH4   ... is now current device

NAND erase: device 0 offset 0x1440000, size 0x6400000
Bad block table found at page 262080, version 0x01
Bad block table found at page 262016, version 0x01
Erasing at 0x7800000 -- 1895825408% complete..
OK

NAND write: device 0 offset 0x1440000, size 0x6400000
 104857600 bytes written: OK
```

6. Run the downloaded software:

```
BRCM.XLP316Lite Rev B0.u-boot# reset
```

6.3 Secondary bootloader update (U-Boot)

Secondary bootloader initializes NAND and the router. During the update, a new file of the secondary bootloader is saved to the flash

To view the current version of the load file operating on the device, execute 'version' command in U-Boot CLI. Also, the version is displayed during the router startup.:

```
BRCM.XLP316Lite Rev B0.u-boot# version
BRCM.XLP.U-Boot:1.1.0.47 (29/11/2016 - 19:00:24)
```

Firmware update procedure:

1. When U-Boot finishes the router initialization, break the device startup with the **<Esc>** key.

```
Configuring PoE...
distribution 1 dest_threshold 0xa drop_timer 0x0
Configuring POE in bypass mode
NAE configuration done!
initializing port 0, type 2.
initializing port 1, type 2.
SMC Endian Test:b81fb81f
nae-0, nae-1
  =======Skip: Load SYS UCORE for old 8xxB1/3xxB0 revision on default.
Hit any key to stop autoboot:  2
```

2. Specify TFTP server address:

```
BRCM.XLP316Lite Rev B0.u-boot# setenv serverip 10.100.100.1
```

3. Specify router IP address:

```
BRCM.XLP316Lite Rev B0.u-boot# setenv ipaddr 10.100.100.2
```

4. You may save the environment using 'saveenv' command for future updates.

5. Launch firmware update procedure:

```
BRCM.XLP316Lite Rev B0.u-boot# run upd_uboot (or «run tftp_update_uboot» - depends
on the bootloader version)
```

```
Using nae-1 device
TFTP from server 10.100.100.1; our IP address is 10.100.100.2
Filename 'esr1000/u-boot.bin'.
Load address: 0xa800000078020000
Loading: #################################################################
done
Bytes transferred = 852648 (d02a8 hex)
SF: Detected MX25L12805D with page size 256, total 16777216 bytes
16384 KiB MX25L12805D at 0:0 is now current device
```

6. Reboot the router:

```
BRCM.XLP316Lite Rev B0.u-boot# reset
```

7 ROUTER CONFIGURATION EXAMPLES

7.1 VLAN Configuration

VLAN (Virtual Local Area Network) is a logical (virtual) local area network that represents a group of devices which communicate on channel level regardless of their physical location.

Objective 1: On the basis of the factory configuration, remove gi1/0/1 port from VLAN 2.

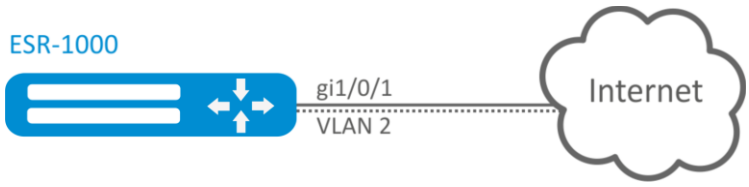


Fig. 7.1 —Network structure

Solution:

Remove VLAN2 from gi1/0/1 port:

```
esr-1000(config)# interface gi 1/0/1
esr-1000(config-if-gi)# switchport general allowed vlan remove 2 untagged
esr-1000(config-if-gi)# no switchport general pvid
```

Configuration changes will take effect when the configuration is applied:

```
esr-1000# commit
Configuration has been successfully committed
esr-1000# confirm
Configuration has been successfully confirmed
```

Objective 2: Configure gi1/0/1 and gi1/0/2 ports for packet transmission and reception in VLAN 2, VLAN 64, VLAN 2000.

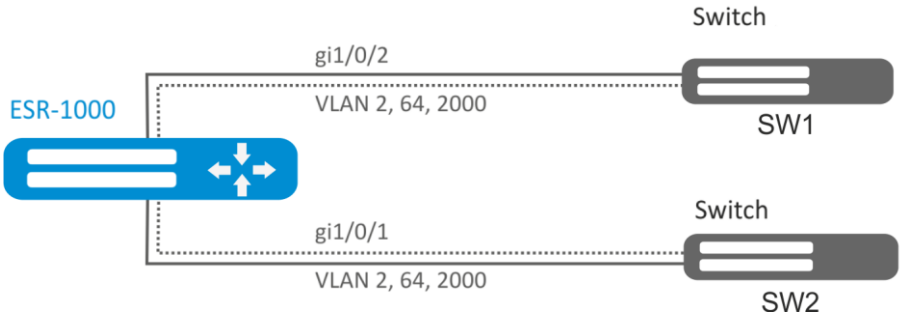


Fig. 7.2 —Network structure

Solution:

Create VLAN 2, VLAN 64, VLAN 2000 on ESR-1000:

```
esr-1000(config)# vlan 2,64,2000
```

Specify VLAN 2, VLAN 64, VLAN 2000 for gi1/0/1-2 port:

```
esr-1000(config)# interface gi1/0/1
esr-1000(config-if-gi)# switchport forbidden default-vlan
esr-1000(config-if-gi)# switchport general allowed vlan add 2,64,2000 tagged
```

Configuration changes will take effect when the configuration is applied:

```
esr-1000# commit
Configuration has been successfully committed
esr-1000# confirm
```

Objective 3: Configure gi1/0/1 ports for packet transmission and reception in VLAN 2, VLAN 64, VLAN 2000 in trunk mode, configure gi1/0/2 port in access mode for VLAN 2 on ESR-100/ESR -200.

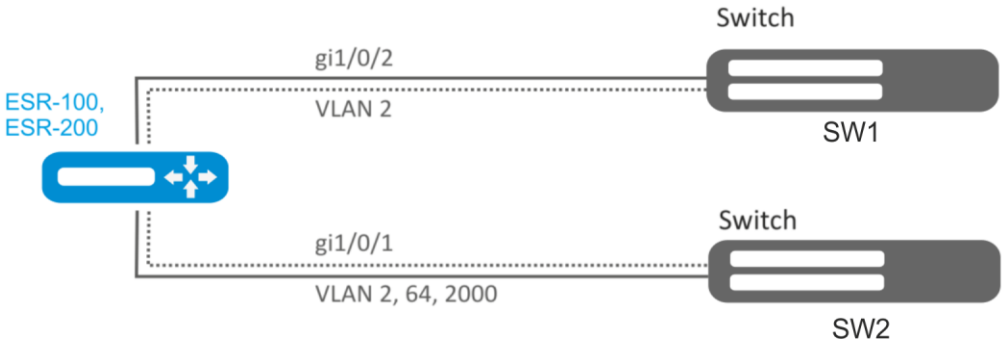


Fig. 7.3—Network structure

Solution:

Create VLAN 2, VLAN 64, VLAN 2000 on ESR-100/ ESR-200:

```
esr(config)# vlan 2,64,2000
```

Specify VLAN 2, VLAN 64, VLAN 2000 for gi1/0/1 port:

```
esr(config)# interface gi1/0/1
esr(config-if-gi)# switchport forbidden default-vlan
esr(config-if-gi)# switchport mode trunk
esr(config-if-gi)# switchport trunk allowed vlan add 2,64,2000
```

Specify VLAN2 to gi1/0/2 port:

```
esr(config)# interface gi1/0/1
esr(config-if-gi)# switchport access vlan 2
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
```

7.2 QinQ termination configuration

QinQ is a technology of packet transmission with two 802.1q tags. The technology is used for extending quantity of VLANs in data networks. 802.1q header, which is closer to payload, is an Inner Tag also known as C-VLAN (Custimer VLAN). 802.1q header, which is comes before C-VLAN, is an Outer Tag also known as S-VLAN (Service VLAN). Using of double tags in Ethernet frames is describing by 802.1ad protocol.

Objective: Configure 192.168.1.1/24 subnet termination (Combinations C-VLAN: 741, S-VLAN: 828) on gigabitethernet 1/0/1 physical interface.

Solution:

Enable 802.1ad protocol support on physical interface:

```
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# switchport dot1q ethertype egress stag 802.1ad
esr(config-if-gi)# exit
```

Create subinterface for S-VLAN: 828

```
esr(config)# interface gigabitethernet 1/0/1.828
esr(config-subif)# exit
```

Create QinQ subinterface for C-VLAN: 741

```
esr(config)# interface gigabitethernet 1/0/1.828.741
esr(config-qinq-if)# ip address 192.168.1.1/24
esr(config-qinq-if)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr-1000# commit
Configuration has been successfully committed
esr-1000# confirm
Configuration has been successfully confirmed
```

Besides assigning IP address, it is necessary to disable firewall or to configure corresponding security zone on qinq interface.

7.3 AAA configuration

AAA (Authentication, Authorization, Accounting) is used for description of access provisioning and control.

- Authentication is a matching of a person (request) for the existing account in the security system. Performed by the login and password.
- Authorization (authorization, privilege verification, access level verification) is a matching of the existing account in the system (passed authentication) and specific privileges.
- Accounting (accounting)is a monitoring of user connection or changes made by the user.

Objective: Configure authentication for users being connected via Telnet and RADIUS (192.168.16.1/24).

Solution:

Configure connection to RADIUS server and specify the key (password):

```
esr# configure
esr(config)# radius-server host 192.168.16.1
esr(config-radius-server)# key ascii-text encrypted 8CB5107EA7005AFF
esr(config-radius-server)# exit
```

Create authentication profile:

```
esr(config)# aaa authentication login log radius
```

Specify authentication mode used for Telnet protocol connection:

```
esr(config)# line telnet
esr(config-line-telnet)# login authentication log
esr(config-line-telnet)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view the information on RADIUS server connection settings, use the following command:

```
esr# show aaa radius-servers
```

To view the authentication profiles, use the following command:

```
esr# show aaa authentication
```

7.4 Command privilege configuration

Command privilege configuration is a flexible tool that allows you to assign baseline user privilege level (1–15) to a command set. In future, you may specify privilege level during user creation which will define a command set available to them.

- *Levels 1-9* enable all monitoring commands (show …).
- *Levels 10-14* enable all commands except for device reboot, user management and other specific commands.
- *Level 15* enables all monitoring commands.

Objective: Transfer all interface information display commands to the privilege level 10 except for 'show interfaces bridges' command. Transfer 'show interfaces bridges' command to the privilege level 3.

Solution:

In configuration mode, identify commands enabled for operation under privilege level 10 and privilege level 3.

```
esr(config)# privilege root level 3 "show interfaces bridge"
esr(config)# privilege root level 10 "show interfaces"
```

Configuration changes will take effect when the configuration is applied and only for new user sessions:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

7.5 DHCP server configuration

Integrated DHCP server of the router allows you to configure LAN device network settings. Router DHCP server is able to send additional options to network devices, for example:

- *default-router*—IP address of the router used as default gateway.
- *domain-name*—domain name which will be used by client while solving host names via domain name system (DNS).
- *dns-server*—list of domain name server addresses for the current network that should be known by the client. Server addresses are listed in descending order of their preference.

Objective: Configure DHCP server operation in a local network that belongs to the 'trusted' security zone. Define IP address pool from 192.168.1.0/24 subnet for distribution to clients. Define address lease time equal to 1 day. Configure transmission of the default route, domain name and DNS server addresses to clients using DHCP options.

Solution:

Create **'trusted'** security zone and define the inherence of the network interfaces being used to zones:

```
esr# configure
esr(config)# security zone trusted
esr(config-zone)# exit
esr(config)# interface gi1/0/2-24
esr(config-if-gi)# security-zone TRUSTED
esr(config-if-gi)# exit
```

Create address pool named '**Simple**' and add IP address range intended for server clients lease into this pool. Define parameters of the subnet that the pool belongs to, and the lease time for addresses.

```
esr# configure
esr(config)# ip dhcp-server pool Simple
esr(config-dhcp-server)# network 192.168.1.0/24
esr(config-dhcp-server)# address-range 192.168.1.100-192.168.1.125
esr(config-dhcp-server)# default-lease-time 1:00:00
```

Configure transfer of additional network parameters to clients:

- default route: 192.168.1.1
- domain name: eltex.loc
- DNS server list: DNS1: 172.16.0.1, DNS2: 8.8.8.8.

```
esr(config-dhcp-server)# domain-name "eltex.loc"
esr(config-dhcp-server)# default-router 192.168.1.1
esr(config-dhcp-server)# dns-server 172.16.0.1 8.8.8.8
```

```
esr(config-dhcp-server)# exit
```

To enable IP address distribution from the configurable pool by DHCP server, IP interface should be created on the router that belongs to the same subnet as the pool addresses.

```
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# security-zone trusted
esr(config-if-gi)# ip address 192.168.1.1/24
esr(config-if-gi)# exit
```

To enable DHCP protocol message transmission to the server, you should create the respective port profiles including source port 68 and destination port 67 used by DHCP protocol and create the allowing rule in the security policy for UDP protocol packet transmission.

```
esr(config)# object-group service dhcp_server
esr(config-object-group-service)# port-range 67
esr(config-object-group-service)# exit
esr(config)# object-group service dhcp_client
esr(config-object-group-service)# port-range 68
esr(config-object-group-service)# exit
esr(config)# security zone-pair trusted self
esr(config-zone-pair)# rule 30
esr(config-zone-rule)# match protocol udp
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# match source-port dhcp_client
esr(config-zone-rule)# match destination-port dhcp_server
esr(config-zone-rule)# action permit
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

Allow server operation:

```
esr(config)# ip dhcp-server
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view the list of leased addresses, use the following command:

```
esr# show ip dhcp binding
```

To view the configured address pools, use the following command:

```
esr# show ip dhcp server pool
esr# show ip dhcp server pool Simple
```

Configuration of settings for IPv6 is performed by analogy to IPv4.

7.6 Destination NAT configuration

Destination NAT (DNAT) function includes destination IP address translation for packets transferred through the network gateway.

DNAT is used for redirection of traffic, coming to a specific 'virtual' address in a public network, to a 'real' server in LAN located behind the network gateway. This function may be used for establishing a public access to servers located within the private network without any public network address.

Objective: Establish access from the public network, that belongs to the 'UNTRUST' zone, to LAN server in 'TRUST' zone. Server address in LAN—10.1.1.100. Server should be accessible from outside the network—address 1.2.3.4, access port 80.

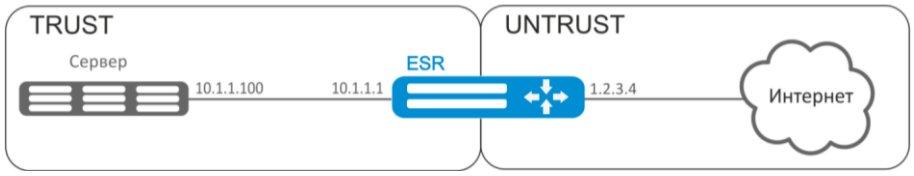


Fig. 7.4—Network structure

Solution:

Create 'UNTRUST' and 'TRUST' security zones. Define the inherence of the network interfaces being used to zones. Assign IP addresses to interfaces simultaneously.

```
esr# configure
esr(config)# security zone UNTRUST
esr(config-zone)# exit
esr(config)# security zone TRUST
esr(config-zone)# exit

esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# security-zone TRUST
esr(config-if-gi)# ip address 10.1.1.1/25
esr(config-if-gi)# exit

esr(config)# interface tengigabitethernet 1/0/1
esr(config-if-te)# ip address 1.2.3.4/29
esr(config-if-te)# security-zone UNTRUST
esr(config-if-te)# exit
```

Create IP address and port profiles required for configuration of the Firewall and DNAT rules.

- NET_UPLINK—public network address profile
- SERVER_IP—local area network address profile
- SRV_HTTP—port profile

```
esr(config)# object-group network NET_UPLINK
esr(config-object-group-network)# ip address 1.2.3.4
esr(config-object-group-network)# exit

esr(config)# object-group service SRV_HTTP
esr(config-object-group-network)# port 80
esr(config-object-group-network)# exit

esr(config)# object-group network SERVER_IP
esr(config-object-group-network)# ip address 10.1.1.100
esr(config-object-group-network)# exit
```

Proceed to DNAT configuration mode and create destination address and port pool that will be used for translation of packet addresses coming to address 1.2.3.4 from the external network.

```
esr(config)#  nat destination
esr(config-dnat)# pool SERVER_POOL
esr(config-dnat-pool)# ip address 10.1.1.100
esr(config-dnat-pool)# ip port 80
esr(config-dnat-pool)# exit
```

Create 'DNAT' rule set which will be used for address translation. In the set attributes, specify that the rules are applying only to packets coming from the 'UNTRUST' zone. Rule set includes data matching requirements for destination address and port (match destination-address, match destination-port) and for the protocol. Also, the set includes an action that applies to the data that satisfy all of the rules (action destination-nat). The rule set is applied with 'enable' command.

```
esr(config-dnat)# ruleset DNAT
esr(config-dnat-ruleset)# from zone UNTRUST
esr(config-dnat-ruleset)# rule 1
esr(config-dnat-rule)# match destination-address NET_UPLINK
esr(config-dnat-rule)# match protocol tcp
esr(config-dnat-rule)# match destination-port SERV_HTTP
esr(config-dnat-rule)# action destination-nat pool SERVER_POOL
esr(config-dnat-rule)# enable
esr(config-dnat-rule)# exit
esr(config-dnat-ruleset)# exit
esr(config-dnat)# exit
```

To transfer the traffic coming from 'UNTRUST' zone into 'TRUST' zone, create the respective pair of zones. Only DNAT-translated traffic with the destination address matching the 'SERVER_IP' specified in the profile should be transferred.

```
esr(config)# security zone-pair UNTRUST TRUST
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address SERVER_IP
esr(config-zone-rule)# match protocol any
esr(config-zone-rule)# match destination-nat
esr(config-zone-rule)# action permit
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To view the performed settings, use the following command:

```
esr# show ip nat destination pools
esr# show ip nat destination rulesets
esr# show ip nat proxy-arp
esr# show ip nat translations
```

7.7 Source NAT configuration

Source NAT (SNAT) function substitutes source address for packets transferred through the network gateway. When packets are transferred from LAN into public network, source address is substituted to one of the gateway public addresses. Additionally, source port substitution may be added to the source address. When packets are transferred back from public network to LAN, address and port are reverted to their original values.

SNAT function enables Internet access for computers located in LAN. At that, there is no need in assigning public IP addresses for these computers.

Objective 1: Configure access for users in LAN 10.1.2.0/24 to public network using Source NAT function. Define public network address range for SNAT 100.0.0.100-100.0.0.249.

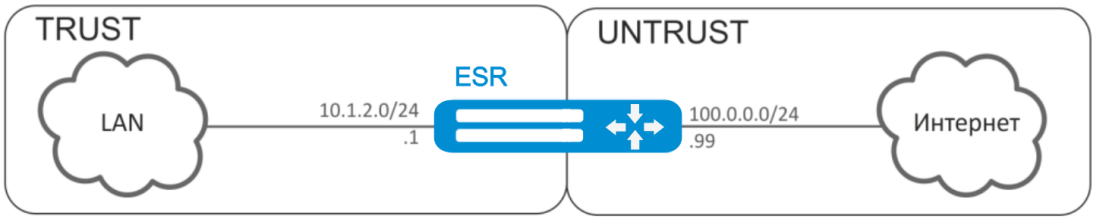


Fig. 7.5—Network structure

Solution:

Begin configuration with creation of security zones, configuration of network interfaces and their inherence to security zones. Create 'TRUST' zone for LAN and 'UNTRUST' zone for public network.

