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RC1201-4FE4E1T1
Product Description
(P100R001_01)

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Notice

Preface

Objectives

This document describes the RC1201-4FE4E1T1 in terms of product orientation, network applications, features, system structure, services, functions, OAM, technical specifications, and installation. The appendix lists all terms, acronyms, and abbreviations involved in this document.

Versions

The following table lists the product versions related to this document.

Product name	Version
RC1201-4FE4E1T1	P100R001

Conventions

Symbol conventions

The symbols that may be found in this document are defined as below.

Symbol	Description
	Indicate a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
	Indicate a potentially hazardous situation that, if not avoided, could cause equipment damage, data loss, and performance degradation, or unexpected results.
	Provide additional information to emphasize or supplement important points of the main text.
	Indicate a tip that may help you solve a problem or save time.

General conventions

Convention	Description
Times New Roman	Normal paragraphs are in Times New Roman.
Arial	Paragraphs in Warning, Caution, Notes, and Tip are in Arial.
Boldface	Buttons and navigation path are in **Boldface**.
Italic	Book titles are in *italics*.
`Lucida Console`	Terminal display is in `Lucida Console`.
Book Antiqua	Heading 1, Heading 2, Heading 3, and Block are in Book Antiqua.

Change history

Updates between document versions are cumulative. Therefore, the latest document version contains all updates made to previous versions.

Issue 01 (2012-05-21)

Initial commercial release

Contents

Figures

Tables

1 Overview

This chapter describes features and networking applications of the RC1201-4FE4E1T1, including the following sections:

- Introduction
- Networking applications
- Features
- Ordering information

1.1 Introduction

As the 3G era approaches, data services grow rapidly. Traditional Time Division Multiplex (TDM), based on circuit switching, is of inadequate bandwidth, low channel multiplexing rate, and weak expansion, which can hardly meet requirements from data services. The Packet Switched Network (PSN), based on packet switching, is of flexible networking applications, high bandwidth, and low cost, which becomes trend of the Next Generation Network (NGN).

However, a great number of TDM devices are still in service on the network, are still predominant, and will coexist with the PSN for a long time. As a result, Time Division Multiplex over Packet (TDMoP) is introduced.

The RC1201-4FE4E1T1 is a TDMoP device developed by Raisecom. It can access both voice services and data services. It provides the following interfaces:

- Four E1/T1 interfaces
- Four 10/100 Mbit/s Ethernet electrical interfaces
- One 1000 Mbit/s Ethernet optical interface

With these interfaces, the RC1201-4FE4E1T1 can meet requirements for multiple services. Any of the previous 5 Ethernet interfaces can work as the uplink interface while the rest 4 can work as the local switch interface. The RC1201-4FE4E1T1 is a 1U-high standard cartridge chassis.

Basic functions of the RC1201-4FE4E1T1 are emulating TDM services, carrying emulated service packets through the PSN, and implementing transparent transmission of TDM services on the PSN. As a remote device, it can cooperate with Raisecom aggregation TDMoP devices, such as the RC1201-2GE16E1T1.

1.2 Networking applications

Oriented to the access layer of the network, the RC1201-4FE4E1T1 is of modular design, small size, and high integration. In NGN construction, it expands the PSN to the access end by providing reliable E1/T1 service access, high bandwidth Ethernet leased line access, complete Operation, Administration, and Maintenance (OAM) features, and high-precision clock synchronization.

Typical application scenarios for the RC1201-4FE4E1T1 include:

- Key customer leased line access
- Multiplexing of multiple ways of voice and Ethernet services

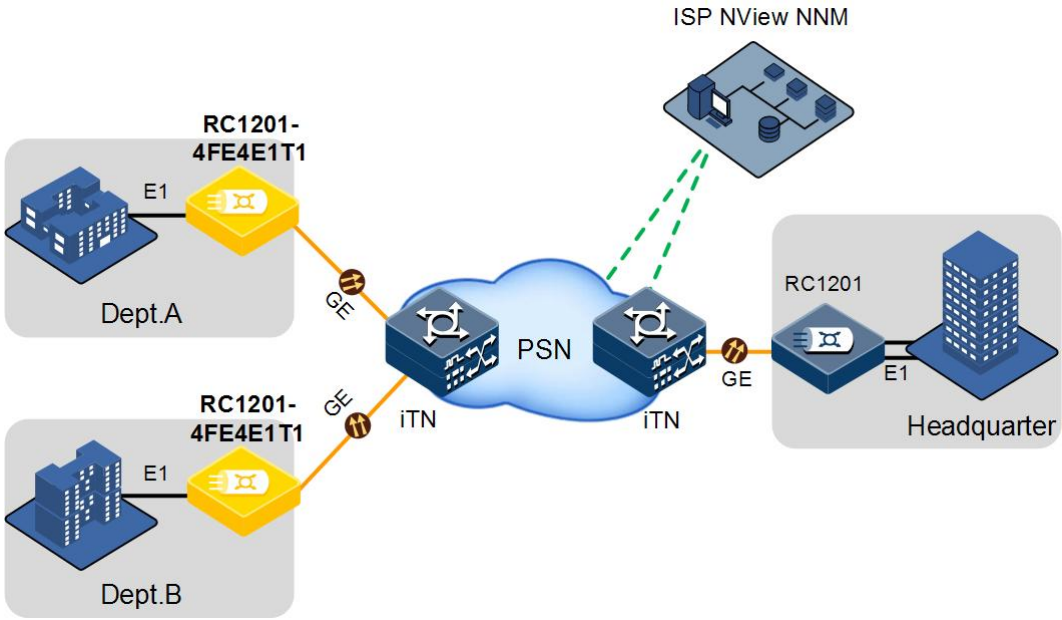
1.2.1 Key customer leased line access

As show in Figure 1-1, a leased line customer's headquarter and departments are located separately. To ensure high security, the customer uses TDM devices for networking. When being transmitted to the PSN Metropolitan Access Network (MAN), TDM private line services are emulated by TDMoP devices. The headquarter and departments implement point-to-multipoint communication under the conditions as below:

- The headquarter is connected to the PSN MAN through uplink GE interfaces on the aggregation TDMoP device RC1201-4FE4E1T1.
- The departments are connected to the PSN MAN through uplink GE interfaces on a TDMoP device.

This networking application is used for Structure-Agnostic Time Division Multiplexing over Packet (SAToP).

Figure 1-1 Networking with device for key customer leased line access



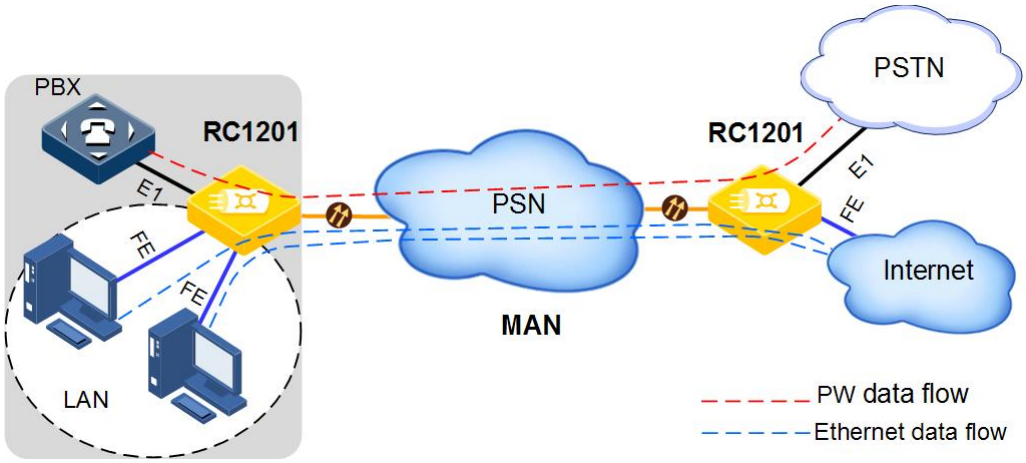
1.2.2 Multiplexing of multiple ways of voice and Ethernet services

As shown in Figure 1-2, to ensure high security, the customer uses voice services through TDM interfaces. When the carrier does not deploy Synchronous Digital Hierarchy (SDH) network but Ethernet MAN only,

- Voice and Ethernet services of the customer are transmitted together to the Ethernet MAN through TDMoP devices.
- Voice services are transmitted to the Public Switched Telephone Network (PSTN) and IP services are transmitted to the Internet at the CO.

This networking application is used for Circuit Emulation over Packet Switching Network (CESoPSN) and Ethernet service access.

Figure 1-2 Networking for multiplexing multi-way voice and Ethernet services with device



1.3 Features

The RC1201-4FE4E1T1 supports E1/T1 services and Ethernet services, and provides abundant features to ensure service transmission of high quality and efficiency.

1.3.1 Service types

The RC1201-4FE4E1T1 supports the following types of service:

- TDMoP service: E1/T1 service emulation
- Ethernet service: VLAN, MAC address forwarding, and QinQ

1.3.2 PSN types

The RC1201-4FE4E1T1 supports the following PSNs:

- UDP/IP: IP carrier network
- MPLS: Multi Protocol Label Switching (MPLS) carrier network
- MEF: Metro Ethernet Forum (MEF) pure carrier network

1.3.3 Payload encapsualation types

The RC1201-4FE4E1T1 supports multiple payload encapsulation protocols to emulate data of different TDM frame types, including:

- SAToP
- CESoPSN
- Time Division Multiplexing over IP (TDMoIP)

1.3.4 Interface types

The RC1201-4FE4E1T1, an aggregation TDMoP device, provides the following interfaces:

- Four balanced/unbalanced adaptive E1 interfaces
- Four balanced T1 interfaces
- Four 10/100 Mbit/s Ethernet electrical interfaces
- One 1000 Mbit/s Ethernet optical interface
- SNMP interface
- Console interface

1.3.5 Clock synchronization and recovery mechanism

TDMoP services require precise clocks. The RC1201-4FE4E1T1 supports the following clock synchronization modes:

- Internal crystal oscillator
- E1/T1 line recovery clock
- Ethernet side recovery clock
- External clock
- Differential clock

1.3.6 OAM features

The RC1201-4FE4E1T1 supports the following OAM features:

- IEEE 802.3ah Ethernet in the First Mile (EFM) OAM protocols
- Standard OAM discovery, link monitoring, remote loopback, fault display, and performance statistics
- Standard OAM active mode, passive mode, Dying Gasp, and so on

1.4 Ordering information

Table 1-1 lists ordering information about the RC1201-4FE4E1T1.

Table 1-1 Ordering information about device

Model	Description
RC1201-4FE4E1T1	• 1U-high 19-inch standard chassis • Single power • Supporting the clock card • Four E1/T1 interfaces (balanced/unbalanced E1 interface and balanced T1 interface) • Four 10/100 Mbit/s Ethernet electrical interface • One 1000 Mbit/s Ethernet optical interface

2 System structure

This chapter describes system structure of the RC1201-4FE4E1T1, including the following sections:

- Hardware structure
- Software structure

2.1 Hardware structure

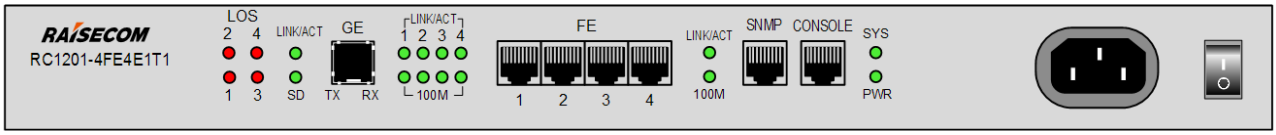
2.1.1 Panels

The RC1201-4FE4E1T1 is a 1U-high 19-inch-wide cartridge chassis, thus facilitating deployment in different scenarios.

Front panel

Figure 2-1 shows the front panel of the RC1201-4FE4E1T1, with one Console interface, one SNMP interface, four 10/100 Mbit/s Ethernet electrical interfaces, one 1000 Mbit/s Ethernet optical interface, their LEDs, and four LOS LEDs.

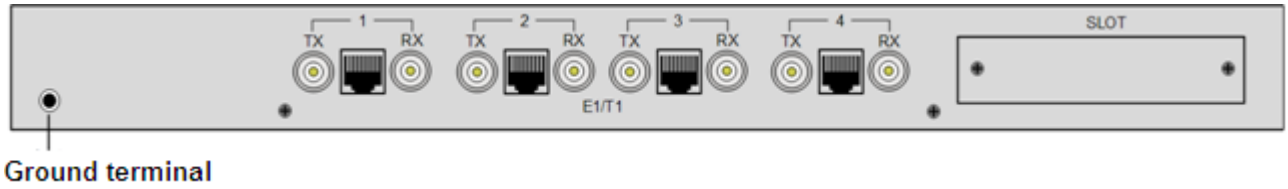
Figure 2-1 Front panel



Rear panel

Figure 2-2 shows the rear panel of the RC1201-4FE4E1T1, with 4 BNC E1 interfaces and 4 RJ45 E1/T1 interfaces.

Figure 2-2 Rear panel



2.1.2 Interface types

The RC1201-4FE4E1T1 has three types of external interfaces: service interfaces, the SNMP interface, and the Console interface.

Service interfaces

The RC1201-4FE4E1T1 accesses services with multiple types of service interfaces, as listed in Table 2-1.

Table 2-1 Service interfaces

Name	Type	Description	Quantity
GE	SFP	The Ethernet optical interface can use the 1000Base-X optical module and work as an uplink interface.	1
E1/T1 (1–4)	BNC and RJ45	The E1/T1 interface can be configured to the following two modes: • E1 mode: support the BNC unbalanced interface and RJ45 balanced interface, and be adaptive to these two interfaces without software support. • T1 mode: support the RJ45 balanced interface.	4
FE (1–4)	RJ45	The Ethernet electrical interface can access Ethernet services and work as an uplink interface.	4

Management and auxiliary interfaces

Table 2-2 lists the management and auxiliary interfaces on the RC1201-4FE4E1T1.

Table 2-2 Management and auxiliary interfaces

Name	Type	Description	Quantity
Console	RJ45	Console interface You can conduct initial configuration and later management of the RC1201-4FE4E1T1 through the Hyper Terminal program.	1
SNMP	RJ45	Network management interface It is connected to the NMS server.	1

2.1.3 Interface parameters

Optical interface

Table 2-3 lists parameters of the 1000Base-X SFP optical interface.

Table 2-3 Parameters of the 1000Base-X SFP optical interface

Parameter	Description
Connector type	LC/PC
Optical interface parameters	Depending on the selected SFP
Coding type	8B/10B
Transmission rate	1.25 Gbit/s
Duplex mode	Full duplex
Flow control	Supporting IEEE 802.3x flow control in full duplex
Data frame length	1632 bytes
Compliant standard	IEEE 802.3
Frame format	• Ethernet-II • Ethernet-SAP • Ethernet-SNAP
Network protocol	IP

E1/T1 interface

Table 2-4 lists parameters of the E1 interface.