```
esr# configure
esr(config)# security zone UNTRUST
esr(config-zone)# exit
esr(config)# security zone TRUST
esr(config-zone)# exit

esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# ip address 10.1.2.1/24
esr(config-if-gi)# security-zone TRUST
esr(config-if-gi)# exit

esr(config)# interface tengigabitethernet 1/0/1
esr(config-if-te)# ip address 100.0.0.99/24
esr(config-if-te)# security-zone UNTRUST
esr(config-if-te)# exit
```

For SNAT function configuration and definition of rules for security zones, create 'LOCAL_NET' LAN address profile that includes addresses which are allowed to access the public network and 'PUBLIC_POOL' public network address profile.

```
esr(config)# object-group network LOCAL_NET
esr(config-object-group-network)# ip address-range 10.1.2.2-10.1.2.254
esr(config-object-group-network)# exit

esr(config)# object-group network PUBLIC_POOL
esr(config-object-group-network)# ip address-range 100.0.0.100-100.0.0.249
esr(config-object-group-network)# exit
```

To transfer traffic from 'TRUST' zone into 'UNTRUST' zone, create a pair of zones and add rules allowing traffic transfer in this direction. Additionally, there is a check in place to ensure that data source address belongs to 'LOCAL_NET' address range in order to limit the access to public network. Rules are applied with **enable** command.

```
esr(config)# security zone-pair TRUST UNTRUST
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# match source-address LOCAL_NET
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# match protocol any
esr(config-zone-rule)# action permit
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

Configure SNAT service. First step is to create public network address pool for use with SNAT.

```
esr(config)# nat sourse
esr(config-snat)# pool TRANSLATE_ADDRESS
esr(config-snat-pool)# ip address-range 100.0.0.100-100.0.0.249
esr(config-snat-pool)# exit
```

Second step is to create SNAT rule set. In the set attributes, specify that the rules are applying only to packets transferred to public network—into the 'UNTRUST' zone. Rules include a check which ensures that data source address belongs to 'LOCAL_NET' pool.

```
esr(config-snat)# ruleset SNAT
esr(config-snat-ruleset)# to zone UNTRUST
esr(config-snat-ruleset)# rule 1
esr(config-snat-rule)# match source-address LOCAL_NET
esr(config-snat-rule)# match destination-address any
esr(config-snat-rule)# match destination-port any
esr(config-snat-rule)# action source-nat pool TRANSLATE_ADDRESS
esr(config-snat-rule)# enable
esr(config-snat-rule)# exit
esr(config-snat-ruleset)# exit
```

In order the router could response to the ARP requests for addresses from the public pool, you should launch ARP Proxy service. ARP Proxy service is configured on the interface that IP address from 'PUBLIC_POOL' public network address profile subnet belongs to.

```
esr(config)# interface tengigabitethernet 1/0/1
esr(config-if-te)# ip nat proxy-arp PUBLIC_POOL
```

To enable public network access for LAN devices, they should be configured for routing—10.1.2.1 should be defined as a gateway address.

On the router, you should create the route for public network. Define this route as a default using the following command.

```
esr(config)# ip route 0.0.0.0/0 100.0.0.100
esr(config)# exit
```

Configuration changes will take effect when commit command is executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

Objective 2: Configure access for users in LAN 21.12.2.0/24 to public network using Source NAT function without the firewall. Public network address range for SNAT 200.10.0.100-200.10.0.249.

Fig. 7.6—Network structure

Solution:

Begin configuration with network interface configuration and disabling the firewall:

```
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# ip address 21.12.2.1/24
esr(config-if-gi)# ip firewall disable
esr(config-if-gi)# exit

esr(config)# interface tengigabitethernet 1/0/1
esr(config-if-te)# ip address 200.10.0.99/24
esr(config-if-te)# ip firewall disable
esr(config-if-te)# exit
```

For SNAT function configuration, create 'LOCAL_NET' LAN address profile that includes addresses which are allowed to access the public network and 'PUBLIC_POOL' public network address profile.

```
esr(config)# object-group network LOCAL_NET
esr(config-object-group-network)# ip address-range 21.12.2.2-21.12.2.254
esr(config-object-group-network)# exit

esr(config)# object-group network PUBLIC_POOL
esr(config-object-group-network)# ip address-range 200.10.0.100-200.10.0.249
esr(config-object-group-network)# exit
```

Configure SNAT service.

First step is to create public network address pool for use with SNAT:

```
esr(config)# nat source
esr(config-snat)# pool TRANSLATE_ADDRESS
esr(config-snat-pool)# ip address-range 200.10.0.100-200.10.0.249
esr(config-snat-pool)# exit
```

Second step is to create SNAT rule set. In the set attributes, specify that the rules are applying only to packets transferred to public network through te1/0/1 port. Rules include a check which ensures that data source address belongs to 'LOCAL_NET' pool:

```
esr(config-snat)# ruleset SNAT
esr(config-snat-ruleset)# to interface te1/0/1
esr(config-snat-ruleset)# rule 1
esr(config-snat-rule)# match source-address LOCAL_NET
esr(config-snat-rule)# match destination-address any
esr(config-snat-rule)# match protocol any
esr(config-snat-rule)# action source-nat pool TRANSLATE_ADDRESS
esr(config-snat-rule)# enable
esr(config-snat-rule)# exit
esr(config-snat-ruleset)# exit
```

In order the router could response to the ARP requests for addresses from the public pool, you should launch ARP Proxy service. ARP Proxy service is configured on the interface that IP address from 'PUBLIC_POOL' public network address profile subnet belongs to:

```
esr(config)# interface tengigabitethernet 1/0/1
esr(config-if-te)# ip nat proxy-arp PUBLIC_POOL
```

To enable public network access for LAN devices, they should be configured for routing—21.12.2.1 should be defined as a gateway address.

On the router, you should create the route for public network. Define this route as a default using the following command:

```
esr(config)# ip route 0.0.0.0/0 200.10.0.99
esr(config)# exit
```

Configuration changes will take effect when commit command is executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

7.8 Firewall configuration

Firewall is a package of hardware or software tools that allows for control and filtering of transmitted network packets in accordance with the defined rules.

Objective: Enable message exchange via ICMP between PC1, PC2 and ESR router.

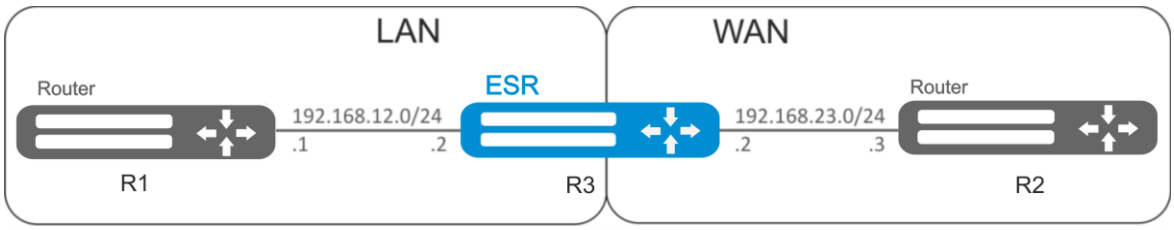


Fig. 7.7—Network structure

Solution:

Create security zone for each ESR network:

```
esr# configure
esr(config)# security zone LAN
esr(config-zone)# exit
esr(config)# security zone WAN
esr(config-zone)# exit
```

Configure network interfaces and identify their inherence to security zones:

```
esr(config)# interface gi1/0/2
esr(config-if-gi)# ip address 192.168.12.2/24
esr(config-if-gi)# security-zone LAN
esr(config-if-gi)# exit
esr(config)# interface gi1/0/3
esr(config-if-gi)# ip address 192.168.23.2/24
esr(config-if-gi)# security-zone WAN
esr(config-if-gi)# exit
```

For definition of rules for security zones, create 'LAN' address profile that includes addresses which are allowed to access WAN network and 'WAN' network address profile.

```
esr(config)# object-group network WAN
esr(config-object-group-network)# ip address-range 192.168.23.2
esr(config-object-group-network)# exit
esr(config)# object-group network LAN
esr(config-object-group-network)# ip address-range 192.168.12.2
esr(config-object-group-network)# exit
esr(config)# object-group network LAN_GATEWAY
esr(config-object-group-network)# ip address-range 192.168.12.1
esr(config-object-group-network)# exit
esr(config)# object-group network WAN_GATEWAY
esr(config-object-group-network)# ip address-range 192.168.23.3
esr(config-object-group-network)# exit
```

To transfer traffic from 'LAN' zone into 'WAN' zone, create a pair of zones and add a rule allowing ICMP traffic transfer from PC1 to PC2. Rules are applied with *enable* command:

```
esr(config)# security zone-pair LAN WAN
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol icmp
esr(config-zone-rule)# match destination-address WAN
esr(config-zone-rule)# match source-address LAN
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

To transfer traffic from 'WAN' zone into 'LAN' zone, create a pair of zones and add a rule allowing ICMP traffic transfer from PC2 to PC1. Rules are applied with *enable* command:

```
esr(config)# security zone-pair WAN LAN
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol icmp
esr(config-zone-rule)# match destination-address LAN
esr(config-zone-rule)# match source-address WAN
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

Router always has a security zone named 'self'. When the traffic recipient is the router itself, i.e. traffic is not transit, pass 'self' zone as a parameter. Create a pair of zones for traffic coming from 'WAN' zone into 'self' zone. In order the router could response to the ICMP requests from 'WAN' zone, add a rule allowing ICMP traffic transfer from PC2 to ESR router:

```
esr(config)# security zone-pair WAN self
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol icmp
esr(config-zone-rule)# match destination-address WAN
esr(config-zone-rule)# match source-address WAN_GATEWAY
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
```

Create a pair of zones for traffic coming from 'LAN' zone into 'self' zone. In order the router could response to the ICMP requests from 'LAN' zone, add a rule allowing ICMP traffic transfer from PC1 to ESR:

```
esr(config)# security zone-pair LAN self
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol icmp
```

```
esr(config-zone-rule)# match destination-address LAN
esr(config-zone-rule)# match source-address LAN_GATEWAY
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
esr(config)# exit
```

Configuration changes will take effect when the following commands are executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view port membership in zones, use the following command:

```
esr# show security zone
```

To view zone pairs and their configuration, use the following commands:

```
esr# show security zone-pair
esr# show security zone-pair configuration
```

To view active sessions, use the following commands:

```
esr# show ip firewall sessions
```

7.9 Access list (ACL) configuration

Access Control List or ACL is a list that contains rules defining traffic transmission through the interface.

Objective: Allow traffic transmission from 192.168.20.0/24 subnet only.

Solution:

Configure access control list for filtering by a subnet:

```
esr# configure
esr(config)# ip access-list extended white
esr(config-acl)# rule 1
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# match source-address 192.168.20.0 255.255.255.0
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
```

Apply access list to Gi1/0/19 interface for inbound traffic:

```
esr(config)# interface gigabitethernet 1/0/19
esr(config-if-gi)# service-acl input white
```

Configuration changes will take effect when the following commands are executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view the detailed information on access control list, use the following command:

```
esr# show ip access-list white
```

7.10 Static routes configuration

Static routing is a type of routing in which routes are defined explicitly during the router configuration without dynamic routing protocols.

Objective: Configure Internet access for users in LAN 192.168.1.0/24 and 10.0.0.0/8 using the static routing. On R1 device, create gateway for Internet access. Traffic within LAN should be routed within LAN zone, traffic from the Internet should belong to WAN zone.

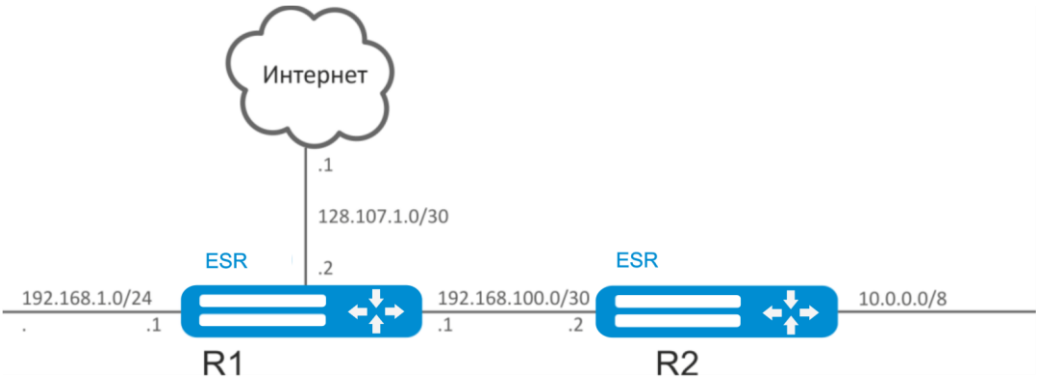


Fig. 7.8—Network structure

Solution:

Define the device name for R1 router:

```
esr# hostname R1
esr#(config)# do commit
R1#(config)# do confirm
```

For gi1/0/1 interface, specify 192.168.1.1/24 address and 'LAN' zone. R1 will be connected to 192.168.1.0/24 network through this interface:

```
R1(config)# interface gi1/0/1
R1(config-if-gi)# security-zone LAN
R1(config-if-gi)# ip address 192.168.1.1/24
R1(config-if-gi)# exit
```

For gi1/0/2 interface, specify 192.168.100.1/30 address and 'LAN' zone. R1 will be connected to R2 device through this interface for the subsequent traffic routing:

```
R1(config)# interface gi1/0/2
R1(config-if-gi)# security-zone LAN
R1(config-if-gi)# ip address 192.168.100.1/30
R1(config-if-gi)# exit
```

For gi1/0/3 interface, specify 128.107.1.2/30 address and 'WAN' zone. R1 will be connected to the Internet through this interface:

```
R1(config)# interface gi1/0/3
R1(config-if-gi)# security-zone WAN
R1(config-if-gi)# ip address 128.107.1.2/30
R1(config-if-gi)# exit
```

Create a route for interaction with 10.0.0.0/8 network using R2 device (192.168.100.2) as a gateway:

```
R1(config)# ip route 10.0.0.0/8 192.168.100.2
```

Create a route for interaction with the Internet using provider gateway (128.107.1.1) as a nexthop:

```
R1(config)# ip route 0.0.0.0/0 128.107.1.1
```

Configuration changes on R1 router will take effect when the following commands are executed:

```
R1# commit
Configuration has been successfully committed
R1# confirm
Configuration has been successfully confirmed
R1#
```

Define the device name for R2 router:

```
esr# hostname R2
esr#(config)# do commit
R2#(config)# do confirm
```

For gi1/0/1 interface, specify 10.0.0.1/8 address and 'LAN' zone. R2 will be connected to 10.0.0.0/8 network through this interface:

```
R2(config)# interface gi1/0/1
R2(config-if-gi)# security-zone LAN
R2(config-if-gi)# ip address 10.0.0.1/8
R2(config-if-gi)# exit
```

For gi1/0/2 interface, specify 192.168.100.2/30 address and 'LAN' zone. R2 will be connected to R1 device through this interface for the subsequent traffic routing:

```
R2(config)# interface gi1/0/2
R2(config-if-gi)# security-zone LAN
R2(config-if-gi)# ip address 192.168.100.2/30
R2(config-if-gi)# exit
```

Create default route by specifying gi1/0/2 interface IP address of R1 router (192.168.100.1) as a nexthop:

```
R2(config)# ip route 0.0.0.0/0 192.168.100.1
```

Configuration changes on R2 router will take effect when the following commands are executed:

```
R2# commit
Configuration has been successfully committed
R2# confirm
Configuration has been successfully confirmed
R2#
```

To check the routing table, use the following command:

```
esr# show ip route
```

7.11 MLPP configuration

Multilink PPP (MLPPP) is an aggregated channel that encompasses methods of traffic transition via multiple physical channels while having a single logical connection. This option allows to enhance bandwidth and enables load balancing.

Fig. 7.9—Network structure

Objective: Configure MLPPP connection to the opposite side with IP address 10.77.0.1/24 via MXE device.

Solution:

Switch gigabitethernet 1/0/10 interface into E1 operation mode:

```
esr# configure
esr(config)# interface gigabitethernet 1/0/10
esr(config-if-gi)# description "*** MXE ***"
esr(config-if-gi)# switchport mode e1
esr(config-if-gi)# switchport e1 slot 0
esr(config-if-gi)# exit
```

Enable interface e1 1/0/1, interface e1 1/0/4 into MLPPP 3 aggregation group:

```
esr(config)#  interface e1 1/0/1
esr(config-e1)# ppp multilink
esr(config-e1)# ppp multilink-group 3
esr(config-e1)# exit
esr(config)#  interface e1 1/0/4
esr(config-e1)# ppp multilink
esr(config-e1)# ppp multilink-group 3
esr(config-e1)# exit
```

Configure MLPPP 3:

```
esr(config)#  interface multilink 3
esr(config-multilink)# ip address 10.77.0.1/24
esr(config-multilink)# security-zone trusted
esr(config-multilink)# exit
esr(config)# exit
```

Configuration changes will take effect when the following commands are executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

7.12 Bridge configuration

Bridge is a method of connection for two Ethernet segments on data-link level without any higher level protocols, such as IP. Packet transmission is based on Ethernet addresses, not on IP addresses. Given that the transmission is performed on data-link level (Level 2 of the OSI model), higher level protocol traffic passes through the bridge transparently.

Objective 1: Combine router interfaces related to LAN and L2TPv3 tunnel passing through the public network into a single L2 domain. For combining, use VLAN 333.

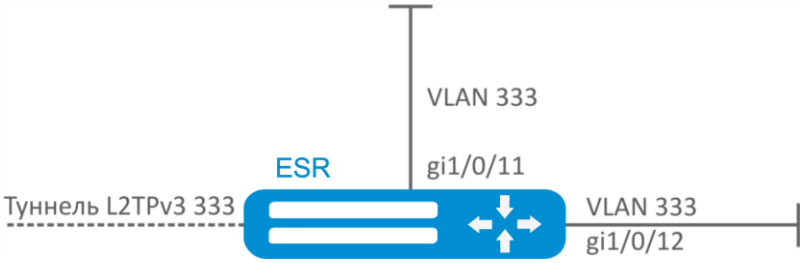


Fig. 7.10—Network structure

Solution:

Create VLAN 333

```
esr(config)# vlan 333
esr(config-vlan)# exit
```

Create 'trusted' security zone:

```
esr(config)# security-zone trusted
esr(config-zone)# exit
```

Add gi1/0/11, gi1/0/12 interfaces to VLAN 333:

```
esr(config)# interface gigabitethernet 1/0/11-12
esr(config-if)# switchport general allowed vlan add 333 tagged
```

Create bridge 333, map VLAN 333 to it and specify membership in 'trusted' zone:

```
esr(config)# bridge 333
esr(config-bridge)# vlan 333
esr(config-bridge)# security-zone trusted
esr(config-bridge)# enable
```

Define the inherence of L2TPv3 tunnel to bridge mapped to LAN (for L2TPv3 tunnel configuration, see Section 7.18): In general, bridge and tunnel identifiers should not match the VID, unlike this example.

```
esr(config)# tunnel l2tpv3 333
esr(config-l2tpv3)# bridge-group 333
```

Objective 2: Configure routing between VLAN 50 (10.0.50.0/24) and VLAN 60 (10.0.60.1/24). VLAN 50 should belong to 'LAN1', VLAN 60—to 'LAN2', enable free traffic transmission between zones.

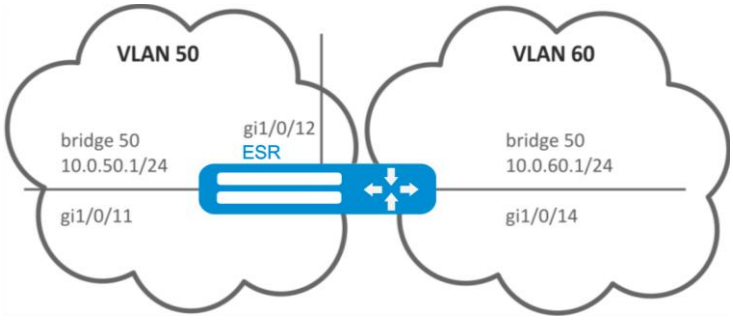


Fig. 7.11—Network structure

Solution:

Create VLAN 50 and 60:

```
esr(config)# vlan 50,60
esr(config-vlan)# exit
```

Create 'LAN1' and 'LAN2' security zones.

```
esr(config)# security-zone LAN1
esr(config-zone)# exit
esr(config)# security-zone LAN2
esr(config-zone)# exit
```

Map VLAN 50 to gi1/0/11, gi1/0/12 interfaces:

```
esr(config)# interface gigabitethernet 1/0/11-12
esr(config-if-gi)# switchport general allowed vlan add 50 tagged
```

Map VLAN 60 to gi1/0/14 interface:

```
esr(config)# interface gigabitethernet 1/0/14
esr(config-if-gi)# switchport general allowed vlan add 60 tagged
```

Create bridge 50, map VLAN 50, define IP address 10.0.50.1/24 and membership in 'LAN1' zone:

```
esr(config)# bridge 50
esr(config-bridge)# vlan 50
esr(config-bridge)# ip address 10.0.50.1/24
esr(config-bridge)# security-zone LAN1
esr(config-bridge)# enable
```

Create bridge 60, map VLAN 60, define IP address 10.0.60.1/24 and membership in 'LAN2' zone:

```
esr(config)# bridge 60
esr(config-bridge)# vlan 60
esr(config-bridge)# ip address 10.0.60.1/24
esr(config-bridge)# security-zone LAN2
esr(config-bridge)# enable
```

Create firewall rules that enable free traffic transmission between zones:

```
esr(config)# security zone-pair LAN1 LAN2
esr(config-zone-pair)# rule 1
```

```
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol any
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
esr(config)# security zone-pair LAN2 LAN1
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# action permit
esr(config-zone-rule)# match protocol any
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# exit
esr(config)# exit
```

Configuration changes will take effect when the following commands are executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view an interface membership in a bridge, use the following command:

```
esr# show interfaces bridge
```

7.13 RIP configuration

RIP is a distance-vector dynamic routing protocol that uses hop count as a routing metric. The maximum count of hops allowed for RIP is 15. By default, each RIP router transmits full routing table into the network every 30 seconds. RIP operates at 3rd level of TCP/IP stack via UDP port 520.

Objective: Configure RIP protocol on the router in order to exchange the routing information with neighbouring routers. Router should announce static routes and subnets 115.0.0.0/24, 14.0.0.0/24, 10.0.0.0/24. Routes should be announced each 25 seconds.

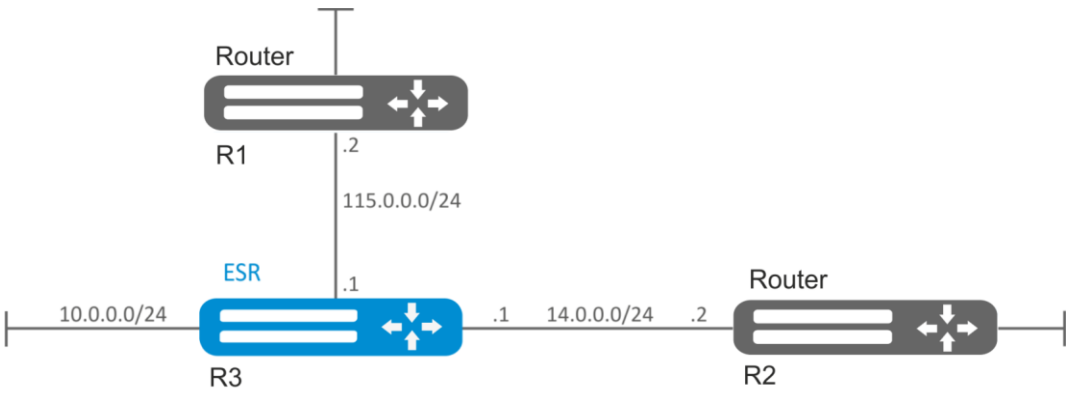


Fig. 7.12—Network structure

Solution:

Pre-configure IP addresses on interfaces according to the network structure shown in Fig. 7.12.

Enter the RIP configuration mode:

```
esr(config)# router rip
```

Define subnets that will be announced by the protocol: 115.0.0.0/24, 14.0.0.0/24 and 10.0.0.0/24:

```
esr(config-rip)# network 115.0.0.0/24
esr(config-rip)# network 14.0.0.0/24
esr(config-rip)# network 10.0.0.0/24
```

To announce static routes by the protocol, execute the following command:

```
esr(config-rip)# redistribute static
```

Configure timer, responsible for routing information transmission:

```
esr(config-rip)# timers update 25
```

When all required settings are done, enable the protocol:

```
esr(config-rip)# enable
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view the RIP routing table, use the following command:

```
esr# show ip rip
```

In addition to RIP protocol configuration, open UDP port 520 in the firewall.

7.14 OSPF configuration

OSPF is a dynamic routing protocol, based on link-state technology and using shortest path first Dijkstra algorithm.

Objective 1: Configure OSPF protocol on the router in order to exchange the routing information with neighbouring routers. Router should be in 1.1.1.1 identifier area and announce routes received via RIP.

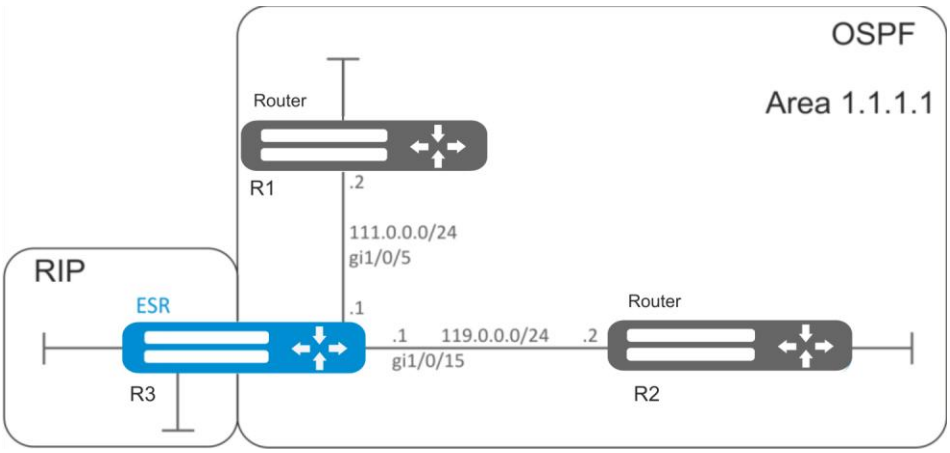


Fig. 7.13—Network structure

Solution:

Pre-configure IP addresses on interfaces according to the network structure shown in Fig. 7.13.

Create OSPF process with identifier 10 and proceed to the OSPF protocol configuration mode:

```
esr(config)# router ospf 10
```

Create and enable the required area:

```
esr(config-ospf)# area 1.1.1.1
esr(config-ospf-area)# enable
esr(config-ospf-area)# exit
```

Enable announcement of the routing information from RIP:

```
esr(config-ospf)# redistribute rip
```

Enable OSPF process:

```
esr(config-ospf)# enable
esr(config-ospf)# exit
```

Neighbouring routers are connected to gi1/0/5 and gi1/0/15 interfaces. To establish the neighbouring with other routers, map them to OSPF process and the area. Next, enable OSPF routing for the interface.

```
esr(config)# interface gigabitethernet 1/0/5
esr(config-if-gi)# ip ospf instance 10
esr(config-if-gi)# ip ospf area 1.1.1.1
esr(config-if)# ip ospf
esr(config-if)# exit

esr(config)# interface gigabitethernet 1/0/15
esr(config-if-gi)# ip ospf instance 10
esr(config-if-gi)# ip ospf area 1.1.1.1
esr(config-if-gi)# ip ospf
esr(config-if-gi)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

Objective 2: Change 1.1.1.1 area type, area should be stub. Stub router should announce routes received via RIP.

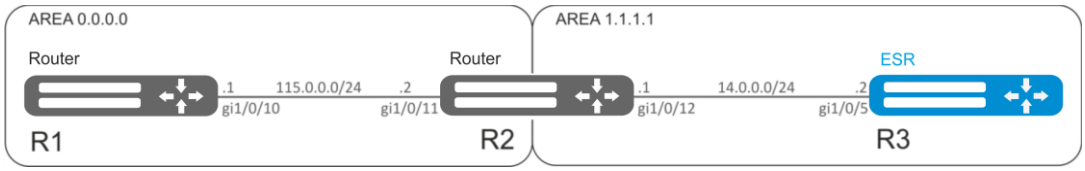


Fig. 7.14—Network structure

Solution:

Pre-configure OSPF protocol and IP addresses on interfaces according to the network structure shown in Fig. 7.14.

Change area type to stub. For each router from 1.1.1.1 area, execute the following command in the configuration mode:

```
esr(config-ospf-area)# area-type stub
```

For R3 stub router, enable announcement of the routing information from RIP:

```
esr(config-ospf)# redistribute rip
```

Configuration changes will take effect when commit command is executed:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

Objective 3: Merge two backbone areas using virtual link.

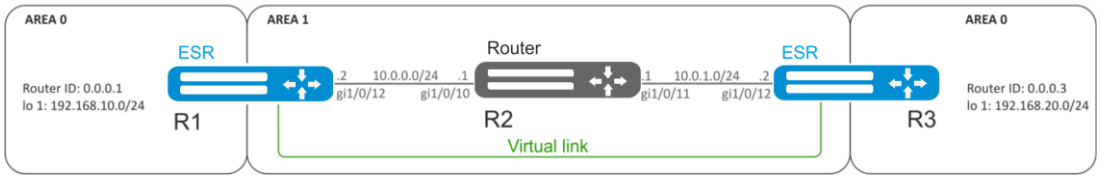


Fig. 7.15—Network structure

Solution:

Virtual link is a specialized connection that allows you to merge a split zone or connect a zone to the backbone zone trough the third zone. Virtual link is configured between two Area Border Routers (ABR).

Pre-configure OSPF protocol and IP addresses on interfaces according to the network structure shown in Fig. 7.15.

For R1 router, proceed to 1.1.1.1 area configuration mode:

```
esr(config-ospf)# area 1.1.1.1
```

Create and enable virtual link with the identifier 0.0.0.3:

```
esr(config-ospf-area)# virtual-link 0.0.0.3
esr(config-ospf-vlink)# enable
```

For R3 router, proceed to 1.1.1.1 area configuration mode:

```
esr(config-ospf)# area 1.1.1.1
```

Create and enable virtual link with the identifier 0.0.0.1:

```
esr(config-ospf-area)# virtual-link 0.0.0.1
esr(config-ospf-vlink)# enable
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

Review the routing table on R1 router:

```
esr# show ip route
C     * 10.0.0.0/24        [0/0]   dev gi1/0/12,                    [direct 00:49:34]
O     * 10.0.1.0/24        [150/20] via 10.0.0.1 on gi1/0/12,       [ospf1 00:49:53]  (0.0.0.3)
O     * 192.168.20.0/24    [150/30] via 10.0.0.1 on gi1/0/12,       [ospf1 00:50:15]  (0.0.0.3)
C     * 192.168.10.0/24    [0/0]   dev lo1,                         [direct 21:32:01]
```

Review the routing table on R3 router:

```
esr# show ip route
O     * 10.0.0.0/24        [150/20] via 10.0.1.1 on gi1/0/12,       [ospf1 14:38:35]  (0.0.0.2)
C     * 10.0.1.0/24        [0/0]   dev gi1/0/12,                    [direct 14:35:34]
C     * 192.168.20.0/24    [0/0]   dev lo1,                         [direct 14:32:58]
O     * 192.168.10.0/24    [150/30] via 10.0.1.1 on gi1/0/12,       [ospf1 14:39:54]  (0.0.0.1)
```

Since OSPF considers virtual link as the part of the area, R1 routes received from R3 are marked as an intrazone and vice versa.

To view the neighbours, use the following command:

```
esr# show ip ospf neighbors 10
```

To view OSPF routing table, use the following command:

```
esr# show ip ospf 10
```

In the firewall, you should enable OSPF protocol (89).

7.15 BGP configuration

BGP protocol is designed to exchange subnet reachability information among autonomous systems (AS), i.e. router groups united under a single technical control that uses interdomain routing protocol for defining packet delivery routes to other AS. Transmitted information includes a list of AS that are accessible through this system. Selection of the optimal routes is based on effective rules for the network.

Objective: Configure BGP on the router with the following parameters:

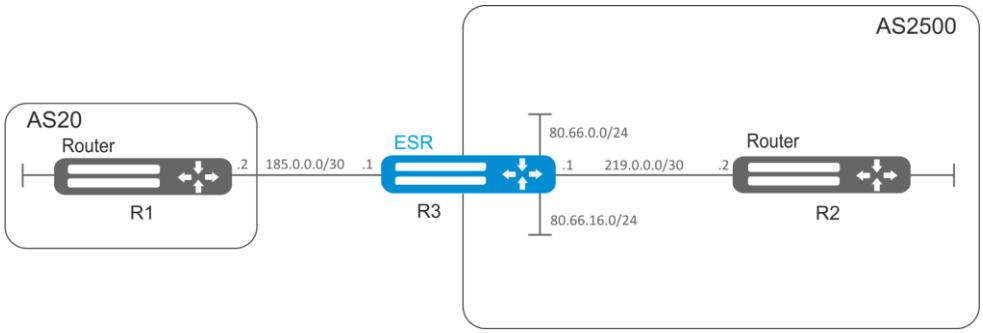


Fig. 7.16—Network structure

- proprietary subnets: 80.66.0.0/24, 80.66.16.0/24;
- announcing of directly connected subnets;
- proprietary AS 2500;
- first neighbouring—subnet 219.0.0.0/30, proprietary IP address 219.0.0.1, neighbour IP address 219.0.0.2, AS 2500;
- second neighbouring—subnet 185.0.0.0/30, proprietary IP address 185.0.0.1, neighbour IP address 185.0.0.2, AS 20.

Solution:

Configure required network parameters:

```
esr# configure
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# ip address 185.0.0.1/30
esr(config-if-gi)# exit
esr(config)# interface gigabitethernet 1/0/2
esr(config-if-gi)# ip address 219.0.0.1/30
esr(config-if-gi)# exit
esr(config)# interface gigabitethernet 1/0/3
esr(config-if-gi)# ip address 80.66.0.1/24
esr(config-if-gi)# exit
esr(config)# interface gigabitethernet 1/0/4
esr(config-if-gi)# ip address 80.66.16.1/24
esr(config-if-gi)# exit
```

Create BGP process for AS 2500 and enter process parameters' configuration mode:

```
esr(config)# router bgp 2500
```

Enter routing information configuration mode for IPv4:

```
esr(config-bgp)# address-family ipv4
```

Announce directly connected subnets:

```
esr(config-bgp-af)# redistribute connected
```

Create neighboring with 185.0.0.2, 219.0.0.2 specifying AS and enable them:

```
esr(config-bgp-af)# neighbor 185.0.0.2
esr(config-bgp-neighbor)# remote-as 20
esr(config-bgp-neighbor)# enable
esr(config-bgp-neighbor)# exit
```

```
esr(config-bgp-af)# neighbor 219.0.0.2
esr(config-bgp-neighbor)# remote-as 2500
esr(config-bgp-neighbor)# enable
esr(config-bgp-neighbor)# exit
```

Enable protocol operation:

```
esr(config-bgp-af)# enable
esr(config-bgp-af)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

To view BGP peer information, use the following command:

```
esr# show ip bgp 2500 neighbors
```

To view BGP routing table, use the following command:

```
esr# show ip bgp
```

You should open TCP port 179 in the firewall.

7.16 PBR routing policy configuration

7.16.1 Route-map for BGP configuration

Route-maps may serve as filters processing routing information when it is received from or sent to the neighbouring device. Processing may include filtering based on various route criteria and setting attributes (MED, AS-PATH, community, LocalPreference, etc.) for the respective routes.

Also, Route-map may assign routes based on access control lists (ACL).