Table 2-4 Parameters of the E1 interface

Parameter	Description
Connector type	RJ45 and BNC
Interface impedance	• 120 Ω (balanced RJ45 interface) • 75 Ω (unbalanced BNC interface)
Interface rate	2.048 Mbit/s
Coding type	HDB3
Frame format	Unframed, framed, multiframed, with or without CRC-4
Frame structure	Complying with ITU-T G.823/G.704 recommendations
Clock	Complying with ITU-T G.823 recommendations
Jitter	Complying with ITU-T G.823 recommendations
Electrical features	Complying with ITU-T G.703 recommendations

Parameter	Description
Transferring features	Complying with ITU-T G.823 recommendations

Table 2-5 lists parameters of the T1 interface.

Table 2-5 Parameters of the T1 interface

Parameter	Description
Connector type	RJ45
Interface impedance	100 Ω balanced interface
Interface rate	1.544 Mbit/s
Coding type	B8ZS
Frame format	Unframed, SF, and ESF
Frame structure	Complying with ITU-T G.823/G.704 recommendations
Clock	Complying with ITU-T G.824 recommendations
Jitter	Complying with ITU-T G.823 recommendations
Electrical features	Complying with ITU-T G.704 recommendations
Transferring features	Complying with ITU-T G.823 recommendations

Electrical interface

Table 2-6 lists parameters of the 10/100Base-T RJ45 Ethernet electrical interface.

Table 2-6 Parameters of the 10/100Base-T RJ45 Ethernet electrical interface

Parameter	Description
Connector type	RJ45
Duplex mode	• Supporting 10/100 Mbit/s auto-negotiation • Supporting half/full duplex auto-negotiation
Flow control	• Supporting IEEE 802.3x flow control in full duplex • Supporting back pressure flow control in half duplex
Data frame length	1632 bytes
Wiring	Supporting auto-MDI/MDIX
Cable specifications	The Cat 5 UTP cable is recommended, or the Cat 5 STP cable is recommended if high EMC is required by the working environment.
Compliance standard	IEEE 802.3

Parameter	Description
Frame format	• Ethernet-II • Ethernet-SAP • Ethernet-SNAP
Network protocol	IP

Console interface

Table 2-7 lists parameters of the Console interface.

Table 2-7 Parameters of the Console interface

Parameter	Description
Connector type	RJ45
Duplex mode	Duplex mode UART
Electrical features	RS-232
Baud rate	9600 baud
Cable specifications	8-wire cable

SNMP interface

Table 2-8 lists parameters of the SNMP interface.

Table 2-8 Parameters of the SNMP interface

Parameter	Description
Connector type	RJ45
Interface rate	Supporting 10/100 Mbit/s auto-negotiation
Wiring	Host mode, supporting auto-MDI/MDIX
Compliant standard	IEEE 802.3

2.1.4 LEDs

The RC1201-4FE4E1T1 has 18 Light-Emitting Diodes (LEDs), and each clock subcard has one LED.

LEDs on MCC

Table 2-9 lists LEDs on the MCC.

Table 2-9 LEDs on the MCC

Type	Interface	Status	Description
–	PWR	Green	Power LED • Green: the power supply is normal. • Off: the power supply is abnormal.
–	SYS	Green	System status LED • Blinking green: the system is working properly. • Off: the system is working improperly.
SNMP interface	LINK/ACT	Green	SNMP interface working LED • Green: the SNMP interface is working properly. • Blinking green: the SNMP interface is receiving or sending data. • Off: the SNMP interface is disconnected or is working improperly.
	100M	Green	SNMP interface status LED • Green: the SNMP interface is working at 100 Mbit/s. • Off: the SNMP interface is working at 10 Mbit/s.
FE interface	LINK/ACT (1–4)	Green	Ethernet electrical interface working LED • Green: the FE interface is working properly. • Off: the FE interface is disconnected or is working improperly. • Blinking green: the FE interface is receiving or sending data.
	100M	Green	Ethernet electrical interface status LED • Green: the FE interface is working at 100 Mbit/s. • Off: the FE interface is working at 10 Mbit/s.
GE interface	LINK/ACT	Green	Ethernet optical interface working LED • Green: the optical interface is working properly. • Blinking green: the optical interface is receiving or sending data. • Off: the optical interface is disconnected or is working improperly.
	SD	Green	Ethernet optical interface status LED • Green: the GE interface is receiving or sending optical signals. • Off: the GE interface is idle.
E1/T1 interface	LOS (1–4)	Red	LOS alarm LED • Red: E1/T1 LOS alarms are generated. • Off: no E1/T1 LOS alarms are generated.

LEDs on clock subcards

Table 2-10 lists LEDs on the clock subcard RC1201-SC-SYNC.

Table 2-10 LEDs on the clock subcard RC1201-SC-SYNC

Type	Interface	Status	Description
TX/RX interface	EXT	Green	External clock status LED • Green: the system clock is an external clock, and the external clock is valid. • Off: the system clock is not an external clock.

Table 2-11 lists LEDs on the clock subcard RC1201-SC-SYNC-BL.

Table 2-11 LEDs on the clock subcard RC1201-SC-SYNC-BL

Type	Interface	Status	Description
–	EXT	Green	External clock status LED • Green: the system clock is an external clock, and the external clock is valid. • Off: the system clock is not an external clock.

Table 2-12 lists LEDs on the clock subcard RC1201-SC-COMMON.

Table 2-12 LEDs on the clock subcard RC1201-SC-COMMON

Type	Interface	Status	Description
RX interface	CMN	Green	External clock status LED • Green: the system clock is an external COMMON clock, and the external clock is valid. • Off: the system clock is not an external COMMON clock.

2.1.5 Cables

The cables used by the RC1201-4FE4E1T1 include:

- Fiber
- E1 cable
- Ethernet cable
- Configuration cable
- Power cable
- Ground cable

Fiber

The RC1201-4FE4E1T1 can use the following fiber:

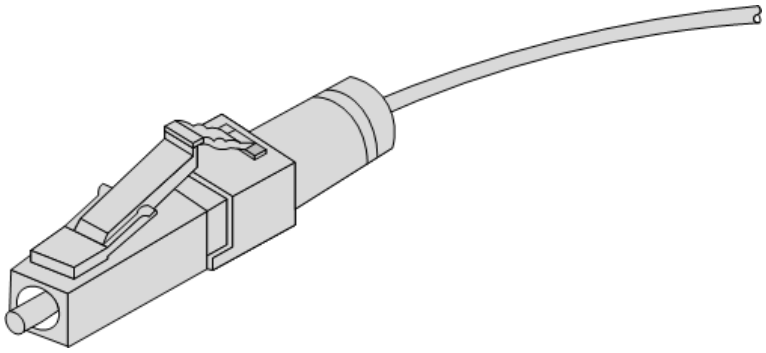
- 2mm Single-Mode Fiber (SMF) with LC/PC connectors
- 2mm Multi-Mode Fiber (MMF) with LC/PC connectors

Note

The length of fiber depends on actual situation.

Figure 2-3 shows the LC/PC fiber connector used by the RC1201-4FE4E1T1.

Figure 2-3 LC/PC fiber connector



When connecting or removing the LC/PC optical connector, align the connector with the optical interface, and do not rotate the fiber. Operate the fiber as below:

- Align the head of the fiber jumper with the optical interface and insert the optical fiber into the interface gently.
- To remove the fiber, press the latch on the connector and pull the fiber out.

E1/T1 cable

The E1/T1 cable connects the E1/T1 interface on the RC1201-4FE4E1T1 to the TDM interface on other devices. The RC1201-4FE4E1T1 supports two types of cables according to connector types.

As shown in Figure 2-4, the RC1201-4FE4E1T1 provides a 50-Ω-long BNC connector-straight-male connector. You can prepare the E1 cable as required. When making the unbalanced BNC-connector E1 cable, we recommend using the following models of the coaxial cable: SYV75-5, SYV75-3, and SYV75-2-2, and keeping the length within 200 m. Make the E1 cable as below:

Step 1 Strip the shielding layer from the coaxial cable, and leave the core exposed.

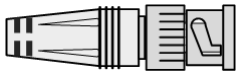
Step 2 Unfasten the tail sheath of the BNC connector, and sheathe the stripped coaxial cable with the sheath.

Step 3 Weld the core of the coaxial cable with the core of the BNC connector properly.

Step 4 Weld the shielding layer of the coaxial cable with the shielding shell of the BNC connector properly.

Step 5 Fasten the sheath to the tail of the BNC connector.

Figure 2-4 Male BNC connector



As shown in Figure 2-5, the RC1201-4FE4E1T1 supports the 8-PIN RJ45 connector. You can prepare the E1/T1 cable as required. For PIN definitions, see Table 2-13. The E1/T1 cable can be an 8-PIN twisted pair cable.

Note

The T1 mode of the RC1201-4FE4E1T1 supports the balanced RJ45 connector cable only. In this mode, PIN definitions in Table 2-13 are for reference only. PIN definitions are subject to actual situations.

Figure 2-5 E1/T1 cable

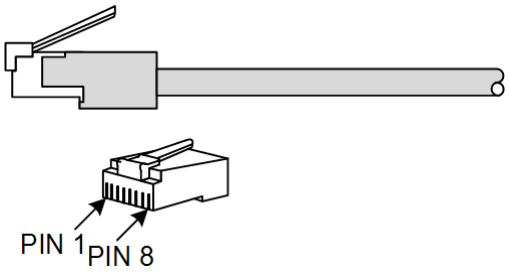


Table 2-13 Wiring of the E1 cable

PIN (RJ45)	Definition	Direction	Function
PIN 1	TD(T)	Tx	Sending data (Tip)
PIN 2	TD(R)	Tx	Sending data (Ring)
PIN 3	–	–	–
PIN 4	RD(T)	Rx	Receiving data (Tip)
PIN 5	RD(R)	Rx	Receiving data (Ring)
PIN 6–PIN 8	–	–	–

Note

If you use the E1/T1 cable to connect the RC1201-4FE4E1T1 to a PDH or SDH device, you can refer to the user manual of the PDH or SDH device for parameters of the E1 interface, such as the connector type and interface impedance.

Ethernet cable

On the RC1201-4FE4E1T1, the Ethernet cable is used to connect:

- Ethernet electrical interface and other devices
- SNMP interface and NView NNM system

The Ethernet interface on the RC1201-4FE4E1T1 is automatically adaptive to the straight-through cable or the cross connection cable, and thus supports them, as shown in Figure 2-6.

Note

- The Ethernet cable is not delivered with the RC1201-4FE4E1T1. Make it according to actual situation on site.
- The Ethernet cable cannot be longer than 100 m and cannot contain junction connectors.

Figure 2-6 Ethernet cable

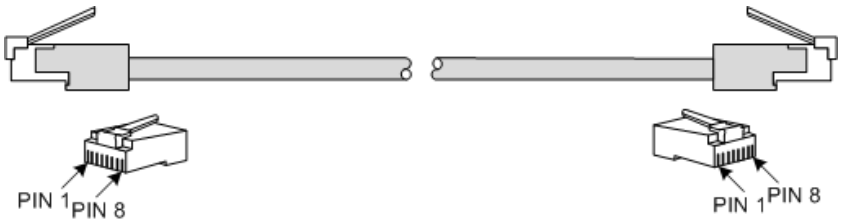


Table 2-14 lists the wiring of the 100 Mbit/s straight-through cable.

Table 2-14 Wiring of the 100 Mbit/s straight-through cable

Starting from (RJ45)	Stopping at (RJ45)	Color	Remarks
PIN 1	PIN 1	White/Orange	Twisted pair
PIN 2	PIN 2	Orange	
PIN 3	PIN 3	White/Green	Twisted pair
PIN 4	PIN 4	Blue	
PIN 5	PIN 5	White/Blue	Twisted pair
PIN 6	PIN 6	Green	
PIN 7	PIN 7	White/Brown	Twisted pair
PIN 8	PIN 8	Brown	

Table 2-15 lists the wiring of the 100 Mbit/s crossover cable.

Table 2-15 Wiring of the 100 Mbit/s crossover network cable

Starting from (RJ45)	Stopping at (RJ45)	Color	Remarks
PIN 1	PIN 3	White/Orange	Twisted pair
PIN 2	PIN 6	Orange	
PIN 3	PIN 1	White/Green	Twisted pair
PIN 6	PIN 2	Green	
PIN 4	PIN 4	Blue	Twisted pair
PIN 5	PIN 5	White/Blue	

Starting from (RJ45)	Stopping at (RJ45)	Color	Remarks
PIN 7	PIN 7	White/Brown	Twisted pair
PIN 8	PIN 8	Brown	

Table 2-16 lists technical specifications of the Ethernet cable.

Table 2-16 Technical specifications of the Ethernet cable

Parameter	Description
Connector	RJ45 crystal head
Cable model	Symmetric twisted pair-100ohm-Cat 5e-0.52mm-24AWG-8 pins
Number of cores	8

Configuration cable

The configuration cable is used to connect the Console interface on the RC1201-4FE4E1T1 to the PC that runs NView NNM software.

Use the DB-9 connector and RJ45 connector as configuration cable connectors for the RC1201-4FE4E1T1, as shown in Figure 2-7.

Figure 2-7 Configuration cable

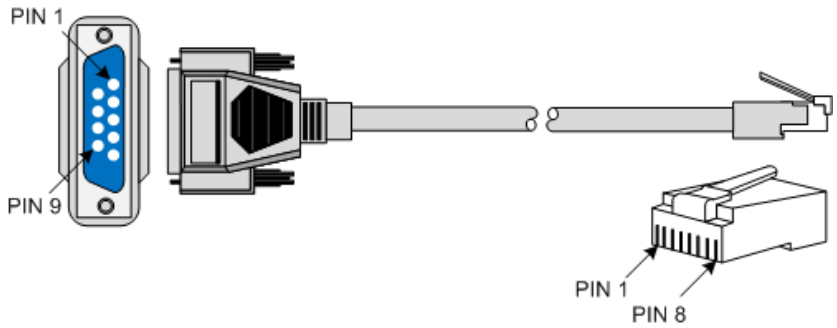


Table 2-17 lists technical specifications of the configurable cable.

Table 2-17 Technical specifications of the configurable cable

Parameter	Description
Name	CBL-RS232-DB9F/RJ45-2m
Connector	• RJ45 connector • DB9 female connector
Type	Unshielded Cat 3 flat cable
Length	2 m

Power cables

The AC power cable transmits 220 VAC power to the AC power supply, and supplies power for the whole RC1201-4FE4E1T1.

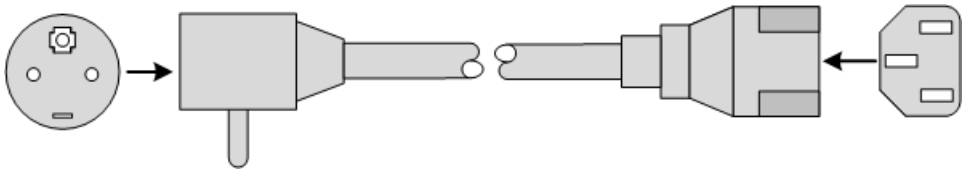
The RC1201-4FE4E1T1 uses different AC power cables in different countries or regions, as listed in Table 2-18.