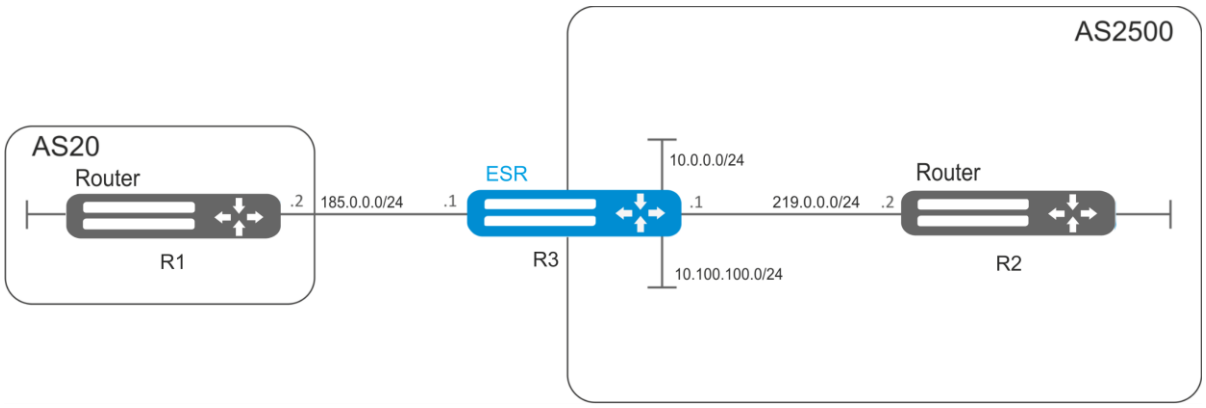


Fig. 7.17—Network structure

Objective 1: Assign community for routing information coming from AS 20:

First, do the following:

- Configure BGP with AS 2500 on ESR router
- Establish neighbouring with AS20.

Solution:

Create a policy:

```
esr# configure
esr(config)# route-map from-as20
```

Create rule 1:

```
esr(config-route-map)# rule 1
```

If AS PATH contains AS 20, assign community 20:2020 to it and exit:

```
esr(config-route-map-rule)# match as-path contain 20
esr(config-route-map-rule)# action set community 20:2020
esr(config-route-map-rule)# exit
esr(config-route-map)# exit
```

In AS 2500 BGP process, enter neighbour parameter configuration:

```
esr(config)# router bgp 2500
esr(config-bgp)# neighbor 185.0.0.2
```

Map the policy to routing information:

```
esr(config-bgp-neighbor)# route-map from-as20 in
```

Objective 2: For the whole transmitted routing information (from community 2500:25), assign MED equal to 240 and define EGP routing information source:

First: Configure BGP with AS 2500 on ESR

Solution:

Create a policy:

```
esr(config)# route-map to-as20
```

Create a rule:

```
esr(config-route-map)# rule 1
```

If community contains 2500:25, assign MED 240 and Origin EGP to it:

```
esr(config-route-map-rule)# match community 2500:25
esr(config-route-map-rule)# action set metric 240
esr(config-route-map-rule)# action set origin egp
esr(config-route-map-rule)# exit
esr(config-route-map)# exit
```

In AS 2500 BGP process, enter neighbour parameter configuration:

```
esr(config)# router bgp 2500
esr(config-bgp)# neighbor 185.0.0.2
```

Map the policy to the routing information being announced:

```
esr(config-bgp-neighbor)# route-map to-as20 out
esr(config-bgp-neighbor)# exit
esr(config-bgp)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

7.16.2 Route-map based on access control lists (Policy-based routing)

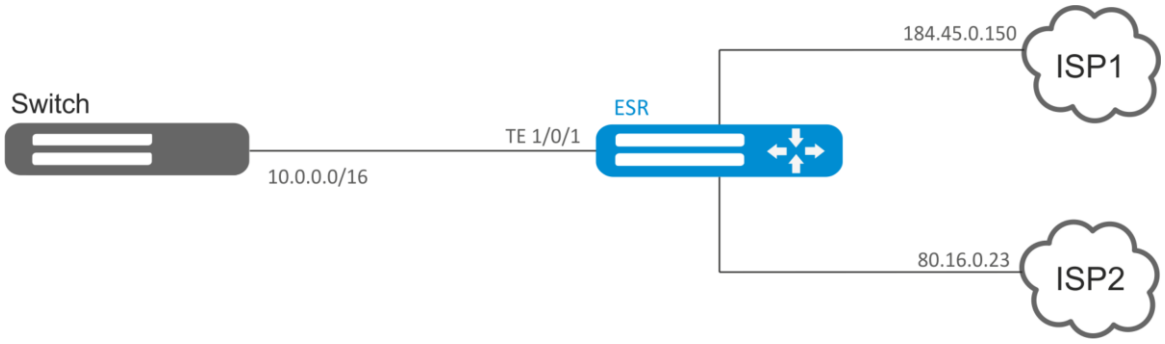


Fig. 7.18—Network structure

Objective 1: Distribute traffic between Internet service providers based on user subnets.

First, do the following:

- Assign IP address to interfaces.

Route traffic from addresses 10.0.20.0/24 through ISP1 (184.45.0.150), and traffic from addresses 10.0.30.0/24 trough ISP2 (80.16.0.23). You should monitor availability of ISP addresses (ISP connection operational capability), and if one the connections goes down, redirect all the traffic from malfunctioning connection to the operational one.

Solution:

Create ACL:

```
esr# configure
esr(config)# ip access-list extended sub20
esr(config-acl)# rule 1
esr(config-acl-rule)# match source-address 10.0.20.0 255.255.255.0
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# action permit
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
esr(config)# ip access-list extended sub30
esr(config-acl)# rule 1
esr(config-acl-rule)# match source-address 10.0.30.0 255.255.255.0
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# action permit
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
```

Create a policy:

```
esr(config)# route-map PBR
```

Create rule 1:

```
esr(config-route-map)# rule 1
```

Specify ACL as a filter:

```
esr(config-route-map-rule)# match ip access-group sub20
```

Specify nexthop for sub20:

```
esr(config-route-map-rule)# action set ip next-hop verify-availability
184.45.0.150 10
esr(config-route-map-rule)# action set ip next-hop verify-availability 80.16.0.23
30
esr(config-route-map-rule)# exit
esr(config-route-map)# exit
```

Rule 1 should provide traffic routing from the network 10.0.20.0/24 to address 184.45.0.150, and in case of its failure, to address 80.16.0.23. Gateway priority is defined by metrics values—10 and 30.

Create rule 2:

```
esr(config-route-map)# rule 2
```

Specify ACL as a filter:

```
esr(config-route-map-rule)# match ip access-group sub30
```

Specify nexthop for sub30 and exit:

```
esr(config-route-map-rule)# action set ip next-hop verify-availability 80.16.0.23
10
esr(config-route-map-rule)# action set ip next-hop verify-availability
184.45.0.150 30
esr(config-route-map-rule)# exit
esr(config-route-map)# exit
```

Rule 2 should provide traffic routing from the network 10.0.30.0/24 to address 80.16.0.23, and in case of its failure, to address 184.45.0.150. Priority is defined by metrics values.

Proceed to TE 1/0/1 interface:

```
esr(config)# interface tengigabitethernet 1/0/1
```

Map the policy the respective interface:

```
esr(config-if-te)# ip policy route-map PBR

esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
esr#
```

7.17 GRE tunnel configuration

GRE (Generic Routing Encapsulation) is a network packet tunnelling protocol. Its main purpose is to encapsulate packets of the OSI model network layer into IP packets. GRE may be used for VPN establishment on 3rd level of OSI model. In ESR router implemented static unmanageable GRE tunnels, i.e. tunnels are created manually via configuration on local and remote hosts. Tunnel parameters for each side should be mutually agreeable, otherwise transferred data will not be decapsulated by the partner.

Objective: Establish L3-VPN for company offices using IP network with GRE protocol for traffic tunnelling.

- IP address 115.0.0.1 is used as a local gateway for the tunnel
- IP address 114.0.0.10 is used as a remote gateway for the tunnel
- IP address of the tunnel at the local side is 25.0.0.1/24

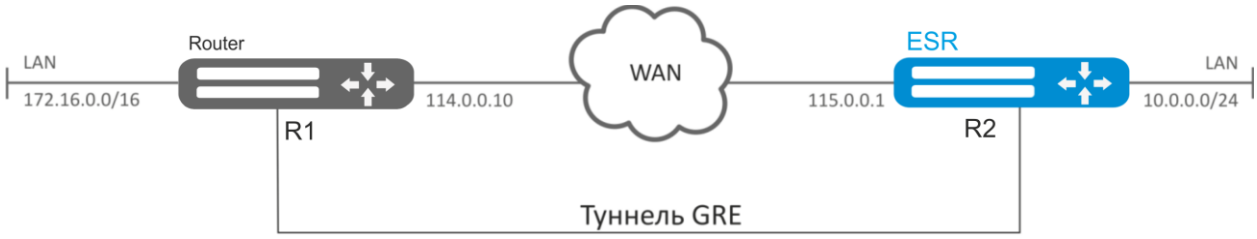


Fig. 7.19—Network structure

Solution:

Create GRE 10 tunnel:

```
esr(config)# tunnel gre 10
```

Specify local and remote gateway (IP addresses of WAN border interfaces):

```
esr(config-gre)# local address 115.0.0.1
esr(config-gre)# remote address 114.0.0.10
```

Specify tunnel IP address 25.0.0.1/24:

```
esr(config-gre)# ip address 25.0.0.1/24
```

Also, the tunnel should belong to the security zone in order to create rules that allow traffic to pass through the firewall. To define the tunnel inherence to a zone, use the following command:

```
esr(config-gre)# security-zone untrusted
```

Enable tunnel:

```
esr(config-gre)# enable
esr(config-gre)# exit
```

Create route to the partner's local area network on the router. Specify previously created GRE tunnel as a destination interface.

```
esr(config)# ip route 172.16.0.0/16 tunnel gre 10
```

To apply configuration changes, execute the following commands:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

When settings are applied, traffic will be encapsulated into the tunnel and sent to the partner regardless of their GRE tunnel existence and settings validity.

Alternatively, you may specify the following parameters for GRE tunnel:

- Enable GRE header checksum calculation and inclusion into a packet with encapsulated packet for outbound traffic:

```
esr(config-gre)# local checksum
```

- Enable check for GRE checksum presence and validity for inbound traffic:

```
esr(config-gre)# remote checksum
```

- Specify a unique identifier:

```
esr(config-gre)# key 15808
```

- Specify DSCP, MTU, TTL values:

```
esr(config-gre)# dscp 44
esr(config-gre)# mtu 1426
esr(config-gre)# ttl 18
```

To view the tunnel status, use the following command:

```
esr# show tunnels status gre 10
```

To view sent and received packet counters, use the following command:

```
esr# show tunnels counters gre 10
```

To view the tunnel configuration, use the following command:

```
esr# show tunnels configuration gre 10
```

IPv4-over-IPv4 tunnel configuration is performed in the same manner.

During tunnel creation, you should enable GRE protocol (47) in the firewall.

7.18 L2TPv3 tunnel configuration

L2TPv3 (Layer 2 Tunneling Protocol Version 3) is a protocol used for tunnelling of 2nd level OSI model packets between two IP nodes. IP or UDP is used as an encapsulation protocol. L2TPv3 may be used as an alternative to MPLS P2P L2VPN (VLL) for L2 VPN establishment. In ESR router implemented static unmanageable L2TPv3 tunnels, i.e. tunnels are created manually via configuration on local and remote hosts. Tunnel parameters for each side should be mutually agreeable, otherwise transferred data will not be decapsulated by the partner.

Objective: Establish L2 VPN for company offices using IP network with L2TPv3 protocol for traffic tunnelling.

- UDP is used as an encapsulation protocol, port number at the local side and port number at the partner's side is 519;
- IP address 21.0.0.1 is used as a local gateway for the tunnel
- IP address 183.0.0.10 is used as a remote gateway for the tunnel
- Tunnel identifier at the local side equals 2, at the partner's side - 3
- Session identifier inside the tunnel equals 100, at the partner's side - 200
- Forward traffic into the tunnel from the bridge with identifier 333.

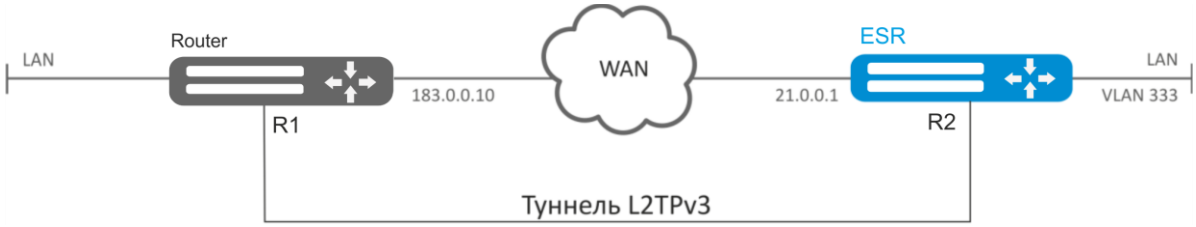


Fig. 7.20—Network structure

Solution:

Create L2TPv3 333 tunnel:

```
esr# configure
esr(config)# tunnel l2tpv3 333
```

Specify local and remote gateway (IP addresses of WAN border interfaces):

```
esr(config-l2tpv3)# local address 21.0.0.1
esr(config-l2tpv3)# remote address 183.0.0.10
```

Specify encapsulation protocol type and UDP ports' numbers:

```
esr(config-l2tpv3)# protocol udp
esr(config-l2tpv3)# local port 519
esr(config-l2tpv3)# remote port 519
```

Specify tunnel identifiers for local and remote sides:

```
esr(config-l2tpv3)# local tunnel-id 2
esr(config-l2tpv3)# remote tunnel-id 3
```

Specify identifiers for session inside the tunnel for local and remote sides:

```
esr(config-l2tpv3)# local session-id 100
esr(config-l2tpv3)# remote session-id 200
```

Define the inherence of L2TPv3 tunnel to a bridge that should be mapped to remote office network (for bridge configuration, see Paragraph 7.11):

```
esr(config-l2tpv3)# bridge-group 333
```

Enable previously created tunnel and exit:

```
esr(config-l2tpv3)# enable
esr(config-l2tpv3)# exit
```

Create sub-interface for switching of traffic coming from the tunnel into LAN with VLAN id 333:

```
esr(config)# interface gi 1/0/2.333
```

Define the inherence of sub-interface to a bridge that should be mapped to LAN (for bridge configuration, see Paragraph 7.11):

```
esr(config-subif)# bridge-group 333
esr(config-subif)# exit
```

To apply configuration changes, execute the following commands:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

When settings are applied, traffic will be encapsulated into the tunnel and sent to the partner regardless of their L2TPv3 tunnel existence and settings validity.

Tunnel settings for the remote office should mirror local ones. IP address 183.0.0.10 should be used as a local gateway. IP address 21.0.0.1 should be used as a remote gateway. Encapsulation protocol port number at the local side should be 520, at the partner's side—519. Tunnel identifier at the local side should be equal to 3, at the partner's side—2. Session identifier inside the tunnel should be equal to 200, at the partner's side—100. Also, the tunnel should belong to a bridge that should be connected with the partner's network.

To view the tunnel status, use the following command:

```
esr# show tunnels status l2tpv3 333
```

To view sent and received packet counters, use the following command:

```
esr# show tunnels counters l2tpv3 333
```

To view the tunnel configuration, use the following command:

```
esr# show tunnels configuration l2tpv3 333
```

In addition to tunnel creation, you should enable UDP inbound traffic in the firewall with source port 519 and destination port 519.

7.19 IPsec VPN configuration

IPsec is a set of protocols that enable security features for data transferred via IP protocol. This set of protocols allows for identity validation (authentication), IP packet integrity check and encryption, and also includes protocols for secure key exchange over the Internet.

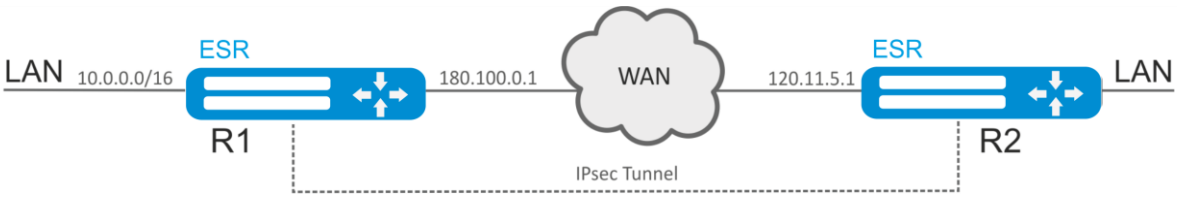


Fig. 7.21—Network structure

Objective: Configure IPsec tunnel between R1 and R2.

- R1 IP address: 120.11.5.1
- R2 IP address: 180.100.0.1
- IKE:
  Diffie-Hellman group: 2
  encryption algorithm: AES 128 bit
  authentication algorithm: MD5
- IPSec:
  encryption algorithm: AES 128 bit
  authentication algorithm: MD5

7.19.1 Route-based IPsec VPN configuration:

Solution:

1. R1 configuration

Configure external network interface and identify its inherence to a security zone:

```
esr# configure
esr(config)# interface gi 1/0/1
esr(config-if-gi)# ip address 180.100.0.1/24
esr(config-if-gi)# security-zone untrusted
esr(config-if-gi)# exit
```

Create VTI tunnel. Traffic will be routed via VTI into IPsec tunnel. Specify IP addresses of WAN border interfaces as a local and remote gateways:

```
esr(config)# tunnel vti 1
esr(config-vti)# local address 180.100.0.1
esr(config-vti)# remote address 120.11.5.1
esr(config-vti)# enable
esr(config-vti)# exit
```

To configure rules for security zones, you should create ISAKMP port profile:

```
esr(config)# object-group service ISAKMP
```

```
esr(config-object-group-service)# port-range 500
esr(config-object-group-service)# exit
```

Create a static route to the remote LAN. For each subnet located behind an IPsec tunnel, specify a route via VTI tunnel:

```
esr(config)# ip route 192.0.2.0/24 tunnel vti 1
```

Create IKE protocol profile. In the profile, select Diffie-Hellman group 2, AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IKE connection:

```
esr(config)# security ike proposal ike_prop1
esr(config-ike-proposal)# dh-group 2
esr(config-ike-proposal)# authentication algorithm md5
esr(config-ike-proposal)# encryption algorithm aes128
esr(config-ike-proposal)# exit
```

Create IKE protocol policy. For the policy, specify the list of IKE protocol profiles that may be used for node and authentication key negotiation:

```
esr(config)# security ike policy ike_pol1
esr(config-ike-policy)# pre-shared-key hexadecimal 123FFF
esr(config-ike-policy)# proposal ike_prop1
esr(config-ike-policy)# exit
```

Create IKE protocol gateway. For this profile, specify VTI tunnel, policy, protocol version and mode of traffic redirection into the tunnel.

```
esr(config)# security ike gateway ike_gw1
esr(config-ike-gw)# ike-policy ike_pol1
esr(config-ike-gw)# mode route-based
esr(config-ike-gw)# bind-interface vti 1
esr(config-ike-gw)# version v2-only
esr(config-ike-gw)# exit
```

Create security parameters' profile for IPsec tunnel. For the profile, select AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IPsec tunnel:

```
esr(config)# security ipsec proposal ipsec_prop1
esr(config-ipsec-proposal)# authentication algorithm md5
esr(config-ipsec-proposal)# encryption algorithm aes128
esr(config-ipsec-proposal)# exit
```

Create policy for IPsec tunnel. For the policy, specify the list of IPsec tunnel profiles that may be used for node negotiation:

```
esr(config)# security ipsec policy ipsec_pol1
esr(config-ipsec-policy)# proposal ipsec_prop1
esr(config-ipsec-policy)# exit
```

Create IPsec VPN. For VPN, specify IKE protocol gateway, IPsec tunnel policy, key exchange mode and connection establishment method. When all parameters are entered, enable tunnel using *enable* command.

```
esr(config)# security ipsec vpn ipsec1
esr(config-ipsec-vpn)# mode ike
esr(config-ipsec-vpn)# ike establish-tunnel immediate
esr(config-ipsec-vpn)# ike gateway ike_gw1
esr(config-ipsec-vpn)# ike ipsec-policy ipsec_pol1
esr(config-ipsec-vpn)# enable
esr(config-ipsec-vpn)# exit
```

```
esr(config)# exit
```

2. R2 configuration

Configure external network interface and identify its inherence to a security zone:

```
esr# configure
esr(config)# interface gi 1/0/1
esr(config-if)# ip address 120.11.5.1/24
esr(config-if)# security-zone untrusted
esr(config-if)# exit
```

Create VTI tunnel. Traffic will be routed via VTI into IPsec tunnel. Specify IP addresses of WAN border interfaces as a local and remote gateways:

```
esr(config)# tunnel vti 1
esr(config-vti)# remote address 180.100.0.1
esr(config-vti)# local address 120.11.5.1
esr(config-vti)# enable
esr(config-vti)# exit
```

To configure rules for security zones, you should create ISAKMP port profile:

```
esr(config)# object-group service ISAKMP
esr(config-addr-set)# port-range 500
esr(config-addr-set)# exit
```

Create a static route to the remote LAN. For each subnet located behind an IPsec tunnel, specify a route via VTI tunnel:

```
esr(config)# ip route 10.0.0.0/16 tunnel vti 1
```

Create IKE protocol profile. In the profile, select Diffie-Hellman group 2, AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IKE connection:

```
esr(config)# security ike proposal ike_prop1
esr(config-ike-proposal)# dh-group 2
esr(config-ike-proposal)# authentication algorithm md5
esr(config-ike-proposal)# encryption algorithm aes128
esr(config-ike-proposal)# exit
esr(config)#
```

Create IKE protocol policy. For the policy, specify the list of IKE protocol profiles that may be used for node and authentication key negotiation:

```
esr(config)# security ike policy ike_pol1
esr(config-ike-policy)# pre-shared-key hexadecimal 123FFF
esr(config-ike-policy)# proposal ike_prop1
esr(config-ike-policy)# exit
```

Create IKE protocol gateway. For this profile, specify VTI tunnel, policy, protocol version and mode of traffic redirection into the tunnel.

```
esr(config)# security ike gateway ike_gw1
esr(config-ike-gw)# ike-policy ike_pol1
esr(config-ike-gw)# mode route-based
esr(config-ike-gw)# bind-interface vti 1
esr(config-ike-gw)# version v2-only
esr(config-ike-gw)# exit
```

Create security parameters' profile for IPsec tunnel. For the profile, select AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IPsec tunnel:

```
esr(config)# security ipsec proposal ipsec_prop1
esr(config-ipsec-proposal)# authentication algorithm md5
esr(config-ipsec-proposal)# encryption algorithm aes128
esr(config-ipsec-proposal)# exit
```

Create policy for IPsec tunnel. For the policy, specify the list of IPsec tunnel profiles that may be used for node negotiation:

```
esr(config)# security ipsec policy ipsec_pol1
esr(config-ipsec-policy)# proposal ipsec_prop1
esr(config-ipsec-policy)# exit
```

Create IPsec VPN. For VPN, specify IKE protocol gateway, IPsec tunnel policy, key exchange mode and connection establishment method. When all parameters are entered, enable tunnel using *enable* command.

```
esr(config)# security ipsec vpn ipsec1
esr(config-ipsec-vpn)# mode ike
esr(config-ipsec-vpn)# ike establish-tunnel immediate
esr(config-ipsec-vpn)# ike gateway ike_gw1
esr(config-ipsec-vpn)# ike ipsec-policy ipsec_pol1
esr(config-ipsec-vpn)# enable
esr(config-ipsec-vpn)# exit
esr(config)# exit
```

To view the tunnel status, use the following command:

```
esr# show security ipsec vpn status ipsec1
```

To view the tunnel configuration, use the following command:

```
esr# show security ipsec vpn configuration ipsec1
```

In the firewall, you should enable ESP and ISAKMP protocol (UDP port 500).

7.19.2 Policy-based IPSec VPN configuration

Solution:

1. R1 configuration

Configure external network interface and identify its belonging to the security zone:

```
esr# configure
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# ip address 120.11.5.1/24
esr(config-if-gi)# security-zone untrusted
esr(config-if-gi)# exit
```

Create ISAKMP port profile in order to configure security zone rules:

```
esr(config)# object-group service ISAKMP
esr(config-object-group-service)# port-range 500
esr(config-object-group-service)# exit
```

Create IKE profile. In the profile, specify Diffie-Hellman group as 2, encryption algorithm - AES 128 bit, authentication algorithm - MD5. This security parameters is used for protection of IKE connection:

```
esr(config)# security ike proposal ike_prop1
esr(config-ike-proposal)# dh-group 2
esr(config-ike-proposal)# authentication algorithm md5
esr(config-ike-proposal)# encryption algorithm aes128
esr(config-ike-proposal)# exit
```

Create IKE protocol policy. Specify list of IKE protocol profiles, which can be used for nodes and authentication key negotiation:

```
esr(config)# security ike policy ike_pol1
esr(config-ike-policy)# pre-shared-key hexadecimal 123FFF
esr(config-ike-policy)# proposal ike_prop1
esr(config-ike-policy)# exit
```

Create IKE protocol gateway. In this profile, specify VTI tunnel, policy, version of protocol and traffic to tunnel redirection mode:

```
esr(config)# security ike gateway ike_gw1
esr(config-ike-gw)# ike-policy ike_pol1
esr(config-ike-gw)# local address 180.100.0.1
esr(config-ike-gw)# local network 10.0.0.0/16
esr(config-ike-gw)# remote address 120.11.5.1
esr(config-ike-gw)# remote network 192.0.2.0/24
esr(config-ike-gw)# mode policy-based
esr(config-ike-gw)# exit
```

Create security parameters' profile for IPsec tunnel. For the profile, select AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IPsec tunnel:

```
esr(config)# security ipsec proposal ipsec_prop1
esr(config-ipsec-proposal)# authentication algorithm md5
esr(config-ipsec-proposal)# encryption algorithm aes128
esr(config-ipsec-proposal)# exit
```

Create policy for IPsec tunnel. For the policy, specify the list of IPsec tunnel profiles that may be used for node negotiation:

```
esr(config)# security ipsec policy ipsec_pol1
esr(config-ipsec-policy)# proposal ipsec_prop1
esr(config-ipsec-policy)# exit
```

Create IPsec VPN. For VPN, specify IKE protocol gateway, IPsec tunnel policy, key exchange mode and connection establishment method. When all parameters are entered, enable tunnel using *enable* command.

```
esr(config)# security ipsec vpn ipsec1
esr(config-ipsec-vpn)# mode ike
esr(config-ipsec-vpn)# ike establish-tunnel immediate
esr(config-ipsec-vpn)# ike gateway ike_gw1
esr(config-ipsec-vpn)# ike ipsec-policy ipsec_pol1
esr(config-ipsec-vpn)# enable
esr(config-ipsec-vpn)# exit
esr(config)# exit
```

2. R2 configuration

Configure external network interface and identify its inherence to a security zone:

```
esr# configure
esr(config)# interface gi 1/0/1
esr(config-if)# ip address 120.11.5.1/24
esr(config-if)# security-zone untrusted
esr(config-if)# exit
```

Create ISAKMP port profile in order to configure security zone rules:

```
esr(config)# object-group service ISAKMP
esr(config-addr-set)# port-range 500
esr(config-addr-set)# exit
```

Create IKE profile. In the profile, specify Diffie-Hellman group as 2, encryption algorithm - AES 128 bit, authentication algorithm - MD5. This security parameters is used for protection of IKE connection:

```
esr(config)# security ike proposal ike_prop1
esr(config-ike-proposal)# dh-group 2
esr(config-ike-proposal)# authentication algorithm md5
esr(config-ike-proposal)# encryption algorithm aes128
esr(config-ike-proposal)# exit
esr(config)#
```

Create IKE protocol policy. Specify list of IKE protocol profiles, which can be used for nodes and authentication key negotiation:

```
esr(config)# security ike policy ike_pol1
esr(config-ike-policy)# pre-shared-key hexadecimal 123FFF
esr(config-ike-policy)# proposal ike_prop1
esr(config-ike-policy)# exit
```

Create IKE protocol gateway. In this profile, specify VTI tunnel, policy, version of protocol and traffic to tunnel redirection mode:

```
esr(config)# security ike gateway ike_gw1
esr(config-ike-gw)# ike-policy ike_pol1
esr(config-ike-gw)# remote address 180.100.0.1
esr(config-ike-gw)# remote network 10.0.0.0/16
esr(config-ike-gw)# local address 120.11.5.1
esr(config-ike-gw)# local network 192.0.2.0/24
esr(config-ike-gw)# mode policy-based
esr(config-ike-gw)# exit
```

Create security parameters' profile for IPsec tunnel. For the profile, select AES 128 bit encryption algorithm, MD5 authentication algorithm. Use the following parameters to secure IPsec tunnel:

```
esr(config)# security ipsec proposal ipsec_prop1
esr(config-ipsec-proposal)# authentication algorithm md5
esr(config-ipsec-proposal)# encryption algorithm aes128
esr(config-ipsec-proposal)# exit
```

Create policy for IPsec tunnel. For the policy, specify the list of IPsec tunnel profiles that may be used for node negotiation:

```
esr(config)# security ipsec policy ipsec_pol1
esr(config-ipsec-policy)# proposal ipsec_prop1
esr(config-ipsec-policy)# exit
```

Create IPsec VPN. For VPN, specify IKE protocol gateway, IPsec tunnel policy, key exchange mode and connection establishment method. When all parameters are entered, enable tunnel using *enable* command.

```
esr(config)# security ipsec vpn ipsec1
esr(config-ipsec-vpn)# mode ike
esr(config-ipsec-vpn)# ike establish-tunnel immediate
esr(config-ipsec-vpn)# ike gateway ike_gw1
esr(config-ipsec-vpn)# ike ipsec-policy ipsec_pol1
esr(config-ipsec-vpn)# enable
esr(config-ipsec-vpn)# exit
esr(config)# exit
```

You can view the state of the tunnel using following command:

```
esr# show security ipsec vpn status ipsec1
```

You can view the configuration of the tunnel using following command:

```
esr# show security ipsec vpn configuration ipsec1
```

It is necessery to enable ESP and ISAKMP (UDP - port 500) in firewall.

7.20 LT-tunnels configuration

LT (logical tunnel) is a type of tunnels dedicated for transmission of routing information and traffic between different virtual routers (VRF Lite) configured on a router. LT-tunnel might be used for organization of interaction between two or more VRF using firewall restrictions.

Objective: Organize interaction between hosts terminated in two VRF vrf_1 and vrf_2.

Initial configuration:

```
hostname esr

ip vrf vrf_1
exit
ip vrf vrf_2
exit
interface gigabitethernet 1/0/1
  ip vrf forwarding vrf_1
  Ip firewall disable
  ip address 10.0.0.1/24
exit
interface gigabitethernet 1/0/2
  ip vrf forwarding vrf_2
  Ip firewall disable
  ip address 10.0.1.1/24
exit
```

Solution:

Create LT-tunnels for each VRF, specifying IP address from one subnet:

```
esr(config)# tunnel lt 1
esr(config-lt)# ip vrf forwarding vrf_1
esr(config-lt)# Ip firewall disable
esr(config-lt)# ip address 192.168.0.1/30
esr(config-lt)# exit
esr(config)# tunnel lt 2
esr(config-lt)# ip vrf forwarding vrf_2
esr(config-lt)# Ip firewall disable
esr(config-lt)# ip address 192.168.0.2/30
esr(config-lt)# exit
```

Designate LT-tunnel from VRF, which is necessary to establish link with, for each LT-tunnel and activate them.

```
esr(config)# tunnel lt 1
esr(config-lt)# peer lt 2
esr(config-lt)# enable
esr(config-lt)# exit
esr(config)# tunnel lt 2
esr(config-lt)# peer lt 1
esr(config-lt)# enable
esr(config-lt)# exit
```

If NONE of dynamic routing protocols works in VRF, specify static routes for each VRF:

```
esr(config)# ip route vrf vrf_1 0.0.0.0/0 192.168.100.2
esr(config)# ip route vrf vrf_2 0.0.0.0/0 192.168.100.1
```

7.21 Configuring remote access to corporate network via PPTP protocol

PPTP (Point-to-Point Tunneling Protocol) is a point-to-point tunnelling protocol that allows a computer to establish secure connection with a server by creating a special tunnel in a common unsecured network. PPTP encapsulates PPP frames into IP packets for transmission via global IP network, e.g. the Internet. PPTP may be used for tunnel establishment between two local area networks. PPTP uses an additional TCP connection for tunnel handling.

Objective: Configure PPTP server on a router.

- PPTP server address: 120.11.5.1
- Gateway inside the tunnel for connecting clients: 10.10.10.1
- IP address pool for lease: 10.10.10.5-10.10.10.25
- DNS servers 8.8.8.8, 8.8.8.4
- Accounts for connection: fedor, ivan

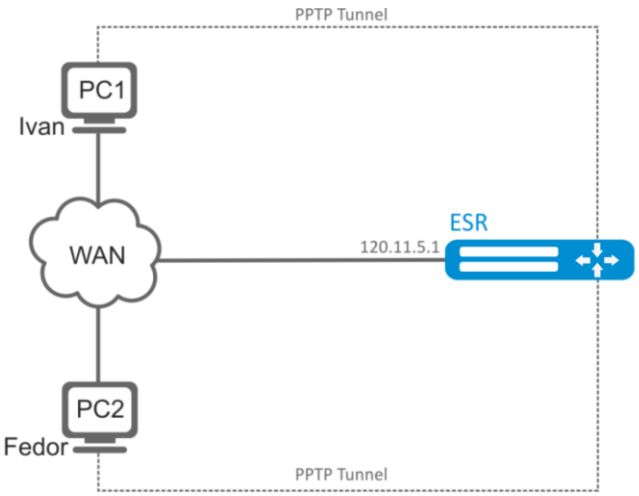


Fig. 7.22—Network structure

Solution:

Create an address profile that contains an address to be listened by the server:

```
esr# configure
esr(config)# object-group network pptp_outside
esr(config-object-group-network)# ip address-range 120.11.5.1
esr(config-object-group-network)# exit
```

Create address profile that contains local gateway address:

```
esr(config)# object-group network pptp_local
esr(config-object-group-network)# ip address-range 10.10.10.1
esr(config-object-group-network)# exit
```

Create address profile that contains client addresses:

```
esr(config)# object-group network pptp_remote
esr(config-object-group-network)# ip address-range 10.10.10.5-10.10.10.25
esr(config-object-group-network)# exit
```

Create address profile that contains DNS servers:

```
esr(config)# object-group network pptp_dns
esr(config-object-group-network)# ip address-range 8.8.8.8
esr(config-object-group-network)# ip address-range 8.8.4.4
esr(config-object-group-network)# exit
```

Create PPTP server and map profiles listed above:

```
esr(config)# remote-access pptp remote-workers
esr(config-pptp)# local-address object-group pptp_local
esr(config-pptp)# remote-address object-group pptp_remote
esr(config-pptp)# outside-address object-group pptp_outside
esr(config-pptp)# dns-servers object-group pptp_dns
```

Select authentication method for PPTP server users:

```
esr(config-pptp)# authentication mode local
```

Specify security zone that user sessions will be related to:

```
esr(config-pptp)# security-zone VPN
```

Create PPTP users *Ivan* and *Fedor* for PPTP server:

```
esr(config-pptp)# username ivan
esr(config-pptp-user)# password ascii-text password1
esr(config-pptp-user)# enable
esr(config-pptp-user)# exit
esr(config-pptp)# username fedor
esr(config-pptp-user)# password ascii-text password2
esr(config-pptp-user)# enable
esr(config-pptp-user)# exit
esr(config-pptp)# exit
```

Enable PPTP server:

```
esr(config-pptp)# enable
```

When a new configuration is applied, the router will listen to 120.11.5.1:1723. To view PPTP server session status, use the following command:

```
esr# show remote-access status pptp server remote-workers
```

To view PPTP server session counters, use the following command:

```
esr# show remote-access counters pptp server remote-workers
```

To clear PPTP server session counters, use the following command:

```
esr# clear remote-access counters pptp server remote-workers
```

To end PPTP server session for user 'fedor', use one of the following commands:

```
esr# clear remote-access session pptp username fedor
esr# clear remote-access session pptp server remote-workers username fedor
```

To view PPTP server configuration, use the following command:

```
esr# show remote-access configuration pptp remote-workers
```

In addition to PPTP server creation, you should open TCP port 1723 designed for connection handling and enable GRE protocol (47) for the tunnel traffic in the firewall.

7.22 Configuring remote access to corporate network via L2TP/IPsec protocol

L2TP (Layer 2 Tunnelling Protocol) is a sophisticated tunnelling protocol used to support virtual private networks. L2TP encapsulates PPP frames into IP packets for transmission via global IP network, e.g. the Internet. L2TP may be used for tunnel establishment between two local area networks. L2TP uses an additional UDP connection for tunnel handling. L2TP protocol does not provide data encryption, therefore it is usually combined with an IPsec protocol group that provides security on a packet level.

Objective: Configure L2TP server on a router for remote user connection to LAN. Authentication is performed on RADIUS server.

- L2TP server address: 120.11.5.1
- Gateway inside the tunnel: 10.10.10.1
- Radius server address: 192.168.1.4
- For IPsec, key authentication method is used: key—'password'

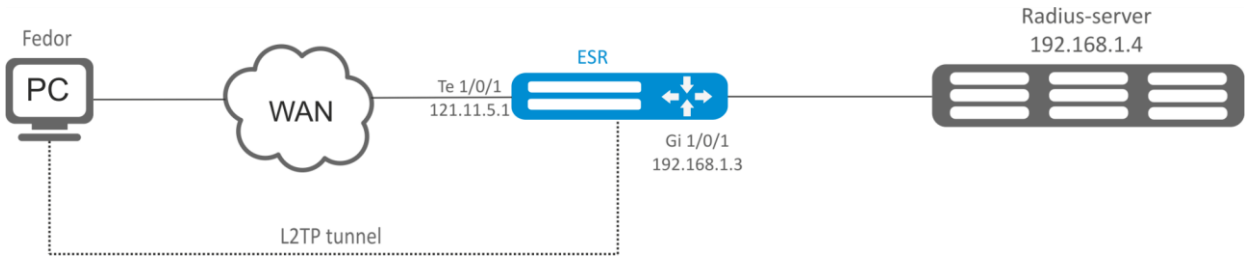


Fig. 7.23—Network structure

Solution:

First, do the following:

- Configure RADIUS server connection.
- Configure zones for te1/0/1 and gi1/0/1 interfaces.
- Specify IP addresses for te1/0/1 and te1/0/1 interfaces

Create address profile that contains local gateway address:

```
esr(config)# object-group network l2tp_local
esr(config-object-group-network)# ip address-range 10.10.10.1
esr(config-object-group-network)# exit
```

Create address profile that contains DNS servers:

```
esr(config)# object-group network pptp_dns
esr(config-object-group-network)# ip address-range 8.8.8.8
esr(config-object-group-network)# ip address-range 8.8.4.4
esr(config-object-group-network)# exit
```

Create L2TP server and map profiles listed above to it:

```
esr(config)# remote-access l2tp remote-workers
esr(config-l2tp)# local-address ip-address  10.10.10.1
esr(config-l2tp)# remote-address address-range 10.10.10.5-10.10.10.15
esr(config-l2tp)# outside-address ip-address 120.11.5.1
esr(config-l2tp)# dns-server object-group l2tp_dns
```

Select authentication method for L2TP server users:

```
esr(config-l2tp)# authentication mode radius
```

Specify security zone that user sessions will be related to:

```
esr(config-l2tp)# security-zone VPN
```

Specify authentication method for IKE phase 1 and define an authentication key.