Table 2-18 Technical specifications of the AC power cable

Regional standard	Description
Europe	European French mode C13 connector-10A/250V-1.5m/RoHS
America	American mode-3-pin-1.5m-10A/250V/RoHS

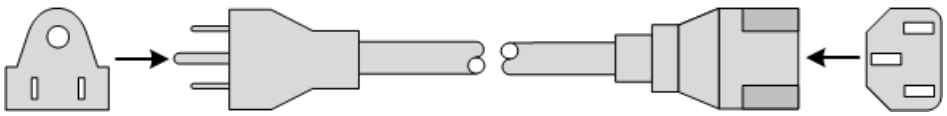
The AC power cable which meets European standard is composed of the European French-mode 3-pin plug and C13 connector, as shown in Figure 2-8.

Figure 2-8 European AC power cable



The AC power cable which meets American standard is composed of the American 3-pin plug and C13 connector, as shown in Figure 2-9.

Figure 2-9 American AC power cable



The DC power cable transmits -48 or +24 VDC power to the power interface of the RC1201-4FE4E1T1, and supplies power to the entire device, as shown in Figure 2-10.

Figure 2-10 DC power cable

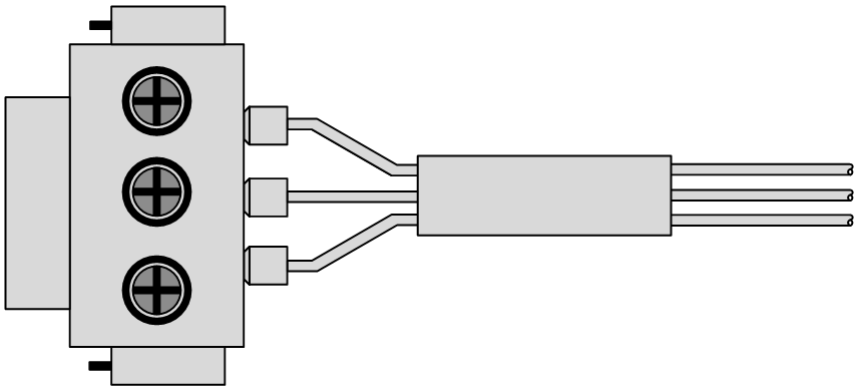


Table 2-19 lists technical specifications of the DC power cable.

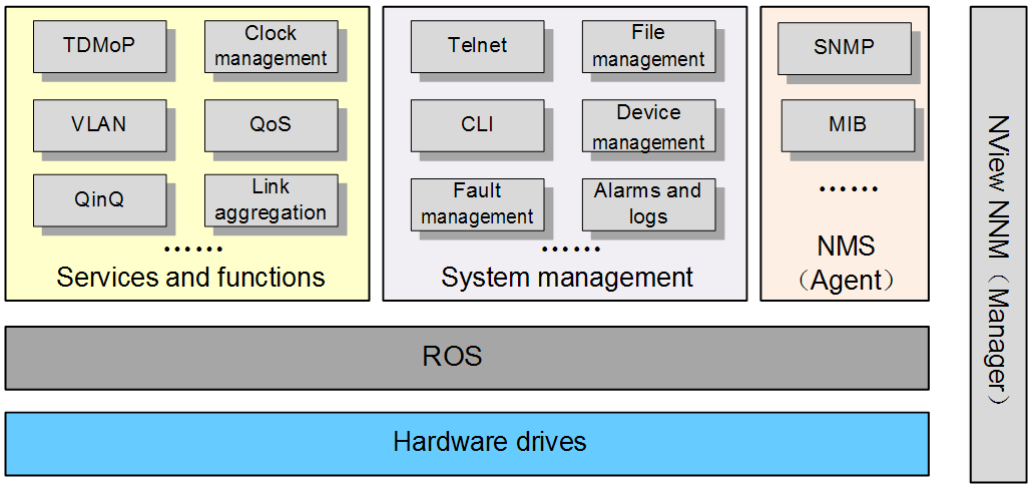
Table 2-19 Technical specifications of the DC power cable

Parameter	Description
Cable	DC power cable-1.5m
Connector	DC power cable pressed U-shaped terminal (M4)/RoHS
Length	1.5 m

2.2 Software structure

As shown in Figure 2-11, based on Raisecom Operating System (ROS), the RC1201-4FE4E1T1 supports diverse services, functions, and performance indexes

Figure 2-11 Software structure



The functions of each software module on the RC1201-4FE4E1T1 are as below:

- Hardware driver: provides drivers for the MCC, fan, and power.
- ROS: provides the Operating System (OS) as the core of software structure of the RC1201-4FE4E1T1. To the downlink, it manages hardware system of the RC1201-4FE4E1T1; to the uplink, it provides a uniform OS for all programs of software system. It is of high reliability, realtime feature, self-healing, and maintainability.
- Services and functions: the RC1201-4FE4E1T1 provides multiple services and functions, including Time Division Multiplex over Packet (TDMoP), clock synchronization, VLAN, QinQ, QoS, OAM, link aggregation, and storm control.
- System management: the RC1201-4FE4E1T1 provides file management, device management (power supply, fans, and so on), Command Line Interface (CLI), remote login (Telnet), Trap, and logging. These facilitate you in OAM.
- Network management module (Agent): inside the RC1201-4FE4E1T1, it converts the commands or requests from the Manager to the commands available for the RC1201-4FE4E1T1 to complete these commands, and returns information and events about the RC1201-4FE4E1T1 to the Manager.

- NView NNM (Manager): a PC or server where NMS software is running, it sends management commands, and receives management information from Agents. The NView Network Node Management (NNM), as a new integrated network node management system developed by Raisecom, is based on SNMP and oriented for the access network. The NView NNM implements integrated configuration of Network Elements (NEs), fault detection, topology management, and trap management.

3 Service functions and features

This chapter describes service functions and features supported by the RC1201-4FE4E1T1, including the following sections:

- Service functions
- TDMoP
- TDMoP clock synchronization
- Ethernet
- QoS
- Link aggregation
- Storm control

3.1 Service functions

The RC1201-4FE4E1T1 supports transmitting multiple types of service, including TDMoP services and Ethernet services.

3.1.1 TDMoP services

The PSN, with low cost and strong expansion, becomes a trend for the NGN; however, a great number of TDM devices are in service on the current network. How to evolve to the PSN smoothly, namely, to both protect current investment and deploy the PSN, is difficult. As a result, TDMoP is developed accordingly. The RC1201-4FE4E1T1, a TDMoP device based on Pseudo-Wire Emulation Edge to Edge (PWE3), has the following functions and features:

- Support three types of PSN network: User Datagram Protocol/Internet Protocol (UDP/IP), Multi-protocol Label Switch (MPLS), and Metropolitan Ethernet Forum (MEF).
- Support multiple encapsulation protocols, such as CESoPSN, SAToP, and TDMoIP.
- Provide up to 64 Bundles.
- Support configurable encapsulated payload.
- Support clock synchronization: adaptive clock, E1/T1 line recovery clock, and system clock, with clock compliant with G.823/G.824 standards.
- Support configurable jitter buffer ranging from 1.5 to 250ms.
- Support 2% disorder and packet loss, which comply with G.8261 standard.

3.1.2 Ethernet services

Being flexible, simple, and easy to implement, Ethernet becomes an important technology for networking on a LAN. The RC1201-4FE4E1T1 supports not only TDMoP services but also Ethernet services, thus implementing multiplexing of multiple ways of E1/T1 services and Ethernet services.

The RC1201-4FE4E1T1 supports the following Ethernet services:

- Support MTU to be 1632 bytes.
- Support full duplex and half duplex.
- Support auto-negotiation on interfaces.
- Support IEEE 802.3x flow control and back pressure flow control.
- Support auto-MDI/MDIX.
- Support MAC address learning based on interface.
- Support 8K MAC addresses and 30 static MAC addresses.
- Support configuring the aging time of MAC addresses to 0–3825s.
- Support 4K concurrent VLANs.
- Support QinQ, manual link aggregation, and loop detection.
- Support QoS and determining 4 output queues by priority.
- Support interface isolation.
- Support transparent transmission of BPDUs, LACP, and 802.1x packets.
- Support storm control over broadcast, multicast, and DLF packets based on interface.
- Support rate limiting based on interface and configuring rate limit from 62 kbit/s to 1000 Mbit/s.

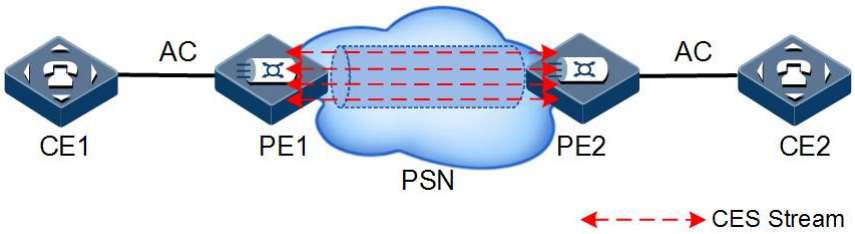
3.2 TDMoP

Principles of PWE3

PWE3 is a protocol structure to transmit layer 2 emulation services through edge-to-edge tunnel, as shown in Figure 3-1. For details, refer to the RFC3985.

CE1 transmits TDM service data to PE 1 through AC, and PE 1 encapsulates TDM service data to emulation packets through corresponding protocols. Emulation packets are carried by the tunnel defined by PSN protocols, such as MPLS, Metro Ethernet Forum (MEF), and UDP/IP, traverse a PSN, and reach the peer PE2. In this case, TDM service data is transparent to the PSN. PE 2 removes the header of emulation packets, decapsulates and transmits TDM service data to CE 2 through AC.

Figure 3-1 Principles of PWE3



- CE: Customer Edge, connected to the ISP network through the TDM interface. A CE may be a TDM device or router. The CE cannot sense the PSN.
- AC: Attachment Circuit, an independent link or circuit connecting the CE and PE. AC parameters include encryption type, MTU, and interface parameters of a specified link type.
- PE: a TDMoP device at the edge of the ISP network. At the PSN side, the PE encapsulates received TDM service data into emulation services and then transmits emulation services to the PTN through the uplink interface. At the E1/T1 side of the TDMoP device, the PE decapsulates received emulation services to TDM service data, and transmits TDM service data from the TDM interface to the CE through AC.
- CES Stream: Circuit Emulation Service Stream, data stream transmitted in the PSN after TDM service data is encapsulated, namely, multiple Bundles.

Bundle

A Bundle is a virtual channel carrying TDM services to traverse the PSN. TDM service data is encapsulated into Bundle packets to be transmitted in the PSN. The PSN is transparent to the TDM services.

The Bundle is identified by the ID. The Bundle ID is defined based on PSN type:

- MPLS: the Bundle ID is defined by the MPLS outer label.
- UDP/IP: the Bundle ID is defined by the UDP port number.
- MEF 8.0: the Bundle ID is defined by the Emulated Circuit Identifier (ECID) of Ethernet frames.

After both the local Bundle and peer Bundle are established, emulation services can be transmitted. Pay attention to the following points:

- A Bundle connection is unidirectional, so you have to establish Bundle connections on both the local and peer devices.
- The Bundle ID in the Tx and Rx directions can be different, but Bundle parameters of both the local and peer devices must be the same.

The RC1201-4FE4E1T1 supports three types of PSNs: MPLS, UDP/IP, and MEF 8.0.

Encapsulation protocols

The RC1201-4FE4E1T1 encapsulates TDM service data into emulation messages through corresponding protocols. The RC1201-4FE4E1T1 supports the following encapsulation protocols:

- SAToP: it provides emulation for TDM services on the PSN. It fragments and encapsulates TDM services as serial data code flow, and then transmits TDM services through PW packets. SAToP is defined by the RFC4553.

- CESoPSN: it provides structured TDM emulation service transmission, has a frame structure, and can recognize and process signaling inside TDM frames. CESoPSN discards idle timeslots and encapsulates timeslots in use, thus improving bandwidth utilization.
- TDMoIP: it provides structured or unstructured transmission of emulation TDM service. Defined by RFC 5087, TDMoIP encapsulation includes structured and unstructured encapsulation modes. It is divided into two adaption modes according to the type of encapsulation payload:
  - AAL1: usually used for 64 kbit/s voice services, fixed-rate non-compressed video services, and leased line services in the data network. This layer adapts data to a cell with a fixed length of 48 bits. It is used for adapting structured or unstructured TDM signals, and TDM signals that occupy fixed timeslots.
  - HDLC: used for adapting Channel Associated Signaling (CAS), High-Level Data Link Control (HDLC), Point to Point Protocol (PPP), and Frame Relay (FR).

Jitter buffer

Delay jitter is the change of frame delay on a network, namely, the delay for each frame after being transmitted on the network is variable. It is introduced by delay for encapsulating emulation packets and delay for transmitting PSN packets. It has great impact on performance of emulation services, so compensation must be taken to emulation services.

Jitter buffer on the destination can reduce the impact from change of frame delay. It buffers earlier or later frames. Its capacity should be set properly.

The RC1201-4FE4E1T1 supports configuring capacity of the jitter buffer through commands.

3.3 TDMoP clock synchronization

The key to TDMoP is clock synchronization. A feature of TDM services is high realtime requirement; namely, the clocks of both the sender and the receiver must be in the same precision grade.

The encapsulation causes produces delay and transmission of the encapsulated PW packets also causes delay. End-to-end clock asynchronization causes TDM services to be delayed, thus degrading performance of TDM services.

To eliminate this impact, clock synchronization is used in TDMoP to ensure transparent transmission of clock synchronization signals in the PSN, thus making the sender and the receiver synchronized.

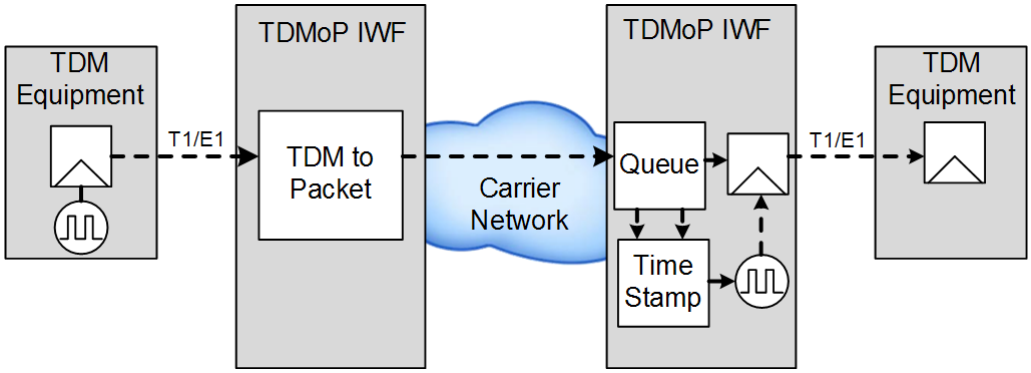
The main clock synchronization mechanisms used by TDMoP are as below:

- Adaptive clock recovery (Ethernet-side recovery clock)
- E1/T1 line recovery clock
- Internal crystal oscillation clock

Adaptive clock recovery

Figure 3-2 shows principles of adaptive clock recovery.