```
esr(config-l2tp)# ipsec authentication method psk
esr(config-l2tp)# ipsec authentication pre-shared-key ascii-text password
```

Enable L2TP server:

```
esr(config-l2tp)# enable
```

When a new configuration is applied, the router will listen to IP address 120.11.5.1 and port 1701. To view L2TP server session status, use the following command:

```
esr# show remote-access status l2tp server remote-workers
```

To view L2TP server session counters, use the following command:

```
esr# show remote-access counters l2tp server remote-workers
```

To clear L2TP server session counters, use the following command:

```
esr# clear remote-access counters l2tp server remote-workers
```

To end L2TP server session for user 'fedor', use one of the following commands:

```
esr# clear remote-access session l2tp username fedor
esr# clear remote-access session l2tp server remote-workers username fedor
```

To view L2TP server configuration, use the following command:

```
esr# show remote-access configuration l2tp remote-workers
```

In addition to L2TP server creation, you should open UDP port 500, 1701, 4500 designed for connection handling and enable ESP (50) and GRE protocol (47) for the tunnel traffic in the firewall.

7.23 Configuring remote access to corporate network via OpenVPN protocol

OpenVPN is a sophisticated tool based on SSL that implements Virtual Private Networks (VPN), enables remote access and solves many different tasks related to data transmission security.

Objective: Configure Open VPN server in L3 mode on a router for remote user connection to LAN.

- OpenVPN server subnet: 10.10.100.0/24
- Mode: L3
- Authentication based on certificates

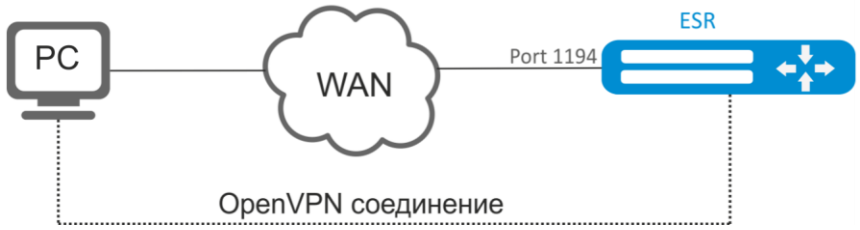


Fig. 7.24—Network structure

Solution:

First, do the following:

- Prepare certificates and keys:
  - CA certificate
  - OpenVPN server key and certificate
  - Diffie-Hellman and HMAC key for TLS
- Configure zone for te1/0/1 interface
- Specify IP address for te1/0/1 interface

Import certificates and keys via tftp

```
esr# copy tftp://192.168.16.10:/ca.crt certificate:ca/ca.crt
esr# copy tftp://192.168.16.10:/dh.pem certificate:dh/dh.pem
esr# copy tftp://192.168.16.10:/server.key certificate:server-key/server.key
esr# copy tftp://192.168.16.10:/server.crt certificate:server-crt/server.crt
esr# copy tftp://192.168.16.10:/ta.key certificate:ta/ta.key
```

Create OPENVPN server and a subnet for its operation:

```
esr(config)# remote-access openvpn AP
esr(config-openvpn)# network 10.10.100.0/24
```

Specify L3 connection type and encapsulation protocol.

```
esr(config-openvpn)# tunnel ip
esr(config-openvpn)# protocol tcp
```

Announce LAN subnets that will be available via OpenVPN connection and define DNS server

```
esr(config-)# route 10.10.0.0/20
esr(config-openvpn)# dns-server 10.10.1.1
```

Specify previously imported certificates and keys that will be used with OpenVPN server:

```
esr(config-openvpn)#  certificate ca ca.crt
esr(config-openvpn)#  certificate dh dh.pem
esr(config-openvpn)#  certificate server-key server.key
esr(config-openvpn)#  certificate server-crt server.crt
esr(config-openvpn)#  certificate ta ta.key
```

Specify security zone that user sessions will be related to:

```
esr(config-openvpn)# security-zone VPN
```

Select aes128 encryption algorithm:

```
esr(config-openvpn)# encryption algorithm aes128
```

Enable OpenVPN server:

```
esr(config-openvpn)# enable
```

When a new configuration is applied, the router will listen to port 1194 (used by default).

To view OpenVPN server session status, use the following command:

```
esr# show remote-access status openvpn server AP
```

To view OpenVPN server session counters, use the following command:

```
esr# show remote-access counters openvpn server AP
```

To clear OpenVPN server session counters, use the following command:

```
esr# clear remote-access counters openvpn server AP
```

To end OpenVPN server session for user 'fedor', use one of the following commands:

```
esr# clear remote-access session openvpn username fedor
esr# clear remote-access session openvpn server AP username fedor
```

To view OpenVPN server configuration, use the following command:

```
esr# show remote-access configuration openvpn AP
```

In addition to OpenVPN server creation, you should open TCP port 1194 in the firewall.

7.24 Dual-Homing Configuration[1]

Dual-Homing is a technology based on redundant links that creates a secure connection in order to prevent failures of the key network resources.

[1] In the current firmware version, this functionality is supported only by ESR-1000 router.

Objective: Establish redundancy of the ESR router L2 connections for VLAN 50-55 using SW1 and SW2 devices.

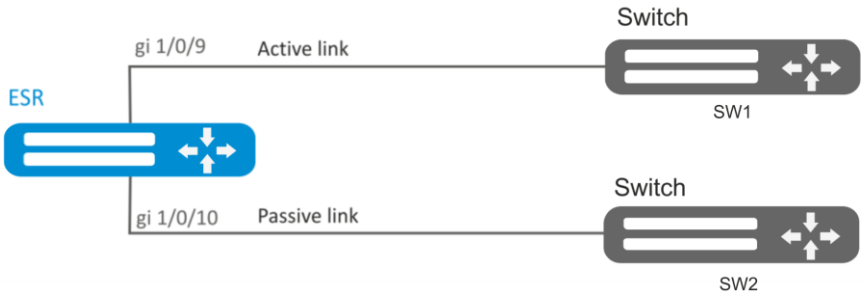


Fig. 7.25—Network structure

Solution:

1. First, do the following:

   Create VLAN 50-55:

```
esr-1000(config)# vlan 50-55
```

   You should disable STP for gigabitethernet 1/0/9 and gigabitethernet 1/0/10 interfaces, i.e. these protocols cannot operate simultaneously.

```
esr-1000(config)# interface gigabitethernet 1/0/9-10
esr-1000(config-if-gi)# spanning-tree disable
```

   Add gigabitethernet 1/0/9 and gigabitethernet 1/0/10 interfaces into VLAN 50-55 in 'general' mode.

```
esr-1000(config-if-gi)# switchport general allowed vlan add 50-55
esr-1000(config-if-gi)# exit
```

2. Main configuration step:

   Make gigabitethernet 1/0/10 redundant for gigabitethernet 1/0/9:

```
esr-1000(config)# interface gigabitethernet 1/0/9
esr-1000(config-if-gi)# backup interface gigabitethernet 1/0/10 vlan 50-55
```

   Configuration changes will take effect when the configuration is applied:

```
esr-1000# commit
Configuration has been successfully committed
esr-1000# confirm
Configuration has been successfully confirmed
```

   To view information on redundant interfaces, use the following command:

```
esr-1000# show interfaces backup
```

7.25 QoS configuration

QoS (Quality of Service) is a technology that provides various traffic classes with various service priorities. QoS service allows network applications to co-exist in a single network without altering the bandwidth of other applications.

7.25.1 Basic QoS

Objective: Configure the following restrictions on gigabitethernet 1/0/8 interface: transfer DSCP 22 traffic into 8th priority queue, DSCP 14 traffic into 7th weighted queue, limit transfer rate to 60Mbps for 7th queue.

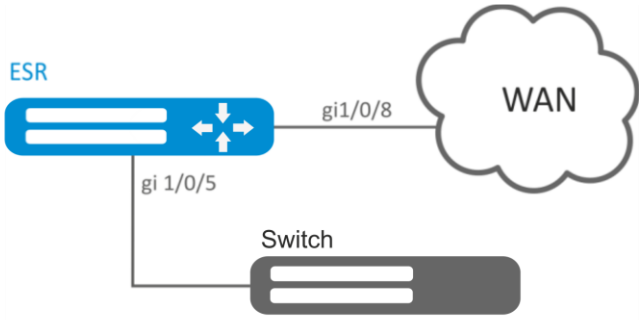


Fig. 7.26—Network structure

Solution:

In order to make 8th queue a priority queue, and 1st to 7th queues weighted ones, limit the quantity of priority queues to 1.

```
esr(config)# priority-queue out num-of-queues 1
```

Redirect DSCP 22 traffic into 8th priority queue:

```
esr(config)# qos map dscp-queue 22 to 8
```

Redirect DSCP 14 traffic into 7th weighted queue:

```
esr(config)# qos map dscp-queue 14 to 7
```

Enable QoS on the inbound interface from LAN side:

```
esr(config)# interface gigabitethernet 1/0/5
esr(config-if-gi)# qos enable
esr(config-if-gi)# exit
```

Enable QoS on the inbound interface from WAN side:

```
esr(config)# interface gigabitethernet 1/0/8
esr(config-if-gi)# qos enable
```

Limit transfer rate to 60Mbps for 7th queue:

```
esr(config-if)# traffic-shape queue 7 60000
esr(config-if)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To view QoS statistics, use the following command:

```
esr# show qos statistics gigabitethernet 1/0/8
```

7.25.2 Extended QoS

Objective: Classify incoming traffic by a subnet (10.0.11.0/24, 10.0.12.0/24), label it by DSCP (38 and 42) and segregate by a subnet (40Mbps and 60Mbps), limit general bandwidth to 250Mbps, process the rest of traffic using SFQ mechanism.

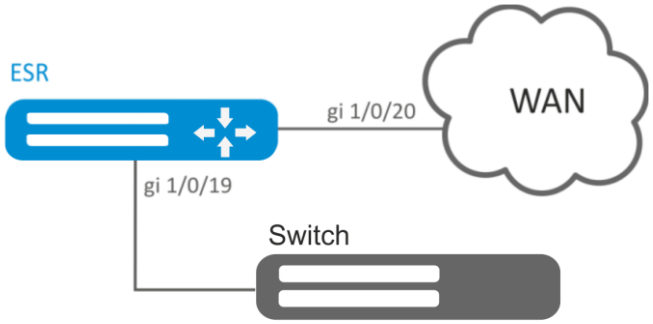


Fig. 7.27—Network structure

Solution:

Configure access control lists for filtering by a subnet, proceed to global configuration mode:

```
esr(config)# ip access-list extended fl1
esr(config-acl)# rule 1
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# match source-address 10.0.11.0 255.255.255.0
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
esr(config)# ip access-list extended fl2
esr(config-acl)# rule 1
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# match source-address 10.0.12.0 255.255.255.0
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
```

Create classes fl1 and fl2, specify the respective access control lists, configure labelling:

```
esr(config)# class-map fl1
esr(config-class-map)# set dscp 38
esr(config-class-map)# match access-group fl1
esr(config-class-map)# exit
esr(config)# class-map fl2
esr(config-class-map)# set dscp 42
esr(config-class-map)# match access-group fl2
esr(config-class-map)# exit
```

Create policy and define general bandwidth limits:

```
esr(config)# policy-map fl
esr(config-policy-map)# shape average 250000
```

Map class to policy, configure bandwidth limit and exit:

```
esr(config-policy-map)# class fl1
esr(config-class-policy-map)# shape average 40000
```

```
esr(config-class-policy-map)# exit
esr(config-policy-map)# class fl2
esr(config-class-policy-map)# shape average 60000
esr(config-class-policy-map)# exit
```

For the rest of traffic, configure a class with SFQ mode:

```
esr(config-policy-map)# class class-default
esr(config-class-policy-map)# mode sfq
esr(config-class-policy-map)# fair-queue 800
esr(config-class-policy-map)# exit
esr(config-policy-map)# exit
```

Enable QoS on the interfaces, policy on gi 1/0/19 interface ingress for classification purposes and gi1/0/20 egress for applying restrictions and SFQ mode for default class:

```
esr(config)# interface gigabitethernet 1/0/19
esr(config-if-gi)# qos enable
esr(config-if-gi)# service-policy input fl
esr(config-if-gi)# exit
esr(config)# interface gigabitethernet 1/0/20
esr(config-if-gi)# qos enable
esr(config-if-gi)# service-policy output fl
esr(config-if-gi)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To view the statistics, use the following command:

```
esr# do show qos policy statistics gigabitethernet 1/0/20
```

7.26 Mirroring configuration[1]

Traffic mirroring is a feature of the router that allows for redirection of traffic from a specific port of the router to another port of the same router (local mirroring) or to a remote device (remote mirroring).

Objective: Establish remote mirroring of traffic through VLAN 50 from gi1/0/11 interface to be sent to server for processing purposes.

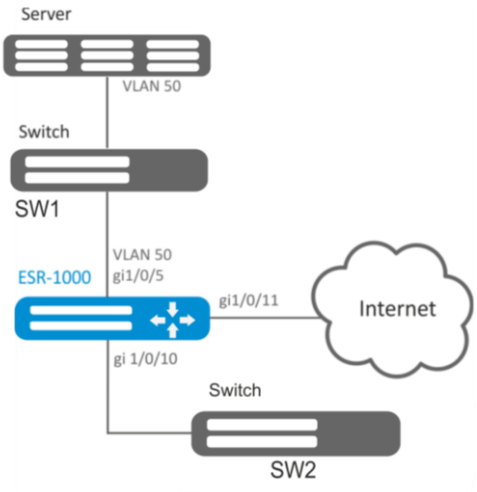


Fig. 7.28—Network structure

Solution:

First, do the following:

- Create VLAN 50.
- On gi 1/0/5 interface, add VLAN 50 in 'general' mode.

Main configuration step:

Specify VLAN that will be used for transmission of mirrored traffic:

```
esr1000(config)# port monitor remote vlan 50
```

For gi 1/0/5 interface, specify a port for mirroring:

```
esr1000(config)# interface gigabitethernet 1/0/5
esr1000(config-if-gi)# port monitor interface gigabitethernet 1/0/11
```

For gi 1/0/5 interface, specify remote mirroring mode:

```
esr1000(config-if-gi)# port monitor remote
```

Configuration changes will take effect when the configuration is applied:

```
esr1000# commit
Configuration has been successfully committed
esr1000# confirm
Configuration has been successfully confirmed
```

[1] In the current firmware version, this functionality is supported only by ESR-1000 router.

7.27 Netflow configuration

Netflow is a network protocol designed for traffic accounting and analysis. Netflow allows to transfer traffic information (source and destination address, port, quantity of information) from the network equipment (sensor) to the collector. Common server may serve as a collector.

Objective: Establish accounting for traffic from gi1/0/1 interface to be sent to the server via gi1/0/8 interface for processing purposes.

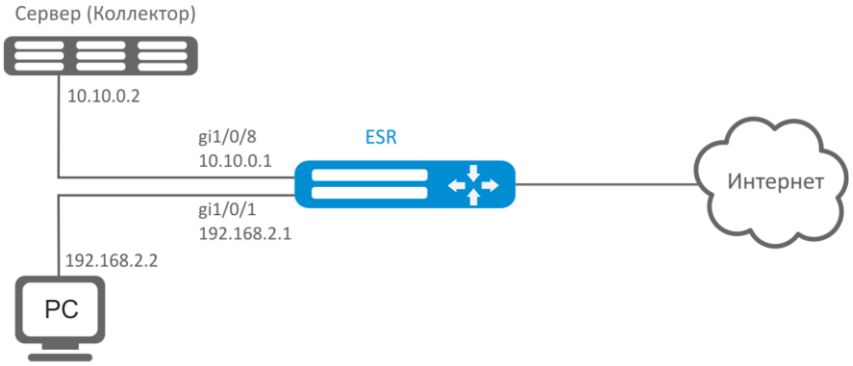


Fig. 7.29—Network structure

Solution:

First, do the following:

- For gi1/0/1, gi1/0/8 interfaces disable firewall with 'ip firewall disable' command.
- Assign IP address to ports.

Main configuration step:

Specify collector IP address:

```
esr(config)# netflow collector 10.10.0.2
```

Enable netflow statistics export collection for gi1/0/1 network interface:

```
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# ip netflow export
```

Enable netflow on the router:

```
esr(config)# netflow enable
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To view the Netflow statistics, use the following command:

```
esr# show netflow statistics
```

Netflow configuration for traffic accounting between zones is performed by analogy to sFlow configuration; for description, see Section *7.28 sFlow configuration.*

7.28 sFlow configuration

Sflow is a computer network, wireless network and network device monitoring standard designed for traffic accounting and analysis.

Objective: Establish accounting for traffic between 'trusted' and 'untrusted' zones.