Figure 3-2 Principles of adaptive clock recovery



The process for adaptive clock recovery is as below:

Step 1 A source Inter-Working Function (IWF) device sends its source clock signals to the destination IWF device according to the clock source of the TDM equipment.

Step 2 The destination IWF device buffers all received signals in a queue, and then sends local clock signals out.

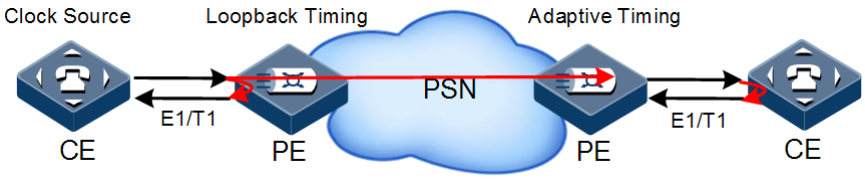
Step 3 If the source IWF clock is not synchronous with the destination IWF clock, the length of the buffering queue on the destination IWF changes, detailed as below:

- If the length increases, the destination clock runs slower than the source clock; thus advance the destination clock.
- If the length decreases, the destination clock runs faster than the source clock; thus slow down the destination clock.

Line loopback clock

The clock source of the TDMoP device is recovered from the E1/T1 receiving line. Namely, the clock recovering from the E1/T1 receiving link is used by the E1/T1 sending line and PSN transmission, as shown in Figure 3-3.

Figure 3-3 Principles of line loopback clock



3.4 Ethernet

3.4.1 MAC address table

The RC1201-4FE4E1T1 implements expedited forwarding of Ethernet packets according to forwarding rules. Each RC1201-4FE4E1T1 has a MAC address table containing the corresponding relations between the MAC address and the interface. All packets coming into an interface are forwarded according to the MAC address table, which is the basis for fast

forwarding. The MAC address table is saved in the cache of the RC1201-4FE4E1T1. The cache capacity determines how many MAC addresses can be saved.

The MAC address entries of the RC1201-4FE4E1T1 contain the following information:

- Destination MAC address
- Type of MAC address entries
- ID of the VLAN to which the interface belongs
- ID of the interface corresponding to the destination MAC address

The RC1201-4FE4E1T1 supports statistics of MAC addresses based on device, interface, or VLAN.

Classification of MAC address entries

MAC address entries of the RC1201-4FE4E1T1 consist of:

- Static MAC address entries: manually added or deleted, not aging. For a network with little changes, manually adding static MAC address entries reduces broadcast traffic, enhances security on interface, and ensure no loss of static MAC address entries upon reboot. After the RC1201-4FE4E1T1 is rebooted, an interface card is hot swapped or reset, static MAC address entries will not be cleared.
- Dynamic MAC address entries: after enabled with MAC address learning, the RC1201-4FE4E1T1 can automatically add MAC address entries which will be aged as configured. After the RC1201-4FE4E1T1 is rebooted, an interface card is hot swapped or reset, dynamic MAC address entries will be cleared.

The RC1201-4FE4E1T1 supports MAC address learning and up to 8K MAC address entries and 30 static MAC addresses.

MAC address forwarding modes

When forwarding packets, based on the information about MAC address entries, the RC1201-4FE4E1T1 adopts the following modes:

- Unicast: when a MAC address entry, which is related to the destination MAC address of a packet, is listed in the MAC address table, the RC1201-4FE4E1T1 will directly forward the packet through the egress port of the MAC address entry.
- Multicast: when receiving a packet whose destination address is a multicast MAC address, the RC1201-4FE4E1T1 will forward the packet through the egress interface of the MAC address entry if the related destination address is listed in the MAC address table; otherwise, the packet will be discarded.
- Broadcast, when the RC1201-4FE4E1T1 receives an all-F packet, or when the RC1201-4FE4E1T1 receives a packet whose MAC address is not listed in the MAC address table, it will flood the packet to all ports except for the port that receives this packet in broadcast mode.

Aging time of MAC addresses

The MAC address table of the RC1201-4FE4E1T1 is limited in capacity. To fully use it to the maximum, the RC1201-4FE4E1T1 updates it through aging mechanism. Namely, it is enabled with an aging timer when a MAC address entry is created. If no packets are received from a MAC address that is already in the MAC address table, the MAC address entry will be automatically deleted.

The RC1201-4FE4E1T1 support automatic aging for MAC address. The aging time ranges from 0s to 3825s.

The aging mechanism takes effect on dynamic MAC address entries only.

Forwarding policies of MAC addresses

The MAC address table has two forwarding policies. When receiving packets on an interface, the RC1201-4FE4E1T1 searches the MAC address table for the interface related to the destination MAC address of packets.

- If successful, it forwards packets on the related interface, records the source MAC addresses of packets, interface number of ingress packets, and VLAN ID in the MAC address table. If packets from other interface are sent to the MAC address, the RC1201-4FE4E1T1 can send them to the related interface.
- If unsuccessful, it broadcasts packets to all interfaces except the source interface, and records the source MAC address in the MAC address table.

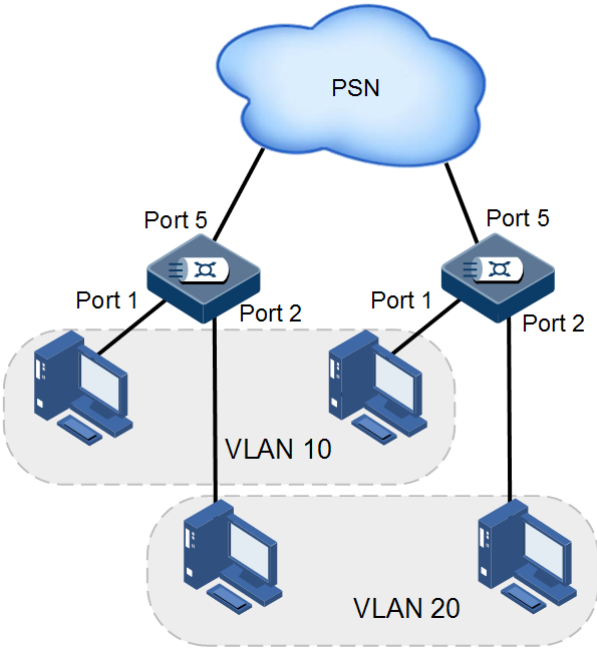
MAC address limit

MAC address limit is used to limit the number of MAC addresses and avoid extending the searching time of forwarding entry caused by an over large MAC address table and degrading the forwarding performance of the device. It is effective to manage the MAC address table.

3.4.2 VLAN

Virtual Local Area Network (VLAN) is a protocol to solve Ethernet broadcast and security problem. It is a Layer 2 isolation technique that partitions a LAN into different broadcast domains logically rather than physically, and then the different broadcast domains can work as virtual groups without any influence from one another. In terms of functions, VLAN has the same features as LAN, but members in one VLAN can access one another without restriction by physical location.

Figure 3-4 VLAN partition



The VLAN technique can partition a physical LAN into different broadcast domains logically. Hosts without intercommunication requirements can be isolated by VLAN, so VLAN partitioning improves network security, and reduces broadcast flow and broadcast storm.

The RC1201-4FE4E1T1 supports IEEE 802.1Q standard VLANs and 4094 concurrent VLANs.

Interface mode and packet forwarding

Interface modes of the RC1201-4FE4E1T1 are divided into Access mode, Trunk mode, and Hybrid mode. For comparison on the port modes and packet forwarding modes, see Table 3-1.

Table 3-1 Interface modes and packet forwarding modes

Interface mode	Forwarding modes for ingress packet		Forwarding modes for egress packet
	Untag packet	Tag packet	
Access	Add Access VLAN Tag into the packet.	• If VLAN ID of the packet is equal to Access VLAN ID, receive the packet. • If VLAN ID of the packet is not equal to Access VLAN ID, discard the packet.	If the VLAN ID of the packet is equal to Access VLAN ID, remove Tag and send the packet.

Interface mode	Forwarding modes for ingress packet		Forwarding modes for egress packet
	Untag packet	Tag packet	
Trunk	Add Native VLAN Tag to the packet.	• If the packet VLAN ID is included in the VLAN ID list allowed to pass by the interface, receive the packet. • If the packet VLAN ID is not included in the VLAN ID list allowed to pass by the interface, discard the packet.	• If the VLAN ID of the packet is equal to Native VLAN ID, remove Tag and send the packet. • If the VLAN ID of the packet is not equal to Native VLAN ID and the interface allows the packet to pass, keep the original Tag and send the packet.
Hybrid		• If the VLAN ID of a packet is in the VLAN ID list on an interface, the packet is received. • If the VLAN ID of a packet is not in the VLAN ID list on an interface, the packet is discarded.	• If the VLAN ID of a packet is in the VLAN ID list on an interface, and is not in the Untag VLAN ID, the packet is sent with the original Tag. • If the VLAN ID of a packet is included in the Untag VLAN ID list, the packet is sent without the original Tag.

Interface-based VLAN

Interface-based VLAN is the most simple and efficient method for partitioning a VLAN. After being added to a specified VLAN, the interface can forward packets with a specified VLAN ID.

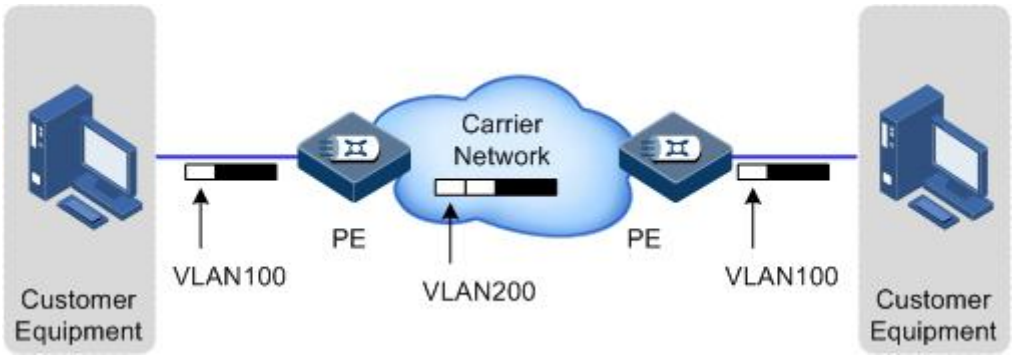
3.4.3 QinQ

QinQ (also called Stacked VLAN or Double VLAN) technology is an extension to 802.1Q, which is defined in the IEEE 802.1ad standard.

QinQ is a simple Layer 2 VPN tunnel technology. At the ISP's access end, QinQ encapsulates an outer VLAN Tag for a private packet, so that the packet traverses the backbone network of the Internet Service Provider (ISP) carrying double VLAN tags.

On the Internet, the packet is transmitted according to the outer VLAN Tag (public VLAN Tag). And the private VLAN Tag is transmitted as data in the packet.

Figure 3-5 Typical networking with basic QinQ



As shown in Figure 3-5, the RC1201-4FE4E1T1 is the Provider Edge (PE). Its uplink interface is connected to the carrier's network while its downlink interface is connected to the customer device.

A packet is sent to the PE by a customer device, and the packet carries a Tag VLAN 100. When passing through the interface of the PE, the packet is added with an outer Tag VLAN 200. And then the packet is sent to the carrier's network through the uplink interface on the PE.

When the packet with the outer Tag VLAN 200 is sent to the other PE, this PE will remove the outer Tag for the packet and then send the packet to the other customer device. Now, the packet carries the Tag VLAN 100 only.

3.4.4 Loop detection

Loop detection can be classified into two types: interface-based loop detection and VLAN-based loop detection. Interface-based loop detection is mainly used for edge interfaces. Interface-based loop detection performs loop detection on interfaces. When a loop is detected on an interface, the interface will be blocked. After the automatic restoration time expires, the interface will be released. VLAN-based loop detection performs loop detection in VLANs.

Loop detection can address the influence on network caused by a loopback, providing the self-detection, fault-tolerance and robustness.

Procedures for loop detection are shown as below:

- All interfaces on the RC1201-4FE4E1T1 send the LoopBack-Detection packet periodically (the interval can be configured. By default, the interval is 4 seconds).
- The RC1201-4FE4E1T1 checks the source MAC field of the received packet. If the MAC address of the RC1201-4FE4E1T1 is saved in the source MAC field, it considers that a loop is detected on some interface of the iTN2100. Otherwise, it discards the packet.
- When the receiving interface ID is the same as the sending interface ID, the interface will be blocked.
- When the receiving interface ID is different from the sending interface ID, the interface, the interface with the greater ID will be blocked while the other interface will be kept Up.

3.4.5 Link aggregation

Introduction

Ethernet is widely used because of its simplicity, high-efficiency and low-cost features. For a long time, the reliability is one major factor that restricts the development of traditional

Ethernet in Telecom network. The poor reliability is related to the packet feature of carried services and the mechanism of Ethernet.

Traffics of packet services are transmitted in burst mode, which is difficult for maintain stable service traffic. As two significant features of Ethernet, the Statistical Time Division Multiplexing (STDM) technology and MAC address learning mechanism improve the utilization rate of channels and devices. However, they also bring uncertainty to service bandwidth and service paths.

To enhance the reliability of Ethernet and to meet the requirements for the Telecom network, you can deploy specified reliability technology in the Ethernet.

Link aggregation

Link aggregation is a load balancing technology. With link aggregation, multiple physical Ethernet interfaces are combined to form a logical Link Aggregation Group (LAG). Multiple physical links in one LAG are taken as a logical link. Link aggregation helps share traffic among member interfaces in a LAG. These aggregated links can back up data for each other dynamically. In addition to effectively improving the reliability on links between devices, link aggregation can help gain greater bandwidth without upgrading hardware.

Generally, the link aggregation consists of manual link aggregation, static Link Aggregation Control Protocol (LACP) link aggregation, and dynamic LACP link aggregation.

- Manual link aggregation refers to aggregating multiple physical interfaces to one logical interface so that they can balance load. It works without any protocol and requires manual configuration to guarantee consistent interface parameters.
- Both static LACP link aggregation and dynamic LACP link aggregation works with LACP and through LACPDU. Static LACP link aggregation requires manual configuration of aggregated interfaces and does not allow the system to automatically add and delete aggregated interfaces. On the contrary, dynamic LACP link aggregation allows the system to automatically add and delete aggregated interfaces without manual configuration.

The RC1201-4FE4E1T1 supports manual link aggregation.

3.5 QoS

Generally, Internet (IPv4), which is based on the storage-and-forward mechanism, only provides Best Effect (BE) service for users. When the network is overloaded or congested, this service mechanism cannot ensure to transmit packets timely and completely.