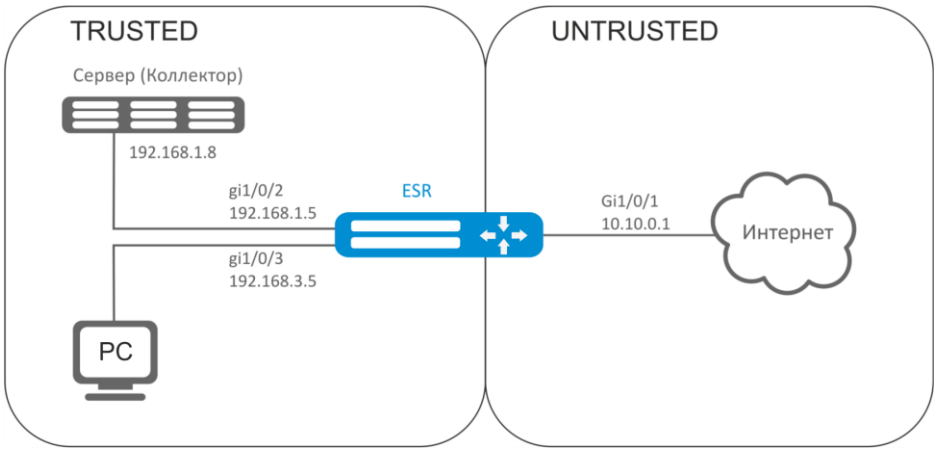


Fig. 7.30—Network structure

Solution:

Create two security zones for ESR networks:

```
esr# configure
esr(config)# security zone TRUSTED
esr(config-zone)# exit
esr(config)# security zone UNTRUSTED
esr(config-zone)# exit
```

Configure network interfaces and identify their inherence to security zones:

```
esr(config)# interface gi1/0/1
esr(config-if-gi)# security-zone UNTRUSTED
esr(config-if-gi)# ip address 10.10.0.1/24
esr(config-if-gi)# exit
esr(config)# interface gi1/0/2-3
esr(config-if-gi)# security-zone TRUSTED
esr(config-if-gi)# exit
esr(config)# interface gi1/0/2
esr(config-if-gi)# ip address 192.168.1.5/24
esr(config-if-gi)# exit
esr(config)# interface gi1/0/3
esr(config-if-gi)# ip address 192.168.3.5/24
esr(config-if-gi)# exit
```

Specify collector IP address:

```
esr(config)# sflow collector 192.168.1.8
```

Enable sFlow protocol statistics export for all traffic within 'rule1' for TRUSTED-UNTRUSTED direction:

```
esr(config)# security zone-pair TRUSTED UNTRUSTED
esr(config-zone-pair)# rule 1
esr(config-zone-pair-rule)# action sflow-sample
```

```
esr(config-zone-pair-rule)# match protocol any
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
```

Enable sFlow on the router:

```
esr(config)# sflow enable
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

sFlow configuration for traffic accounting from the interface is performed by analogy to *7.27 Netflow configuration*.

7.29 LACP configuration

LACP is a link aggregation protocol that allows multiple physical links to be combined into a single logical link. This process allows to increase the communication link bandwidth and robustness.

Objective: Configure aggregated link between ESR router and the switch.

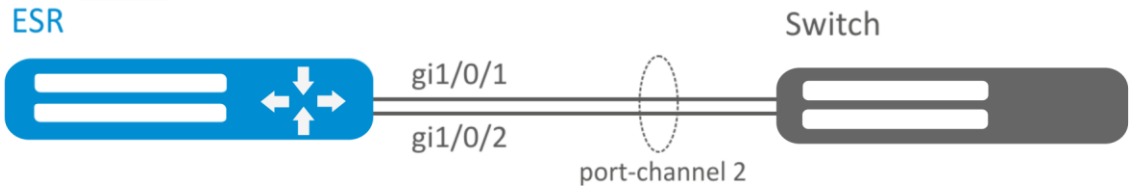


Fig. 7.31—Network structure

Solution:

First, configure the following:

- For gi1/0/1, gi1/0/2 interfaces disable security zone with 'no security-zone' command.

Main configuration step:

Create port-channel 2 interface:

```
esr(config)# interface port-channel 2
```

Add gi1/0/1, gi1/0/2 physical interfaces into the created link aggregation group:

```
esr(config)# interface gigabitethernet 1/0/1-2
esr(config-if-gi)# channel-group 2 mode auto
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
```

```
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

Further port-channel configuration is performed by analogy to the common physical interface.

7.30 VRRP configuration

VRRP (Virtual Router Redundancy Protocol) is a network protocol designed for increased availability of routers, acting as a default gateway. This is performed by aggregation of a router group into a single virtual router and assigning a shared IP address, that will be used as a default gateway for computers in the network.

Objective 1: Establish LAN virtual gateway in VLAN 50 using VRRP. IP address 192.168.1.1 is used as a local virtual gateway.

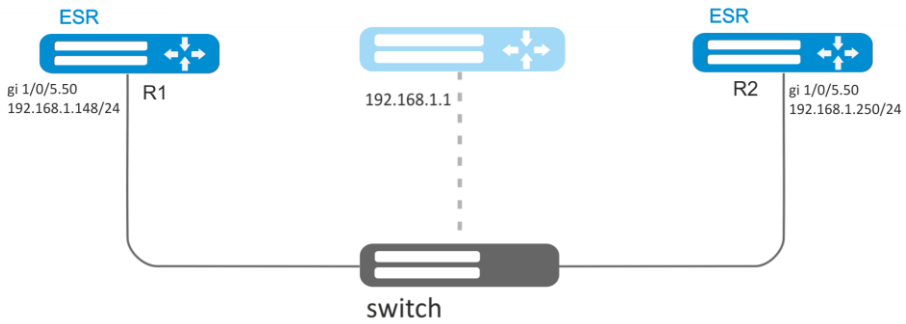


Fig. 7.32—Network structure

Solution:

First, do the following:

- Create the respective sub-interface
- Configure zone for sub-interface
- Specify IP address for sub-interface

Main configuration step:

Configure R1 router.

Configure VRRP in the created sub-interface. Specify unique VRRP identifier:

```
R1(config)#interface gi 1/0/5.50
R1(config-subif)# vrrp id 10
```

Specify virtual gateway IP address 192.168.1.1/24:

```
R1(config-subif)# vrrp ip 192.168.1.1
```

Enable VRRP:

```
R1(config-subif)# vrrp
R1(config-subif)# exit
```

Configuration changes will take effect when the configuration is applied:

```
R1# commit
```

```
Configuration has been successfully committed
R1# confirm
Configuration has been successfully confirmed
```

Configure R2 in the same manner.

Objective 2: Establish virtual gateways for 192.168.20.0/24 subnet in VLAN 50 and 192.168.1.0/24 in VLAN 60 using VRRP with Master sync feature. To do this, you have to group VRRP processes. IP addresses 192.168.1.1 and 192.168.20.1 are used as virtual gateways.

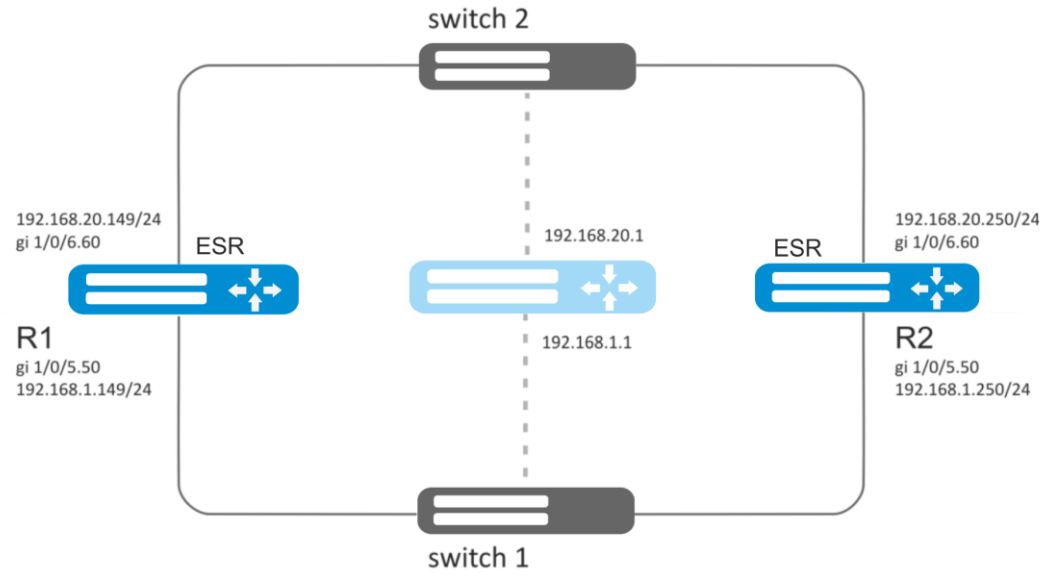


Fig. 7.33—Network structure

Solution:

First, do the following:

- Create the respective sub-interfaces
- Configure zone for sub-interfaces
- Specify IP addresses for sub-interfaces

Main configuration step:

Configure R1 router.

Configure VRRP for 192.168.1.0/24 subnet in the created sub-interface.

Specify unique VRRP identifier:

```
R1(config-sub)#interface gi 1/0/5.50
R1(config-subif)# vrrp id 10
```

Specify virtual gateway IP address 192.168.1.1:

```
R1(config-subif)# vrrp ip 192.168.1.1
```

Specify VRRP group identifier:

```
R1(config-subif)# vrrp group 5
```

Enable VRRP:

```
R1(config-subif)# vrrp
R1(config-subif)# exit
```

Configure VRRP for 192.168.20.0/24 subnet in the created sub-interface.

Specify unique VRRP identifier:

```
R1(config-sub)#interface gi 1/0/6.60
R1(config-subif)# vrrp id 20
```

Specify virtual gateway IP address 192.168.20.1:

```
R1(config-subif)# vrrp ip 192.168.20.1
```

Specify VRRP group identifier:

```
R1(config-subif)# vrrp group 5
```

Enable VRRP:

```
R1(config-subif)# vrrp
R1(config-subif)# exit
```

Configuration changes will take effect when the configuration is applied:

```
R1# commit
Configuration has been successfully committed
R1# confirm
Configuration has been successfully confirmed
```

Configure R2 in the same manner.

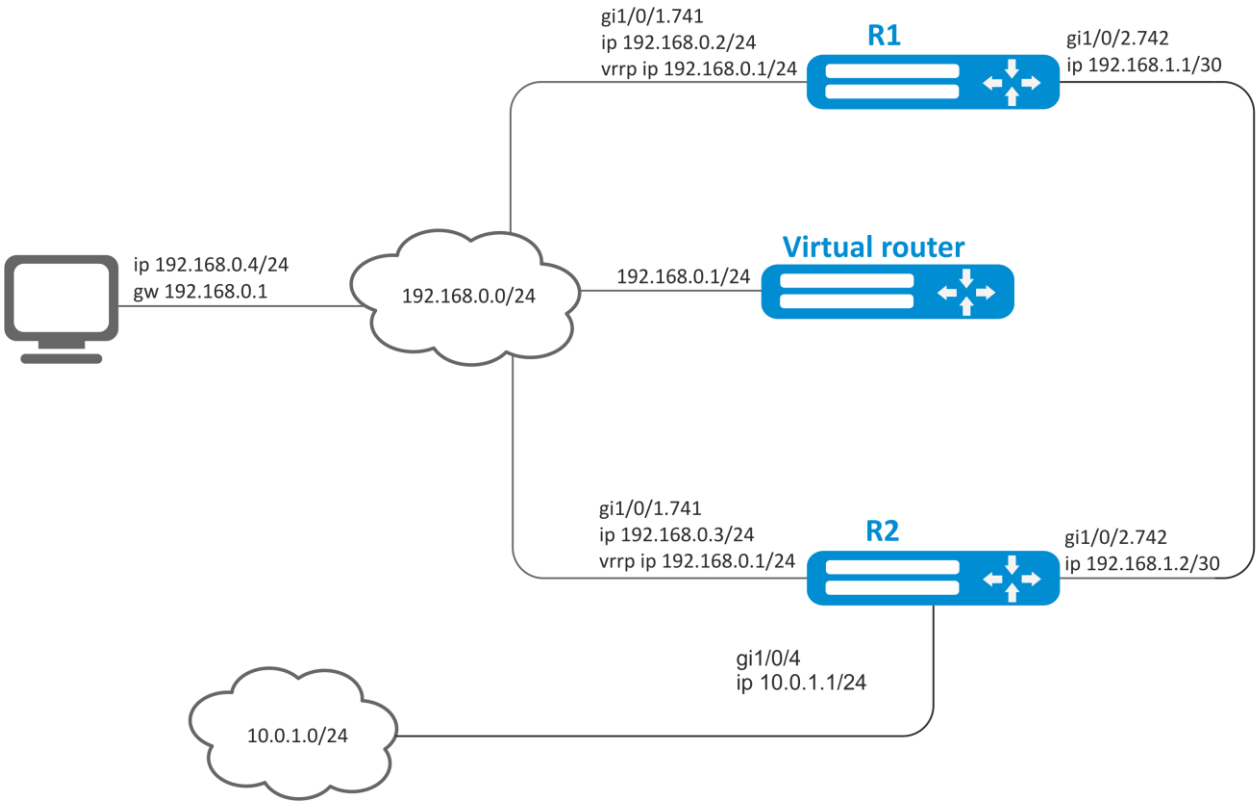
In addition to tunnel creation, you should enable VRRP protocol (112) in the firewall.

7.31 VRRP tracking configuration

VRRP tracking is a mechanism, which allows activating static routes, depending on VRRP state.

Objective: Virtual gateway 192.168.0.1/24 is organized for 192.168.0.0/24 subnet, using VRRP protocol and routers R1 and R2. There is a link with singular subnet 192.168.1.0/30 between R1 and R2 routers. Subnet 10.0.1.0/24 is terminated only on R2 router. PC has IP address - 192.168.0.4/24 and default gateway 192.168.1.1.

When router R1 is in vrrp backup state, traffic from PC will be transmitted without any additional settings. When router R1 is in vrrp master state, additional route is necessary for subnet 10.0.1.0/24 through interface 192.168.1.2.



Initial configurations of the routers:

Router R1:

```
hostname R1

interface gigabitethernet 1/0/1
  switchport forbidden default-vlan
exit
interface gigabitethernet 1/0/1.741
  ip firewall disable
  ip address 192.168.0.2/24
  vrrp ip 192.168.0.1/24
  vrrp
exit
interface gigabitethernet 1/0/2
  switchport forbidden default-vlan
exit
interface gigabitethernet 1/0/2.742
  ip firewall disable
  ip address 192.168.1.1/30
exit
```

Router R2:

```
hostname R2

interface gigabitethernet 1/0/1
  switchport forbidden default-vlan
exit
interface gigabitethernet 1/0/1.741
  ip firewall disable
  ip address 192.168.0.3/24
  vrrp id 10
```

```
  vrrp ip 192.168.0.1/24
  vrrp
exit
interface gigabitethernet 1/0/2
  switchport forbidden default-vlan
exit
interface gigabitethernet 1/0/2.742
  ip firewall disable
  ip address 192.168.1.2/30
exit
interface gigabitethernet 1/0/4
  ip firewall disable
  ip address 10.0.1.1/24
exit
```

Solution:

There is no need in any changes in router R2, since subnet 10.0.1.0/24 is terminated on it and as soon as router R1 is vrrp master, packets will be transmitted to corresponding interface. As soon as R1 become vrrp master, route for packets must be created with destination IP address from network 10.0.1.0/24

Create tracking-object with corresponding condition:

```
R1(config)# tracking 1
R1(config-tracking)# vrrp 10 state master
R1(config-tracking)# enable
R1(config-tracking)# exit
```

Create static route to subnet 10.0.1.0/24 through 192.168.1.2, which will work in case of satisfying of tracking 1 condition:

```
R1(config)# ip route 10.0.1.0/24 192.168.1.2 track 1
```

7.32 VRF Lite configuration

VRF (Virtual Routing and Forwarding) is a technology designed for isolation of routing information that belongs to different classes (e.g., routes of a specific client).

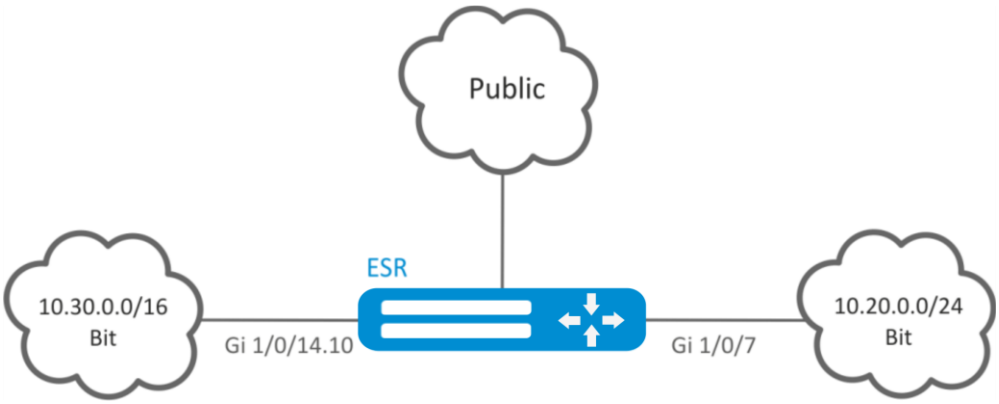


Fig. 7.34—Network structure

Objective: ESR series router features 2 connected networks that should be isolated from other networks.

Solution:

Create VRF:

```
esr(config)# ip vrf bit
esr(config-vrf)# exit
```

Create security zone:

```
esr(config)# security zone vrf-sec
esr(config-zone)# ip vrf forwarding bit
esr(config-zone)# exit
```

Create rule for a pair of zones and allow all TCP/UDP traffic:

```
esr(config)# security zone-pair vrf-sec vrf-sec
esr(config-zone-pair)# rule 1
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# match protocol udp
esr(config-zone-rule)# match source-port any
esr(config-zone-rule)# match destination-port any
esr(config-zone-rule)# action permit
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
esr(config-zone-pair)# rule 2
esr(config-zone-rule)# match source-address any
esr(config-zone-rule)# match destination-address any
esr(config-zone-rule)# match protocol tcp
esr(config-zone-rule)# match source-port any
esr(config-zone-rule)# match destination-port any
esr(config-zone-rule)# action permit
esr(config-zone-rule)# enable
esr(config-zone-rule)# exit
```

Create interface mapping, assign IP addresses, specify an inherence to a security zone:

```
esr(config)# interface gigabitethernet 1/0/7
esr(config-if-gi)# ip vrf forwarding bit
esr(config-if-gi)# ip address 10.20.0.1/24
esr(config-if-gi)# security-zone vrf-sec
esr(config-if-gi)# exit
esr(config)# interface gigabitethernet 1/0/14.10
esr(config-subif)# ip vrf forwarding bit
esr(config-subif)# ip address 10.30.0.1/16
esr(config-subif)# security-zone vrf-sec
esr(config-subif)# exit
esr(config)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To view information on interfaces mapped to VRF, use the following command:

```
esr# show ip vrf
```

To view VRF routing table, use the following command:

```
esr# show ip route vrf bit
```

7.33 MultiWAN configuration

MultiWAN technology establishes a fail-safe connection with redundancy of links from multiple providers and solves the problem involving traffic balancing between redundant links.

Objective: Configure route to the server (108.16.0.1/28) with the load balancing option.

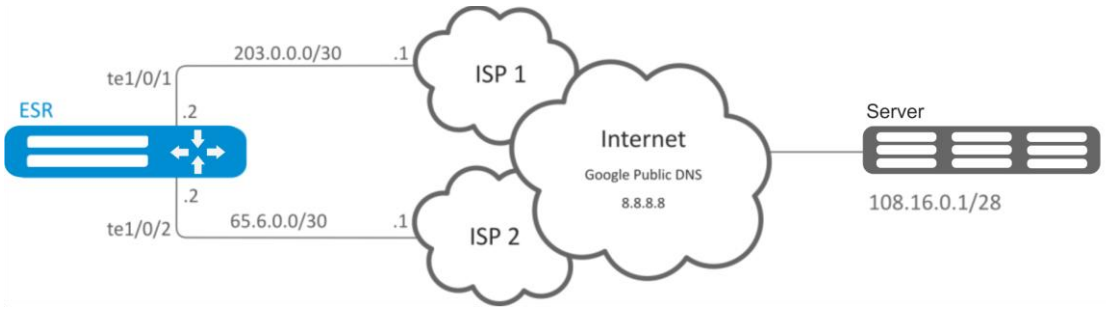


Fig. 7.35—Network structure

Solution:

First, do the following:

- Configure zones for te1/0/1 and te1/0/2 interfaces.
- Specify IP addresses for te1/0/1 and te1/0/2 interfaces.

Main configuration step:

Configure routing:

```
esr(config)# ip route 108.16.0.0/28 wan load-balance rule 1
```

Create WAN rule:

```
esr(config)# wan load-balance rule 1
```

Specify affected interfaces:

```
esr(config-wan-rule)# outbound interface tengigabitethernet 1/0/2
esr(config-wan-rule)# outbound interface tengigabitethernet 1/0/1
```

Enable the created balancing rule and exit the rule configuration mode:

```
esr(config-wan-rule)# enable
esr(config-wan-rule)# exit
```

Create a list for link integrity check:

```
esr(config)# wan load-balance target-list google
```

Create integrity check target:

```
esr(config-target-list)# target 1
```

Specify address to be checked, enable check for the specified address and exit:

```
esr(config-wan-target)# ip address 8.8.8.8
esr(config-wan-target)# enable
esr(config-wan-target)# exit
```

Configure interfaces. In te1/0/1 interface configuration mode, specify nexthop:

```
esr(config)# interface tengigabitethernet 1/0/1
esr(config-if)# wan load-balance nexthop 203.0.0.1
```

In te1/0/1 interface configuration mode, specify a list of targets for link check:

```
esr(config-if)# wan load-balance target-list google
```

In te1/0/1 interface configuration mode, enable WAN mode and exit:

```
esr(config-if)# wan load-balance enable
esr(config-if)# exit
```

In te1/0/2 interface configuration mode, specify nexthop:

```
esr(config)# interface tengigabitethernet 1/0/2
esr(config-if)# wan load-balance nexthop 65.6.0.1
```

In te1/0/1 interface configuration mode, specify a list of targets for link check:

```
esr(config-if)# wan load-balance target-list google
```

In te1/0/2 interface configuration mode, enable WAN mode and exit:

```
esr(config-if)# wan load-balance enable
esr(config-if)# exit
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

To switch into redundancy mode, configure the following:

Proceed to WAN rule configuration mode:

```
esr(config)# wan load-balance rule 1
```

MultiWAN function may also work in redundancy mode when traffic is directed to the active interface with the highest weight. To enable this mode, use the following command:

```
esr(config-wan-rule)# failover
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

7.34 SNMP configuration

SNMP (Simple Network Management Protocol)is a protocol designed for device management in IP networks featuring TCP/UDP architecture. SNMP provides management data as variables that describe the configuration of a system being managed.

Objective: Configure SNMPv3 server with authentication and data encryption for 'admin' user. ESR router IP address: 192.168.52.41, server IP address: 192.168.52.8.

Fig. 7.36—Network structure

Solution:

First, do the following:

- Specify zone for gi1/0/1 interface
- Configure IP address for ge1/0/1 interfaces

Main configuration step:

Enable SNMP server:

```
esr(config)# snmp-server
```

Create SNMPv3 user:

```
esr(config)# snmp-server user admin
```

Specify security mode:

```
esr(snmp-user)# authentication access priv
```

Specify authentication algorithm for SNMPv3 requests:

```
esr(snmp-user)# authentication algorithm md5
```

Define password for SNMPv3 request authentication:

```
esr(snmp-user)# authentication key ascii-text 123456789
```

Specify transferred data encryption algorithm:

```
esr(snmp-user)# privacy algorithm aes128
```

Define password for transferred data encryption:

```
esr(snmp-user)# privacy key ascii-text 123456789
```

Enable SNMPv3 user:

```
esr(snmp-user)# enable
```

Define receiver-server of Trap-PDU messages

esr(config)# snmp-server host 192.168.52.41

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

7.35 BRAS (Broadband Remote Access Server) configuration

Objective: Provide access to the Internet only to authorized users.

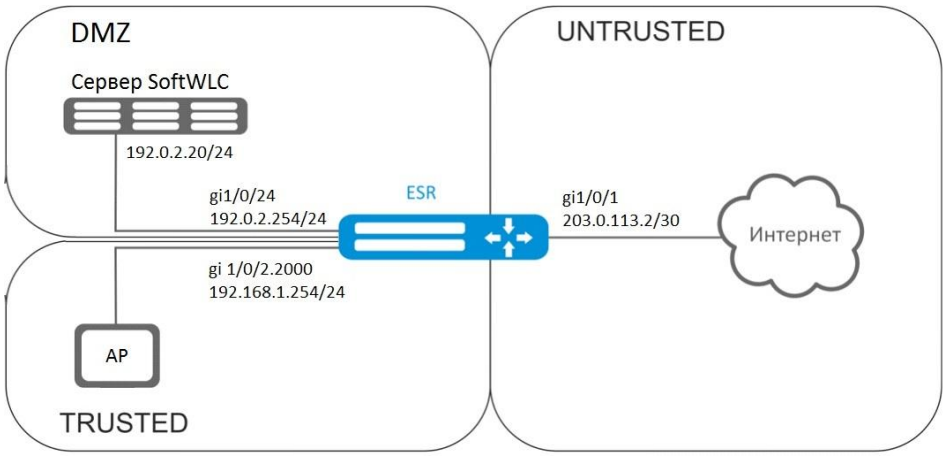


Fig. 7.3 – Network structure

Solution:

SoftWLC server keeps accounts data and tariff plan parameters. You can obtain more detailed information on installation and configuring SoftWLC server using following links:

http://kcs.eltex.nsk.ru/articles/960 - general article of SoftWLC;

http://kcs.eltex.nsk.ru/articles/474 - SoftWLC installation from repositories.

The BRAS license is obligatory for router, after its activation you can start device configuring.

Create 3 security zones, according to the network structure depicted in Fig. 7.3:

```
esr# configure
esr(config)# security zone trusted
esr(config-zone)# exit
esr(config)# security zone untrusted
esr(config-zone)# exit
esr(config)# security zone dmz
esr(config-zone)# exit
```

Configure public port parameters and assign its default gateway:

```
esr(config)# interface gigabitethernet 1/0/1
esr(config-if-gi)# security-zone untrusted
esr(config-if-gi)# ip address 203.0.113.2/30
```

```
esr(config-if-gi)# service-policy dynamic upstream
esr(config-if-gi)# exit
esr(config)# ip route 0.0.0.0/0 203.0.113.1
```

Configure port in direction to the SoftWLC server:

```
esr (config)# interface gigabitethernet 1/0/24
esr (config-if-gi)# security-zone dmz
esr (config-if-gi)# ip address 192.0.2.1/24
esr (config-if-gi)# exit
```

Configure port for Wi-Fi access point connection:

```
esr(config)# bridge 2
esr(config-bridge)# security-zone trusted
esr(config-bridge)# ip address 192.168.0.254/24
esr(config-bridge)# ip helper-address 192.0.2.20
esr(config-bridge)# service-subscriber-control object-group users
esr(config-bridge)# location ssid1
esr(config-bridge)# enable
esr(config-bridge)# exit
esr(config)# interface gigabitethernet 1/0/2.2000
esr(config-subif)# bridge-group 1
esr(config-subif)# exit
esr(config)# interface gigabitethernet 1/0/2
esr(config-if-gi)# service-policy dynamic downstream
esr (config-if-gi)# exit
```

Customer connection must be implemented through subinterfaces to bridges. Selection of tariff plan depends on Location parameter (see bridge 2 configuration).

The module which is control AAA operations is based on eltex-radius and available by SoftWLC IP address. Numbers of ports for authentication and accounting in the example below are the default values for SoftWLC.

Define parameters for interaction with the module:

```
esr(config)# radius-server host 192.0.2.20
esr(config-radius-server)#   key ascii-text password
esr(config-radius-server)#   auth-port 31812
esr (config-radius-server)#  acct-port 31813
esr (config-radius-server)# exit
```

Create AAA profile:

```
esr(config)# aaa radius-profile RADIUS
esr(config-aaa-radius-profile)# radius-server host 192.0.2.20
esr(config-aaa-radius-profile)# exit
```

Specify parameters for access to DAS (Direct-attached storage) server:

```
esr(config)# object-group network server
esr(config-object-group-network)#   ip address-range 192.0.2.20
esr(config-object-group-network)# exit
esr(config)# das-server CoA
esr(config-das-server)#   key ascii-text password
esr(config-das-server)#   port 3799
esr(config-das-server)#   clients object-group server
esr(config-das-server)# exit
esr(config)# aaa das-profile CoA
esr(config-aaa-das-profile)#   das-server CoA
esr(config-aaa-das-profile)# exit
```

The traffic from trusted zone is blocked before authentication as well as DHCP and DNS requests. You need to configure allowing rules in order to pass DHCP and DNS requests:

```
esr(config)# ip access-list extended DHCP
esr(config-acl)#  rule 10
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol udp
esr(config-acl-rule)# match source-address any
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# match source-port 68
esr(config-acl-rule)# match destination-port 67
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# rule 11
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol udp
esr(config-acl-rule)# match source-address any
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# match source-port any
esr(config-acl-rule)# match destination-port 53
esr(config-acl-rule)# enable
esr(config-acl-rule)#exit
esr(config-acl)# exit
```

Then, create rules for redirecting to portal and passing traffic to the Internet:

```
esr(config)# ip access-list extended WELCOME
esr(config-acl)# rule 10
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# match source-address any
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
esr (config)# ip access-list extended INTERNET
esr(config-acl)#  rule 10
esr(config-acl-rule)# action permit
esr(config-acl-rule)# match protocol any
esr(config-acl-rule)# match source-address any
esr(config-acl-rule)# match destination-address any
esr(config-acl-rule)# enable
esr(config-acl-rule)# exit
esr(config-acl)# exit
```

Specify web resources which are available without authorization:

```
esr(config)# object-group url defaultservice
esr(config-object-group-url)# url http://eltex.nsk.ru
esr(config-object-group-url)# exit
```

The URL filtering lists are kept on SoftWLC server (you need to change only IP address of SoftWLC server, if addressing is different from the example. Leave the rest of URL without changes):

```
esr(config)# subscriber-control filters-server-url
http://192.0.2.20:7070/Filters/file/
```

Configure and enable BRAS, define NAS IP as address of the interface interacting with SoftWLC (gigabitethernet 1/0/24 in the example):

```
esr(config)# subscriber-control
esr(config-subscriber-control)#  aaa das-profile CoA
esr(config-subscriber-control)#  aaa sessions-radius-profile RADIUS
esr(config-subscriber-control)#  nas-ip-address 192.0.2.1
esr(config-subscriber-control)#  session mac-authentication
```

```
esr(config-subscriber-control)#  bypass-traffic-acl DHCP
esr(config-subscriber-control)#  default-service
esr(config-subscriber-default-service)#  class-map INTERNET
esr(config-subscriber-default-service)#  filter-name local defaultservice
esr(config-subscriber-default-service)#  filter-action permit
esr(config-subscriber-default-service)#  default-action redirect
http://192.0.2.20:8080/eltex_portal/
esr(config-subscriber-default-service)#  session-timeout 3600
esr(config-subscriber-default-service)# exit
esr(config-subscriber-control)# enable
esr(config-subscriber-control)# exit
```

Configure rules for transition among security zones.

```
esr(config)# object-group service telnet
esr(config-object-group-service)#   port-range 23
esr(config-object-group-service)# exit
esr(config)# object-group service ssh
esr(config-object-group-service)#   port-range 22
esr(config-object-group-service)# exit
esr(config)# object-group service dhcp_server
esr(config-object-group-service)#   port-range 67
esr(config-object-group-service)# exit
esr(config)# object-group service dhcp_client
esr(config-object-group-service)#   port-range 68
esr(config-object-group-service)# exit
esr(config)# object-group service ntp
esr(config-object-group-service)#   port-range 123
esr(config-object-group-service)# exit
```

Enable access to the Internet from trusted and dmz zones:

```
esr(config)# security zone-pair trusted untrusted
esr(config-zone-pair)# rule 10
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol any
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair)# exit
esr(config)# security zone-pair dmz untrusted
esr(config-zone-pair)# rule 10
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol any
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair)# exit
esr(config)# security zone-pair dmz trusted
esr(config-zone-pair)# rule 10
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol any
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair)# exit
```

Enable DHCP transmitting from trusted to dmz:

```
esr (config)# security zone-pair trusted dmz
esr (config-zone-pair)# rule 10
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol udp
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
```

```
esr(config-zone-pair-rule)# match source-port dhcp_client
esr(config-zone-pair-rule)# match destination-port dhcp_server
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair)# exit
```

Enable ICMP transmission to the device. For BRAS operation you need to open ports for web proxying - TCP 3129/3128 (NetPortDiscovery Port/Active API Server port:

```
esr(config)# object-group service bras
esr(config-object-group-service)#   port-range 3129
esr(config-object-group-service)#   port-range 3128
esr(config-object-group-service)# exit
esr(config)#  security zone-pair trusted self
esr(config-zone-pair)#  rule 10
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol tcp
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# match source-port any
esr(config-zone-pair-rule)# match destination-port bras
esr(config-zone-pair-rule)# enable
esr (config-zone-pair-rule)# exit
esr(config-zone-pair)# rule 20
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol icmp
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair-rule)# exit
esr(config)# security zone-pair dmz self
esr(config-zone-pair)# rule 20
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol icmp
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair-rule)# exit
esr(config)# security zone-pair untrusted self
esr(config-zone-pair)# rule 20
esr(config-zone-pair-rule)# action permit
esr(config-zone-pair-rule)# match protocol icmp
esr(config-zone-pair-rule)# match source-address any
esr(config-zone-pair-rule)# match destination-address any
esr(config-zone-pair-rule)# enable
esr(config-zone-pair-rule)# exit
esr(config-zone-pair-rule)# exit
```

Activate DHCP-Relay:

```
esr(config)# ip dhcp-relay
```

Configure SNAT for gigabitethernet 1/0/1 port:

```
esr(config)# nat source

esr(config-snat)# ruleset inet
esr(config-snat-ruleset)# to interface gigabitethernet 1/0/1
esr(config-snat-ruleset)# rule 10
esr(config-snat-rule)# match source-address any
esr(config-snat-rule)# action source-nat interface
esr(config-snat-rule)# enable
esr(config-snat-rule)# end
```

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

8 FREQUENTLY ASKED QUESTIONS

Configuration changes will take effect when the configuration is applied:

```
esr# commit
Configuration has been successfully committed
esr# confirm
Configuration has been successfully confirmed
```

- **Receiving of routes, which are configured in VRF via BGP or/and OSPF, failed. The neighboring is successfully installed, but record of routes in RIB is denied:**

  %ROUTING-W-KERNEL: Can not install route. Reached the maximum number of BGP routes in the RIB

  Allocate RIB resource for VRF (0 by default). Do it in VRF configuration mode:

```
esr(config)# ip vrf <NAME>
esr(config-vrf)# ip protocols ospf max-routes 12000
esr(config-vrf)# ip protocols bgp max-routes 1200000
esr(config-vrf)# end
```

- **SSH/Telnet sessions, which go through ESR router, are closing**

Configure transmission of keepalive packets in order to keep session active. Keepalive transmission option is configured on SSH client, for instance, section "Connection" for PuTTY client.

It is possible to set time to closing inactive TCP sessions (1 hour in example):

```
esr(config)# ip firewall sessions tcp-estabilished-timeout 3600
```

- **Firewall was disabled on interface. However access for active sessions from the port was not closed, according to security zone-pair rules, after including this interface to security zone, removing from 'ip firewall disable' configuration and applying changes.**

  Changes in Firewall configuration will be active only for new sessions. The reset of Firewall active sessions does not occur.You can clear active sessions in firewall, using following command:

```
esr# clear ip firewall session
```

- **LACP does not launch on XG ports of ESR-1000**

  Port-channel has speed 1000M mode by default. Enable speed 10G mode:

```
esr(config)# interface port-channel 1
esr(config-port-channel)# speed 10G
```

- **How to clear ESR configuration completely and reset it to factory default?**

  Copy blank configuration in candidate-config and apply it in running-config.

```
esr# copy system://default-config system://candidate-config
```

Reset to factory default is similar.

```
esr# copy system://factory-config system://candidate-config
```

- **How to attach subinterface to created VLAN?**

While subinterface creation, VLAN is created and attached automatically (direct correlation index sub-VID)

```
esr(config)# interface gigabitethernet 1/0/1.100
```

Information messages are shown after applying:

```
2016-07-14T012:46:24+00:00 %VLAN: creating VLAN 100
```

- **Do the ESR-series routers have features for traffic analysis?**

Opportunity of analysing traffic through CLI interfaces is realized on ESR-series routers. A packet sniffer is launched by *monitor* command.

- **How to configure ip-prefix-list 0.0.0.0./0?**

Example of prefix-list configuration is shown below. The configuration allows route reception by default.

```
esr(config)# ip prefix-list eltex

esr(config-pl)# permit default-route
```

- **Problem of asynchronuous traffic transmission is occurred**

In case of asynchronous routing, Firewall will forbid "incorrect" ingress traffic (which does not open new connection and does not belong any established connection) for security reasons.

Allowing rule in Firewall does not solve the problem.

Firewall should be disabled on ingress interface.

```
esr(config-if-gi)# ip firewall disable
```

TECHNICAL SUPPORT

Contact EltexAlatau Service Centre to receive technical support regarding our products:

For technical assistance in issues related to handling of EltexAlatau Ltd. equipment please address to Service Centre of the company:

9 Ibragimova street, Almaty, Republic of Kazakhstan, 050032,
Phone:
+7(727) 320-18-40
+7(727) 320-18-38
E-mail: info@eltexalatau.kz

In official website of the EltexAlatau Ltd. you can find technical documentation and software for products, refer to knowledge base, consult with engineers of Service center:

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