With the ever-growing of network application, users bring different service quality requirements for network application. Thus the network should distribute and schedule resources for different network applications according to users' demands.

Quality of Service (QoS) can ensure real-time and integrated service when network is overloaded or congested and guarantee the whole network runs high-efficiently.

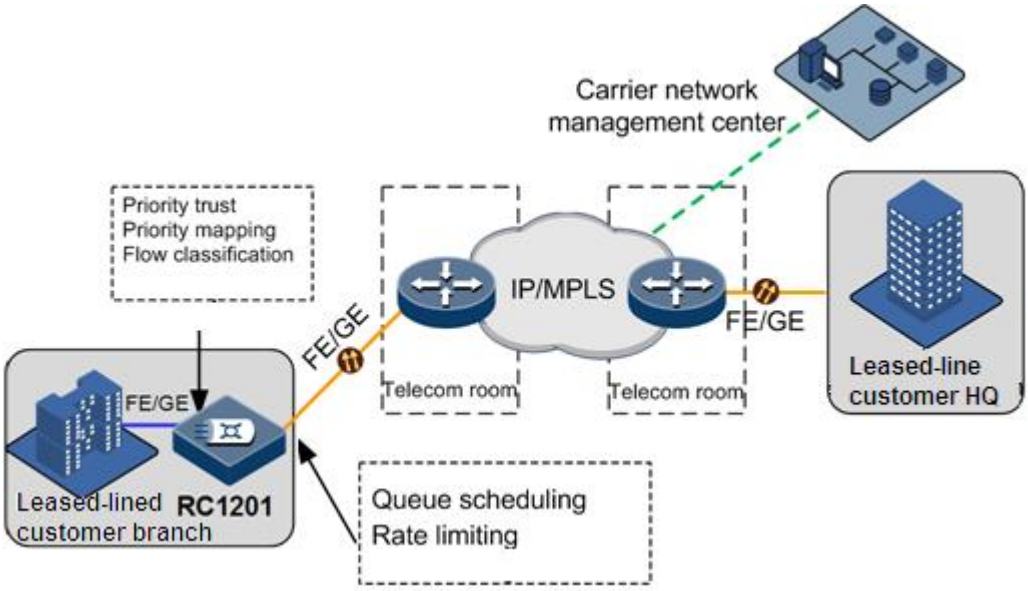
QoS consists of a number of traffic management technologies:

- Priority trust
- Priority mapping
- Traffic classification
- Queue scheduling

- Rate limiting based on interface

Figure 3-6 shows the application of QoS.

Figure 3-6 Application of QoS



3.5.2 Priority trust

Priority trust means that the RC1201-4FE4E1T1 adopts the priority carried by a packet as the classification standard to perform follow-up QoS management on the packet. Generally, the greater the value is, the higher the priority is.

The RC1201-4FE4E1T1supports interface-based priority trust. The priorities are divided into priority based on Differentiated Services Code Point (DSCP) of IP packets and priority based on Class of Service (CoS) of VLAN packets.

3.5.3 Priority mapping

Priority mapping refers to mapping the outer priority carried by packets to the local priority of the RC1201-4FE4E1T1 and sending packets to different queues according to pre-configured mapping between outer priority and local priority. In this case, the RC1201-4FE4E1T1 can schedule different queues on the egress interface.

Specifying the local priority of packets is the prerequisite. For packets from upstream devices, the RC1201-4FE4E1T1 can map priority carried by packets to different local priorities. Then it schedules different queues according to local priorities.

For IP packets, configure the mapping between Type of Service (ToS) priority or DSCP priority and local priority. For VLAN packets, configure the mapping between CoS priority and local priority. You can manage mapping by configuring:

- Mapping between CoS priority and local priority
- DSCP priority and local priority
- Default priority on interfaces
- Priority overriding

Note

The local priority refers to an internal priority that is assigned to packets. It is related to the queue number on the egress port. The greater the value is, the more quickly the packet is processed.

The RC1201-4FE4E1T1 supports priority mapping for DSCP packets based on IP packets or CoS priority for VLAN packets.

Table 3-2 and Table 3-3 list the mapping between the local priority and DSCP, CoS priorities of the RC1201-4FE4E1T1 by default.

Table 3-2 Mapping between the local priority and DSCP priority

Local	0	1	2	3	4	5	6	7
DSCP	0–7	8–15	16–23	24–31	32–39	40–47	48–55	56–63

Table 3-3 Mapping between the local priority and CoS priority

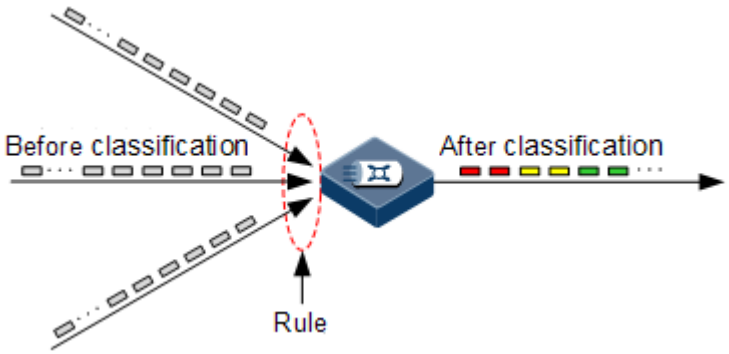
Local	0	1	2	3	4	5	6	7
CoS	0	1	2	3	4	5	6	7

3.5.4 Traffic classification

Traffic classification is a process that recognizes specified packets according to some certain rule. All resulting packets can be treated differently to differentiate the service implied to users.

The RC1201-4FE4E1T1 configures port trust based on traffic. The RC1201-4FE4E1T1 supports classifying traffic based on CoS and DSCP. In addition, it supports classifying traffic based on Access Control List (ACL) rules, class mapping mechanism, and VLAN ID. Figure 3-7 shows the traffic classification process.

Figure 3-7 Traffic classification process



DSCP priority

Structure for IP packet header is displayed in Figure 3-8. An 8-bit ToS field is contained in this packet. For the RFC1349, the first 3 bits of the ToS field representing the ToS priority. For the RFC247, the ToS field is re-defined. The first 6 bits (0–5 bits) indicate the priority of IP packets, which is called DSCP priority, ranging from 0 to 63, where the last 2 bits (6 and 7 bits) are reserved bits. Figure 3-8 and Figure 3-9 show structures of ToS and DSCP priorities.

Figure 3-8 Structure of an IP packet header

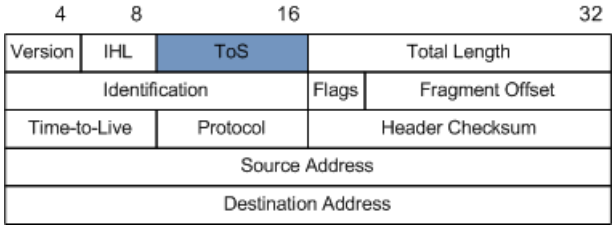
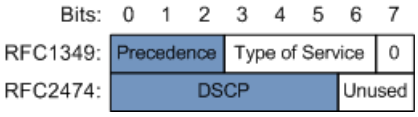


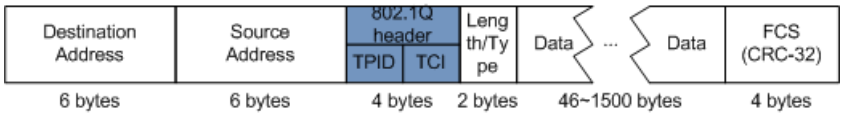
Figure 3-9 Structure of a DSCP packet header



CoS priority

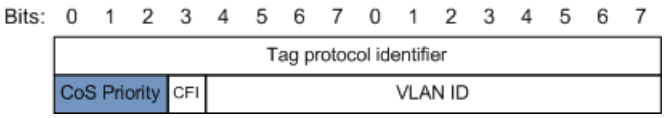
IEEE802.1Q-based VLAN packets are a modification of Ethernet packets. A 4-bit 802.1Q header is added between the source address and protocol type, as shown in Figure 3-10. The 802.1Q header consists a 2-bit Tag Protocol Identifier (TPID, valuing 0x8100) filed and a 2-bit Tag Control Information (TCI) field.

Figure 3-10 Structure of a VLAN packet



The first 3 bits of TCI field represent the CoS priority, which ranges from 0 to 7. CoS priority is used to guarantee QoS on the Layer 2 network.

Figure 3-11 Structure of a CoS priority packet



The value for local priority is based on the DSCP value or CoS value of a packet. It can be configured according to interface trust status and packet types.

Note

- Port trust-based traffic classification and ACL/class mapping-based traffic classification are exclusive. The later configuration takes effect.

- Configurations for QoS trust status and policy trust status are exclusive. The later configuration takes effect.
- Global QoS and interface QoS are used for different devices. They cannot be configured concurrently on the same device.

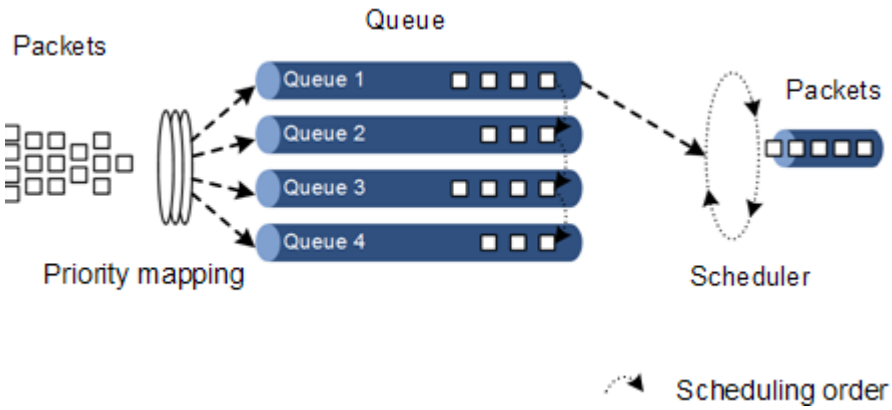
3.5.5 Queue scheduling

You need to perform the queue scheduling when delay-sensitive services need better QoS services than delay-insensitive and when the network is congested sometimes.

Queue scheduling adopts different scheduling algorithms to send packets in a queue. Scheduling algorithms supported by the RC1201-4FE4E1T1 include Fixed Priority (FP) and Weighted Fair Queue (WFQ). All scheduling algorithms are designed for addressing specified traffic problems. And they have different effects on bandwidth distribution, delay, and jitter.

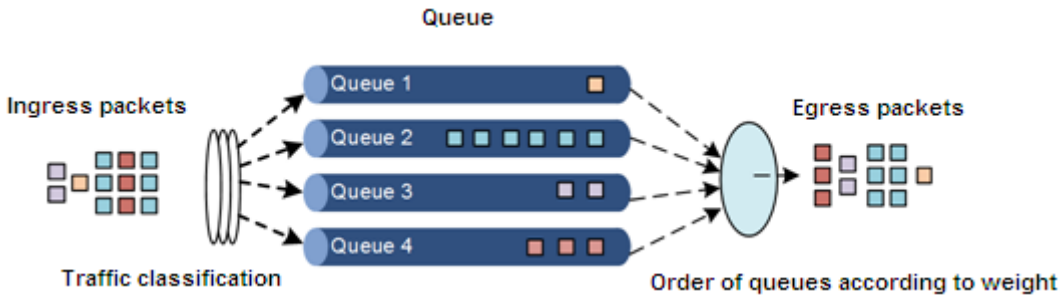
- FP: the device strictly schedules packets in a descending order of priority. Packets with lower priority can be scheduled after packets with higher priority are scheduled, as shown in Figure 3-12.

Figure 3-12 FP scheduling



- WFQ: the device maps packets of different traffic classes to different queues, and schedules packets according to the weight of the queue, as shown in Figure 3-13.

Figure 3-13 WFQ scheduling



The RC1201-4FE4E1T1 supports FP and WFQ scheduling.

3.5.6 Rate limiting based on interface

Rate limiting refers to limiting the rate of the ingress and egress packets through the token bucket. The token bucket allows burst in the flow but does not allow the burst to be greater

than the capacity of the bucket. If rate limiting is configured on an interface, all packets received or sent by the interface will be processed by the token bucket. If there are enough tokens in the token bucket, packets can be received or sent; otherwise, packets will be discarded.

The RC1201-4FE4E1T1 supports interface-based rate limiting.

3.6 Link aggregation

With link aggregation, multiple physical interfaces are combined to form a logical LAG. Multiple physical links in one LAG are taken as a logical link. Link aggregation helps share traffic among members in a LAG. In addition to effectively improving the reliability on links between devices, link aggregation can help gain higher bandwidth without upgrading hardware.

The RC1201-4FE4E1T1 supports manual link aggregation. The process of aggregating multiple physical interfaces to a logical interface does not require any protocol. The consistency of interface parameters is ensured manually.

3.7 Storm control

On most Layer 2 network, unicast traffic is much heavier than broadcast traffic. If rate for broadcast traffic is not limited, when a broadcast storm is generated, total bandwidth will be occupied. Therefore, network performance is reduced and unicast packet cannot be forwarded. In addition, communication between devices may be interrupted.

Configuring storm control on RC1201-4FE4E1T1 prevents broadcast storm occurring when broadcast packets increase sharply in the network, thus ensuring that the unicast packets can be properly forwarded.

Broadcast traffic may exist in following forms, so you need to limit the bandwidth for them on the RC1201-4FE4E1T1.

- Unknown unicast traffic: the unicast traffic whose MAC destination address is not in MAC address table. It is broadcasted by a Layer 2 device.
- Unknown multicast traffic: the multicast traffic whose MAC destination address is not in MAC address table. Generally, it is broadcasted by a Layer 2 device.
- Broadcast traffic: the traffic whose MAC destination address is a broadcast MAC address. It is broadcasted by a Layer 2 device.

4 OAM

This chapter describes Operation, Administration, and Maintenance (OAM) of the RC1201-4FE4E1T1, including the following sections:

- Operation and maintenance
- NView NNM system
- Ethernet OAM

4.1 Operation and maintenance

For operation and maintenance, the RC1201-4FE4E1T1 provides powerful maintainability for the customer in terms of hardware design and function configurations.

4.1.1 Management and operation modes

Management through Console interface

Through the Console interface, you can use a terminal or Personal Computer (PC) that runs the terminal emulation program to manage and configure the RC1201-4FE4E1T1. This management mode is called out-of-band management, and does not use the service network for communication. Even if the network fails, you can manage and configure the RC1201-4FE4E1T1 through the Console interface.

Management through Telnet

The Telnet protocol, a member of the TCP/IP protocol suite, is the standard protocol for remote login on the Internet. With it, you can use your PC as a terminal to log in to the remote host. Then through the Telnet program, you can connect the PC to the SNMP interface on the RC1201-4FE4E1T1. Then you can enter commands in the Telnet program, and these commands will run on the RC1201-4FE4E1T1 as if you enter commands on the console of the RC1201-4FE4E1T1.

You can log in to the RC1201-4FE4E1T1 as a Telnet server from the terminal emulation program on the PC, and then configure and manage the RC1201-4FE4E1T1 in the terminal emulation program.

4.1.2 Maintenance and test tools

The RC1201-4FE4E1T1 supports diagnosing and debugging software and hardware bugs with the following tools.

Ping

Packet Internet Grope (PING), a most widely used command for diagnosing and debugging, is used to test whether two devices are connected. The Ping function is implemented through Internet Control Message Protocol (ICMP) Echo packets. If the connection is normal, response packets will be replied with.

SFP DDM

Small Form-factor Pluggables (SFP) is an optical module in optical module transceivers. SFP Digital Diagnostic Monitoring (DDM) provides a method for monitoring performance. By analyzing monitored data provided by the SFP module, the administrator can predict the lifetime of the SFP module, isolate system faults, and verify the compatibility of the SFP module.

The SFP module has 5 performance parameters:

- Temperature for the transceiver
- Internal Power Feeding Voltage (PFV)
- Tx bias current
- Tx optical power
- Rx optical power

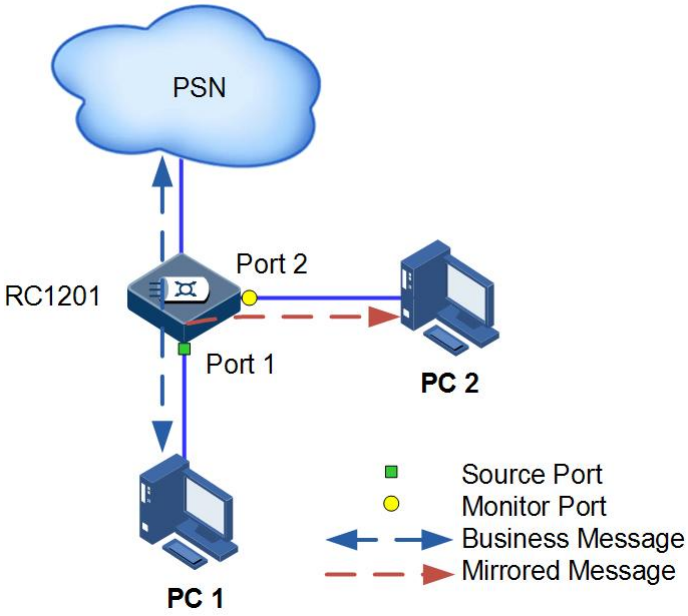
With this function, you can configure SFPs globally, or import and view information about the following tables:

- SFP information table
- SFP detection table
- SFP current period detection table
- SFP period detection table

Port mirroring

Port mirroring refers to mirroring packets of the source port to the monitor port without affecting packets forwarding. You can use this function to monitor the receiving and sending status of some port and analyze the network situation.

Figure 4-1 Principle of port mirroring



Basic principles of port mirroring are displayed in Figure 4-1. PC 1 is connected to the network through port 1 on the RC1201-4FE4E1T1. PC 2 is the monitor PC that is connected to port 2 on the RC1201-4FE4E1T1.

To monitor packets sent by PC 1, you need to configure port 1 as the mirroring port and enable port mirroring for packets on the ingress port. Configure port 2 as the monitor port, namely, the mirroring destination port.

When forwarding a packet sent by PC 1, the RC1201-4FE4E1T1 mirrors one to port 2. The monitor device connected to port 2 receives and analyzes this mirrored packet.

The RC1201-4FE4E1T1 supports port mirroring based on ingress port or egress port. When the port mirroring is enabled, packets on ingress/egress mirroring port will be mirrored to the monitor port.

4.2 NView NNM system

4.2.1 Introduction

"Comprehensive Access, Overall Network Management" is a vision that Raisecom has been in pursuit of. The NView NNM system is developed to meet requirements for overall and efficient OAM. It is of complete functions, friendly User Interface (UI), and easy operations, and thus can meet requirements of service activation and daily maintenance.

The NView NNM system, based on SNMP, can perform centralized configurations and fault detection over all manageable devices. It has the following functions:

- Topology management: display network topology graphically, organize and manage nodes of various types and links between these nodes, and support automatic or manual planning of network functions.

- Alarm management: collect, classify, display, and manages all alarms reported by managed devices. It supports query, sorting, filtering, statistics, forwarding, and voice prompt.
- Performance management: enable you to view realtime or historical performance metrics, such as interfaces, traffic, and bandwidth utilization.
- Inventory management: manage physical inventory, such as devices, chassis, and interfaces.
- User management: manage information about all connected users, and allow building relation between the customer and the device as well as the interface. This function helps quickly locate affected customers.
- Security management: support user account and password rules according to security management features in network management; control authorized access from a client according to the *Client Access Control List*; provide the Invalid Login Verification function, which will lock a user if the times of typing incorrect user name and password exceeds the configured number; provide security control policies based on level, authority, and domain; provide detailed system/device operation logs to facilitate you to control operation authorities.
- Service management: manage predefined system services through the application service management framework, such as Trap receiving service, alarm storm prevention service, and alarm forwarding service.
- Data center: enable you to manage devices, such as backing up, restoring, rolling back, and activating; enable you to manage upgradable files, backup files, operations, and logs for backup. The backup operation is easy, simple and with high security.
- Data downloading: download logs, historical alarms, and performance data from database as viewable files and then delete these data from database. This ensures efficient operation of database in the NView NNM system.

4.2.2 Features

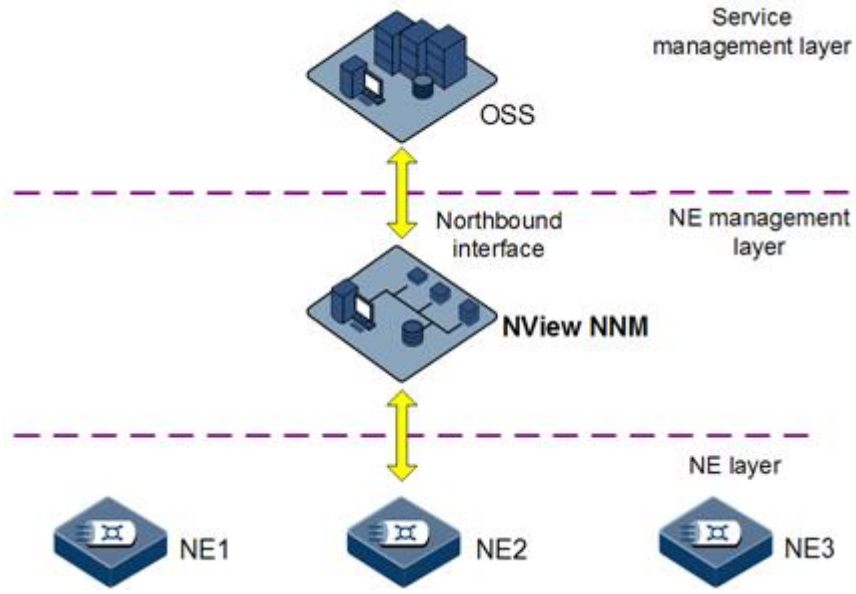
The NView NNM system has the following features:

- Work as a uniform platform for all Raisecom manageable devices.
- Uniformly manage data network and transport network.
- Provide strong NE-level management and subnet-level management.
- Provide northbound interfaces for integration with the OAM system, such as COBRA, SNMP, JDBC, and SOCKET interfaces.
- Communicate with NE-level devices through SNMP in the southbound direction. With a modular design, it supports flexible deployment according to actual situation.

The NView NNM system can be interconnected to the Operation Support System (OOS). It implements OAM functions between the OSS and NEs through the northbound interface, such as service activation, alarm reporting, alarm synchronization, fault diagnosis, and periodical inspection.

Figure 4-2 shows the orientation of the NView NNM system.

Figure 4-2 Orientation of NView NNM



4.3 Ethernet OAM

Initially, Ethernet is designed for LAN. OAM is weak because of its small size and a NE-level administrative system. With constant development of Ethernet technology, Ethernet technologies are more widely applied to the carrier-grade network. Compared with LAN, the carrier-grade network features longer links and larger scale. The lack of effective management and maintenance has seriously hinder application of Ethernet technologies to telecommunication networks.

Complying with IEEE 802.3ah protocol, Ethernet in the First Mile (EFM) is a link-level Ethernet OAM technology. It provides link connectivity detection, link fault monitoring, and remote fault notification for a link between two directly connected devices.

The first mile referred to in OAM EFM is from the office devices of the carrier to the devices at the user side. OAM EFM aims to apply Ethernet technologies that are already widely used to the access network market of end users. In this way, the network performance will be improved sharply and cost on devices and operations will be reduced. EFM is mainly the Ethernet links at the edge of access network.

The RC1201-4FE4E1T1 supports EFM functions compatible with IEEE 802.3ah.

5 Technical specifications

This chapter describes the overall technical specifications and performance specifications, including the following sections:

- Overall technical specifications
- Optical interface parameters
- Laser safety class
- Reliability specifications
- EMC indexes
- Safety standards
- Environmental requirements

5.1 Overall technical specifications

Table 5-1 lists the overall technical specifications of the RC1201-4FE4E1T1.

Table 5-1 Overall technical specifications

Parameter		Description
Dimensions (mm)		440 (Width) × 210 (Depth) × 44.45 (Height, 1U)
Weight (kg)		3
Power consumption (W)		< 13
DC input voltage	Rated voltage (V)	-48
	Voltage range (V)	-36 to -72
AC power	Rated voltage (V)	220
	Voltage range (V)	176–264
	Frequency (Hz)	50/60
Operating temperature (°C)		-5 to 50
Operating humidity		≤ 90% RH (non-condensing)

5.2 Optical interface parameters

Table 5-2 lists parameters of the 1000Base-X SFP optical module.

Table 5-2 Parameters of the 1000Base-X SFP optical module

Model	Wavelength (nm) (laser type)	Receiver type	Tx power (dBm)	Minimal overload point (dBm)	Extinction ratio (dB)	Rx sensitivity (dBm)	Transmission distance (km)
USFP-Gb/M	850 (VCSEL)	PIN	-10 to -3	-3	8.2	-15	0.55
USFP-Gb/S1	1310 (FP)	PIN	-10 to -3	-3	8.2	-20	15
USFP-Gb/S2	1550 (DFB)	PIN	-3 to 2	-3	8.2	-20	40
USFP-Gb/S3	1550 (DFB)	APD	-3 to 2	-9	8.2	-30	80
USFP-Gb/SS13	1310 (FP)	PIN	-10 to -3	-3	8.2	-20	15
USFP-Gb/SS15	1550 (DFB)	PIN	-10 to -3	-3	8.2	-20	15

5.3 Laser safety class

According to the Tx power of the laser, the RC1201-4FE4E1T1 laser belongs to Class 1 in safety class.

In Class 1, the maximum Tx power on the optical interface is smaller than 10 dBm (10 mW).

The laser inside fiber may hurt your eyes. Do not stare into the optical interface directly during installation and maintenance.

5.4 Reliability specifications

Table 5-3 lists reliability specifications of the RC1201-4FE4E1T1.

Table 5-3 Reliability specifications

Parameter	Description
System availability	99.999%. The annual failure time for the RC1201-4FE4E1T1 should be not more than 5 minutes.
Annually system mean repair rate	< 1.5%
MTTR	< 2 hours
MTBF	100,000 hours

5.5 EMC indexes

The RC1201-4FE4E1T1, designed according to ETS 300 386 series and ETS 300 127 series of European Telecommunication Standards Institute (ETSI), has passed Electromagnetic Compatibility tests.

5.6 Safety standards

The RC1201-4FE4E1T1 complies with the following safety standards:

- EN 60950
- UL 60950

5.7 Environmental requirements

The RC1201-4FE4E1T1 complies with the following environmental requirements:

- NEBS GR-63-CORE: Network Equipment-Building System (NEBS) Requirements: physical protection
- ETSI (European Telecommunication Standards Institute) EN 300 019

5.7.1 Storage environment

Atmosphere environment

Table 5-4 lists atmosphere requirements for the RC1201-4FE4E1T1 during storage.

Table 5-4 Atmosphere requirements during storage

Parameter	Description
Air pressure (kPa)	86–106
Temperature (°C)	-25 to +60

Parameter	Description
Relative humidity	10%–90% RH
Solar radiation (W/s ²)	≤ 1120
Thermal radiation (W/s ²)	≤ 600
Wind speed (m/s)	≤ 20

Waterproof environment

Keeping the RC1201-4FE4E1T1 indoor is recommended with the following requirements:

- No ponding in the room
- No water dropping above
- Away from any water leakage area, such as the automatic fire facility or central heating facility

If the RC1201-4FE4E1T1 is stored outdoor, ensure the following four prerequisites:

- The packing box is intact.
- Rainproof measures are taken so that rain will not leak into the packing box.
- No ponding is around the packing box.
- The packing box is not directly exposed to the sun.

Biotic environment

Keep the RC1201-4FE4E1T1 away from:

- Fungus and mould
- Rodent animals such as rats

Air cleanliness

No explosive, conductive, magnetic, and corrosive dust is around the RC1201-4FE4E1T1 during storage.

Table 5-5 lists concentration of active substance for the RC1201-4FE4E1T1 during storage.

Table 5-5 Concentration of active substance during storage

Mechanical active substance	Content
Floating dust (mg/m ³)	≤ 5.00
Droppable dust (mg/m ²h)	≤ 20.0
Grit (mg/m ³)	≤ 300

Table 5-6 lists chemical active substance requirements for the RC1201-4FE4E1T1 during storage.

Table 5-6 Chemical active substance requirements during storage

Chemical active substance	Content
Sulfur dioxide SO_2 (mg/m ³)	≤ 0.30
Hydrogen sulfide H_2S (mg/m ³)	≤ 0.10
Nitrogen dioxide NO_2 (mg/m ³)	≤ 0.50
Ammonia NH_3 (mg/m ³)	≤ 1.00
Chlorine Cl_2 (mg/m ³)	≤ 0.10
Chlorhydric acid HCl (mg/m ³)	≤ 0.10
Hydrofluoric acid HF (mg/m ³)	≤ 0.01
Ozone O_3 (mg/m ³)	≤ 0.05

5.7.2 Tranport environment

Atmosphere environment

Table 5-7 lists atmosphere requirements for the RC1201-4FE4E1T1 during transport.

Table 5-7 Atmosphere requirements during transport

Parameter	Description
Air pressure (kPa)	86–106
Temperature (°C)	-25 to +60
Temperature change rate (℃ /min)	≤ 1
Relative humidity	10%–90% RH (non-condensing)
Solar radiation (W/s ²)	≤ 1120
Thermal radiation (W/s ²)	≤ 600
Wind speed (m/s)	≤ 20

Waterproof environment

When transporting the RC1201-4FE4E1T1, ensure the following prerequisites

- The packing box is intact.
- Rainproof measures are taken that rain will not leak into the packing box.
- No ponding is inside the transport vehicle.

Air cleanliness

No explosive, conductive, magnetic, and corrosive dust is around the RC1201-4FE4E1T1 during transportation.

Table 5-8 lists concentration of active substance for the RC1201-4FE4E1T1 during transportation.

Table 5-8 Concentration of active substance during transportation.

Mechanical active substance	Content
Floating dust (mg/m ^{3})	Unlimited
Droppable dust (mg/m ^{2}h)	≤ 20.0
Grit (mg/m ^{3})	≤ 100

Table 5-9 lists chemical active substance requirements for the RC1201-4FE4E1T1 during transport.

Table 5-9 Chemical active substance requirements during transport

Chemical active substance	Content
Sulfur dioxide SO_2 (mg/m ^{3})	≤ 0.30
Hydrogen sulfide H_2S (mg/m ^{3})	≤ 0.10
Nitrogen dioxide NO_2 (mg/m ^{3})	≤ 0.50
Ammonia NH_3 (mg/m ^{3})	≤ 1.00
Chlorine Cl_2 (mg/m ^{3})	≤ 0.10
Chlorhydric acid HCl (mg/m ^{3})	≤ 0.10
Hydrofluoric acid HF (mg/m ^{3})	≤ 0.01
Ozone O_3 (mg/m ^{3})	≤ 0.05

5.7.3 Operation environment

Atmosphere environment

Table 5-10 lists atmosphere requirements for the RC1201-4FE4E1T1 during operation.

The temperate and humidity referred to are measured 1.5 m above or 0.4 m in front of the RC1201-4FE4E1T1.

Table 5-10 Atmosphere requirements during operation

Parameter	Description
Air pressure (kPa)	86–106
Temperature (℃)	0–50
Relative humidity	10%–90% RH (non-condensing)
Temperature change rate (℃/min)	≤ 0.5
Solar radiation (W/s ³)	≤ 700
Thermal radiation (W/s ³)	≤ 600
Wind speed (m/s)	≤ 5

Biotic environment

Keep the RC1201-4FE4E1T1 away from:

- Fungus and mould
- Rodent animals such as rats

Air cleanliness

No explosive, conductive, magnetic, and corrosive dust is around the RC1201-4FE4E1T1 during transportation.

Table 5-11 lists concentration of active substance for the RC1201-4FE4E1T1 during operation.

Table 5-11 Concentration of active substance during operation

Mechanical active substance	Content
Number of dust grains (/m ³)	≤ 3×10^5
Floating dust (mg/m ³)	≤ 0.2
Droppable dust (mg/m ²h)	≤ 15
Grit (mg/m ³)	≤ 100

Table 5-12 lists chemical active substance requirements for the RC1201-4FE4E1T1 during operation.

Table 5-12 Chemical active substance requirements during operation

Chemical active substance	Content
Sulfur dioxide SO_2 (mg/m ³)	≤ 0.30
Hydrogen sulfide H_2S (mg/m ³)	≤ 0.10

Chemical active substance	Content
Ammonia NH_3 (mg/m ^{3})	≤ 3.00
Chlorine Cl_2 (mg/m ^{3})	≤ 0.10
Chlorhydric acid HCl (mg/m ^{3})	≤ 0.10
Hydrofluoric acid HF (mg/m ^{3})	≤ 0.01
Ozone O_3 (mg/m ^{3})	≤ 0.05

6 Hardware installation

This chapter describes precautions and installation procedure for the RC1201-4FE4E1T1, including the following sections:

- Installation location
- Safety information
- Preparing for installation
- Installation procedure
- Checking installation

6.1 Installation location

The RC1201-4FE4E1T1, a 1U-high cartridge device, can be installed in the following scenarios:

- ETSI 600-mm cabinet
- 19-inch 450-mm cabinet
- 19-inch 600-mm cabinet
- Open chassis
- Workbench

For detailed installation procedure, see section 6.4 Installation procedure.

The brackets and screws used in installation are optional kits not delivered with the RC1201-4FE4E1T1.

6.2 Safety information

To avoid accidents, this section describes safety information for installation and operation.

6.2.1 Safety statement

Note

Carefully read the statement to prevent personal injury or device damage during operations.

Only qualified and authorized service personnel can carry out adjustment and installation.

Device installation should comply with local safety specifications strictly. Safety matters mentioned in the manual are supplementary. Raisecom shall not be liable for the accident caused by violating general safety operation requirements and the safety standard of design, production, and usage.

6.2.2 Safety symbols

The common safety symbols in equipment installation are shown in Table 6-1, which are used to prompt you to comply with safety precautions.

Table 6-1 Types and meanings of safety symbols

Symbol	Description
	Danger of high voltage!
	Electrostatic symbol, indicating that the equipment is sensitive to static electricity.
	Earth connecting symbol, indicating that the equipment should be connected to the earth.
	Danger of electromagnetic radiation!
	Danger of microwave radiation!
	Danger of laser!

6.2.3 Electrical safety

High-voltage safety

High-voltage power supplies provide power for the operation, so direct contact or indirect contact with the wet object will lead to fatal danger.

During installation, ensure the working environment and staff comply with high-voltage safety rules to avoid personal injury and equipment damage.

High-voltage safety rules are as below:

- Operation&installation personnel must have related qualification.
- The installation of AC power device must comply with local regulations.
- The operation must use special tools.
- Do not wear watches, bracelets, rings, and other conductive objects.
- Avoid the device from damping when operating in wet environment. Turn off power supply immediately if the cabinet is damp.

Power cable safety

Do not install and remove the power cable in electrical conditions. The core of power cable conductors will produce electric arc or spark when touching the conductor, which may result in fire or eye injuries.

During installation, ensure the power cable complies with safety rules to avoid personal injury and equipment damage.

Power cable safety rules are as below:

- Turnoff or disconnect the power before installing and removing the power cable.
- Ensure the power cable label displays correct before connection.
- Only power cables meeting the specifications are allowed.

Thunder-and-lightning safety

In a thunderstorm, the operations under high voltage, AC power, iron tower, and mast homework are strictly forbidden.

During a lightning storm, a strong electromagnetic field is produced in the atmosphere. Therefore, to prevent possible damage, you should take thunder-and-lightning protection work for the RC1201-4FE4E1T1.

Electrostatic safety

When contacting equipment or components, you must wear an ESD wrist strap. The ESD wrist strap should contact your skin. Insert the plug to ESD socket on the equipment.
Avoid any contact between components and clothes because the ESD wrist strap cannot prevent the components from producing static when contacting with clothes.

In equipment installation, take ESD measures to avoid device damage.

- The device should be grounded properly in accordance with requirements.
- To prevent body electrostatic from damaging the equipment, you must wear the ESD wrist strap before contacting device or components and ensure that the other side of the ESD wrist strap is grounded properly.
- To guarantee the ESD wrist strap in working condition, the system resistance should be within the range of 0.75–10 MΩ. If the actual resistance is incompliant, change a new ESD wrist strap in time.

6.2.4 Radiation safety

Electromagnetic explosion safety

High-strength radio frequency signal is harmful to human body.

To operate one of multiple Tx antennas installed on a tower or mast, contact related personnel to shut down Tx antennas firstly.

Before entering an area with over strong radiation, you should confirm the area location and turn down the transmitter.

Laser safety

The laser transceiver is used in optical transmission systems and related tests. Bare fiber or interface will transmit invisible laser with high power. You will have your eyes burnt if staring into the laser output interface with naked eyes.

Comply with the following requirements to prevent laser radiation hazard:

- Only authorized personnel with related training can operate the device and fiber.
- Wear goggles in operations.
- Power off the device before disconnecting fiber connectors.
- Cover the optical interface in use and the connected fiber with a dust cap to protect eyes when pulling out the fiber.
- In an uncertain power status, do not watch bare fiber or connector.
- Measure optical power with an optical power meter to ensure that the optical source has turned off.
- Avoid the laser radiation before opening the front door of optical fiber transmission system.

- Do not use the microscope, magnifier, loupe, and other optical instruments to watch the fiber connectors or the ends of fiber.

Obey the following requirement for operations on optical fiber:

- Only trained personnel can cut and weld optical fiber.
- Before cutting or welding fiber optical, disconnect the fiber with optical source. Then use fiber caps to protect all the fiber connectors.

6.2.5 Mechanical safety

Drilling

You are prohibited from drilling in the cabinet on your own. Drilling without meeting the requirements may destroy the electromagnetic shielding performance of the cabinet and damage internal cables. Metal particles generated by drilling into the cabinet will lead to short circuit of cards.

Comply with the following requirements for drilling in the cabinet:

Step 1 Remove cables in the cabinet.

Step 2 Wear goggles to avoid injury caused by sprayed metal particles.

Step 3 Wear protective gloves during drilling.

Step 4 Strictly prevent metal particles from falling into the cabinet. After drilling, clean it up carefully.

Carrying chassis

Be well prepared for load-bearing and avoid being crushed or sprained.
When pulling out the chassis, pay more attention to the unstable and heavy devices on cabinet to avoid being crushed or sprained.

Wear protective gloves during manual lifting to avoid scratching.

Grasp the handle or hold up the bottom edge of chassis when moving or lifting the chassis instead of the handles of installed components inside the chassis (such as power supplies and fan modules).

6.3 Preparing for installation

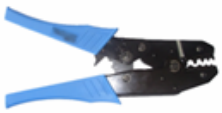
This section describes equipment installation preparation, including the following sections:

- Preparing tools
- Changing installation condition
- Checking boxes

6.3.1 Preparing tools

Table 6-2 lists tools to be prepared for installation.

Table 6-2 Tools to be prepared for installation

Name	Picture	Name	Picture
Tape measure: used to measure the length		Level instrument: used to check the levelness of the equipment installation	
Slotted point screwdriver: used to tighten slotted screws		Cross screwdriver: used to tighten cross screws	
Cold compression pliers: used to crimping old-press terminal matched with small section power cable.		Diagonal pliers: used to cut insulated casing	
Vice crimper: used to crimping the connector of telephone line and cable crystal head		Wire stripper: used to divest insulating layer for small section communication cable	
Crimping plier: used to crimping metal sheath in the end when processing the coaxial cable		Adjustable spanner: used to wrench a certain size hex head or square head bolts and nuts	
Solid wrench: used to tighten bolts and nuts in narrow working space		Hex wrench: used to tighten bolts and nuts. It can be with the ball head or not.	

Name	Picture	Name	Picture
Soldering iron: used to weld small area conductor and connectors		Insulation tape	
ESD wrist strap: used to prevent electrostatic discharge from damaging the equipment		ESD gloves: used for the ESD wrist strap	
Optical Attenuation Measuring Set (OAMS): used to adjust optical signal power by adjusting optical decrement		Cable tester: used to test the cable connectivity	
Optical power Meter: used to measure optical power		2M error detector: used to test whether there is error code in 2 m signal transmission.	
Multi-meter: used to test the chassis insulation, cable connectivity and equipment electrical performance indicator.			

Note

These tools are not delivered with the RC1201-4FE4E1T1. Prepare them by yourself.

6.3.2 Changing installation condition

Installation environment

Table 6-3 lists the working environment requirements that device installation should comply with.

Table 6-3 Working environment

Item	Requirement
Physical address	Far from pollution source and environment with dust, harmful gas and explosives; far away from transformer substation, industrial boiler, heating boiler wireless interference sources and high-intensity magnetic field environment.
Construction	The equipment room height is not less than 3 m; lay the ESD wrist strap raised floor with the load bearing over 600 kg/m^2. Good grounding is required after installation.
Insurance	The power in equipment room must be equipped with a fuse.
Working temperature	-5 to 50 ℃
Working humidity	5%–95% RH (non-condensing)
Air pressure	86–106 kPa
ESD protection	Take effective ESD measures and the electrostatic voltage absolute value must be smaller than 1000 V.
Anti-seismic grade	Up to 8

Power conditions

Table 6-4 lists power conditions that the RC1201-4FE4E1T1 should comply with.

Table 6-4 Power conditions

Parameter	Description
AC power	• Rated voltage: 220 VAC • Voltage range: 176–264 VAC
Alternative power	A special standby power is recommended to keep the device working.
Power consumption	> 40 W

Grounding conditions

The device adopts common earthing mode, and grounding resistance is not greater than 1 Ω. Good grounding is the primary guarantee to lightning protection and anti-interference.

Other conditions

Before installation, check whether auxiliary devices are ready. For example, the optical networking device is properly installed; the fiber is laid in place; alignment racks and patch panels are installed completely.

6.3.3 Checking boxes

Caution

- Avoid colliding with doors, walls, shelves and other objects during transmitting and carrying products and components.
- Avoid touching the parts and unpainted metal surface with sweated and dirty gloves during transport, carrying and installation.

Checking box before opening

Check the box before opening the box:

- The box looks good without serious damage and flooding phenomenon.
- The box is not inverted.
- The place of arrival and the actual installation location are the same.
- The total number equals to the quantity on the packing list attached to the box.

According to the check, take appropriate processing methods:

- Do not open the box if there is severe damage, outside box flooding, box inversion, wrong goods or less of goods phenomenon. Provide feedback to the local Raisecom office when finding out reasons.
- Open box if results of the above items are correct.

Opening chassis

Caution

Stop opening the box immediately if the RC1201-4FE4E1T1 is found to be rusted or flooded in unpacking process. Provide feedback to the local Raisecom office after finding out reasons by customers and Raisecom engineers.

Pay attention to the following items when opening the chassis:

- It should be operated by professional person and make items registration. Check the previous carton before opening the next one. Open the next one after ensuring that there are no goods in the previous carton to avoid omissions.
- The equipment removed from the carton must be transferred to the indoor storage properly.
- Wear the ESD wrist strap or gloves when opening ESD wrist strap protection bag.

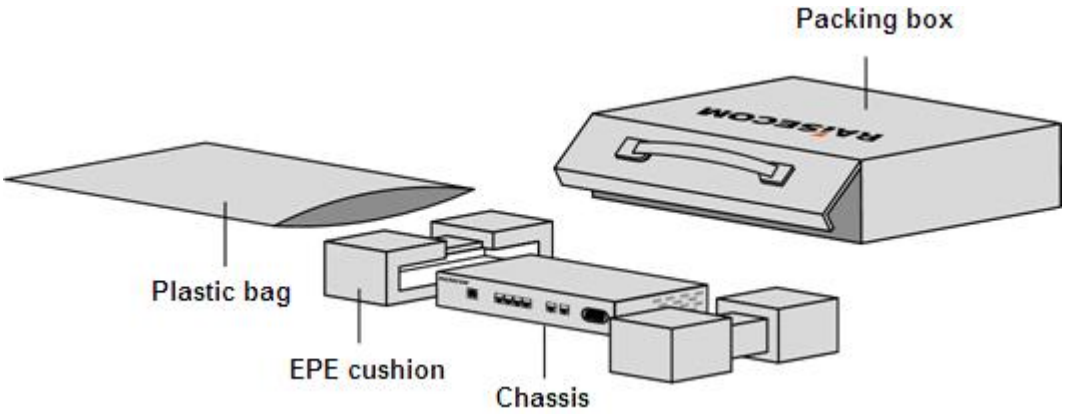
- Do not discard product box and EPE liner arbitrarily.

Open the chassis as below:

Step 1 Check the carton label to see the goods type, quantity, and make a record.

Step 2 Open the packing box and take out the device, as shown in Figure 6-1.

Figure 6-1 Opening the packing box



Acceptance check

Caution

Remove the unpacking devices to indoor storage for protection.
Take pictures of device storage environment, rusted and corroded devices, boxes and packaging materials and keep them in the archives; protect the unpacking boxes and packaging materials well.

After unpacking, Raisecom engineers and customers will check the goods to be accepted carefully according to the *Packing List*.

Check the devices type and quantity according to the *Packing List* and sign to accept them face to face.

- In case of wrong goods or short landed goods phenomenon, please contact Raisecom engineers and customer to confirm and the relevant commissioner will replace goods or replenish goods for customers.
- In case of damaged goods, please contact Raisecom engineers and customers to confirm and fill out the *Product Replacement Application* carefully.

In case of goods discrepancies, keep the goods as below:

- Remove the unpacking devices to indoor storage for protection.
- Take pictures to devices storage environment, rusted and corroded devices, boxes and packaging materials and keep them in the archives.
- Protect the unpacking boxes and packaging materials well.

6.4 Installation procedure

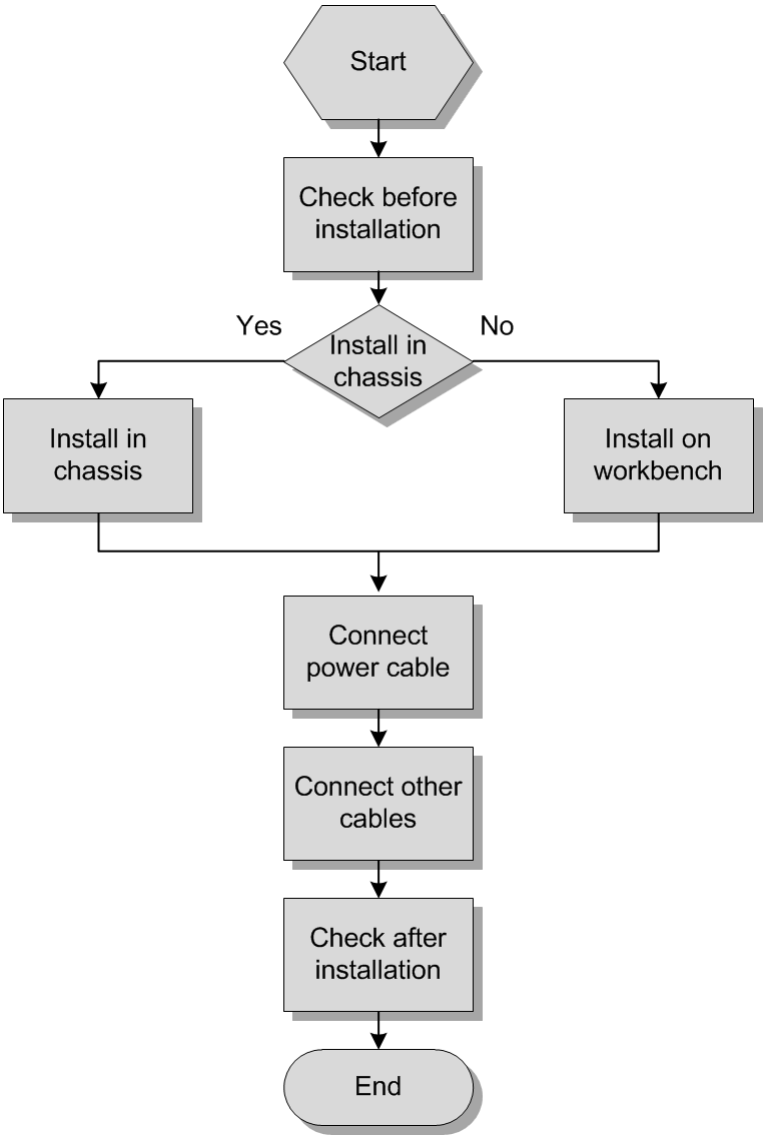
6.4.1 Installation procedure

Note

The RC1201-4FE4E1T1 should be installed inside the room and fixed for use.

Figure 6-2 shows installation process.

Figure 6-2 Installation process



6.4.2 Preparing for installation

Pay attention to the following two items before installing the chassis:

- You have already read section 6.3 Preparing for installation.
- You can meet requirements in section 6.3 Preparing for installation.

The RC1201-4FE4E1T1 may be damaged in transportation or due to other reasons after leaving the factory, so we recommend power-on check before installation to avoid installing a faulty RC1201-4FE4E1T1.

Perform power-on check as below:

Step 1 Remove the chassis from the box, and place it gently on a smooth workbench or floor.

Step 2 Connect the ground cable.

Step 3 Connect power cables as described in section 6.4.5 Connecting power cables.

Step 4 Power on the devices after all the components, ground cable, and power cables are installed correctly.

Step 5 Check the status of LEDs.

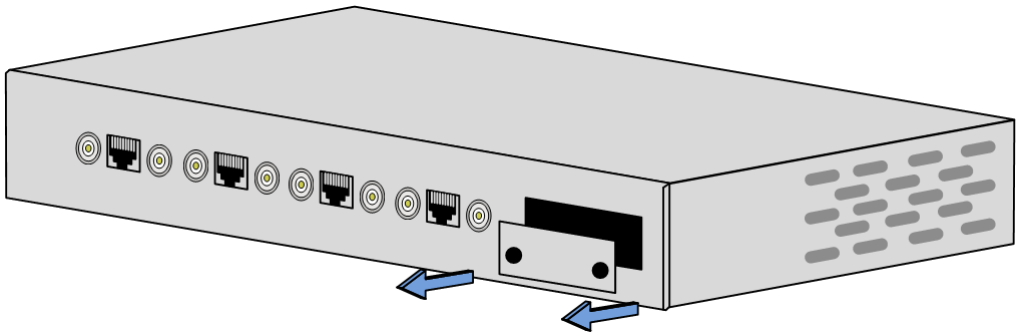
If the status is normal, install the RC1201-4FE4E1T1 according to the complete installation process.

6.4.3 Installing clock subcard

The clock subcard provides an external clock source for the RC1201-4FE4E1T1, and implements end-to-end clock synchronization. Install the clock subcard as below:

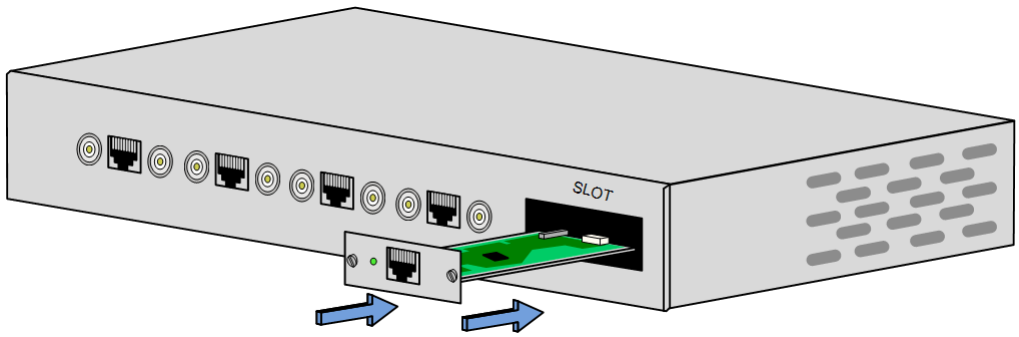
Step 1 Remove the blank panel at the rear panel of the RC1201-4FE4E1T1, as shown in Figure 6-3.

Figure 6-3 Removing the blank panel



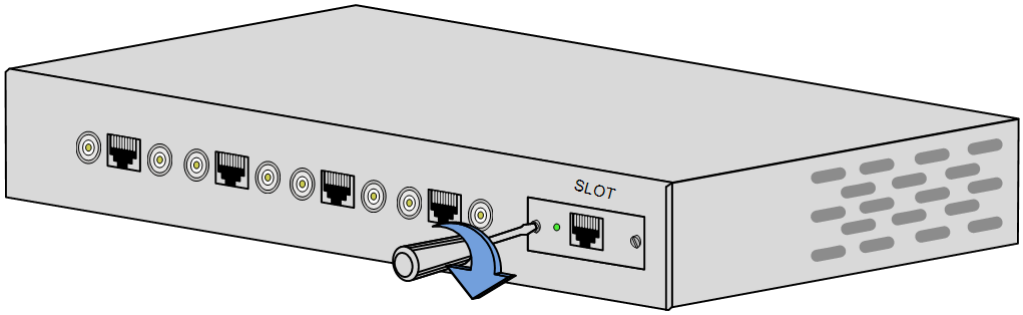
Step 2 Insert the clock subcard into the corresponding slot stably, as shown in Figure 6-4.

Figure 6-4 Inserting the clock subcard



Step 3 Fasten screws on the clock subcard clockwise, as shown in Figure 6-5.

Figure 6-5 Fastening screws



6.4.4 Installing chassis

Installing chassis in rack

Caution

Wear an ESD wrist strap grounded correctly when installing the chassis and components to prevent the chassis and components elements from damaging.

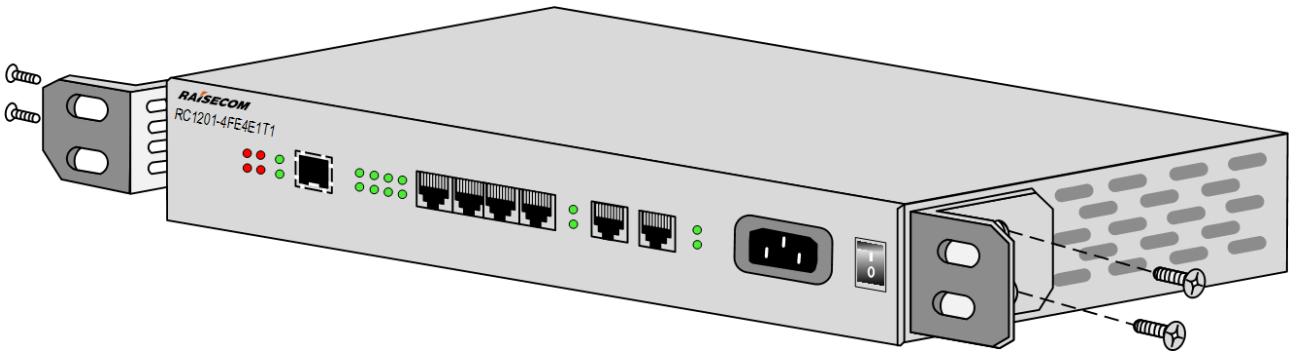
If you wish to install the RC1201-4FE4E1T1 in a rack, choose a proper rack according to Figure 6-6.

- The rack is strong enough to support the weight of the RC1201-4FE4E1T1 and its components.
- The size of the rack is fit for the RC1201-4FE4E1T1 installation; there must be some space around the RC1201-4FE4E1T1 for heat dissipation.
- The rack can provide enough power for the RC1201-4FE4E1T1.
- The rack can be grounded properly.

Install the RC1201-4FE4E1T1 chassis in the rack as below:

Step 1 Install standard brackets in the chassis, as shown in Figure 6-6.

Figure 6-6 Installing brackets on two sides of the chassis



Step 2 Uplift the chassis and move it to the front of rack slowly and stably.

Caution

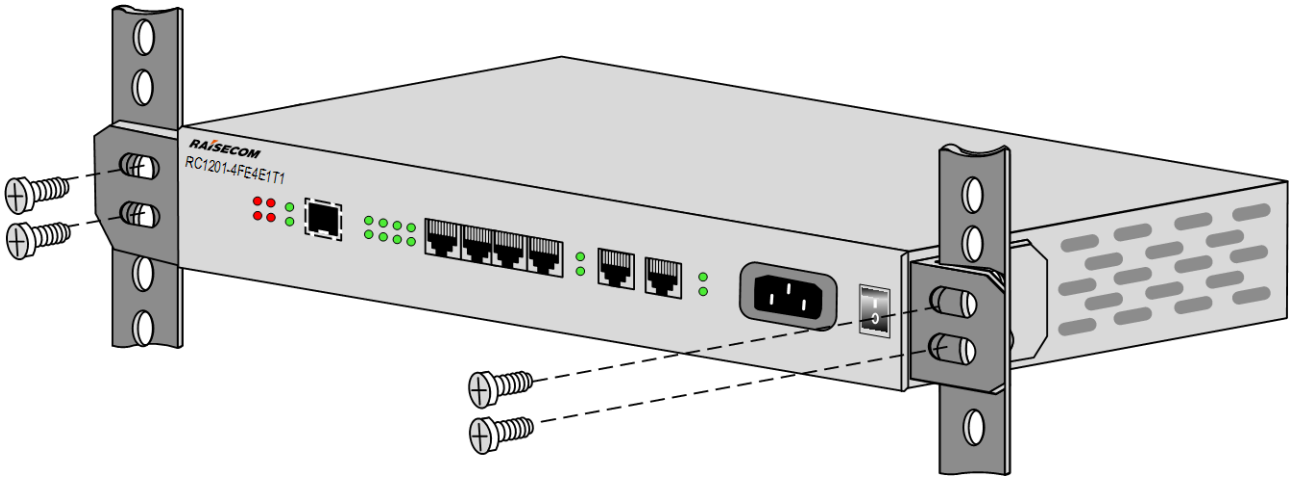
Hold both sides of chassis or the bottom margin when lifting up the chassis.

Step 3 Lift up the chassis upon the rack slide slightly and put it to the slide chute.

Step 4 Push the chassis into the rack slowly until the brackets snaps up the stand column tightly.

Step 5 Fix the chassis to the rack with screws, as shown in Figure 6-7.

Figure 6-7 Installing the chassis in the rack



Installing chassis on workbench

Caution

We do not recommended installing the RC1201-4FE4E1T1 on a workbench, which may cause a number of unforeseen events (such as collision, heavy objects falling) and affect the normal operation or even damage the RC1201-4FE4E1T1. We recommend installing the RC1201-4FE4E1T1 in a standard cabinet or open rack.

If you wish to install the RC1201-4FE4E1T1 on a workbench, ensure that the workbench complies with the following conditions:

- The usable area of workbench is greater than the bottom area of device, which is 440 mm (Width) × 210 mm (Depth).
- The load-bearing capacity of workbench is greater than 80 kg/m^2.
- The surface of workbench should be smooth and even.
- The materials for workbench should meet the ESD wrist strap requirements, preferentially wood. There is ground terminal or special ESD mat on the workbench.

Caution

The workbench must be able to remain smooth and steady and cannot tilt.

After selecting a proper workbench, place the RC1201-4FE4E1T1 steadily in the equipment room in line with the following conditions:

- The workbench environment is clean and tidy.
- There is at least 30-cm space around the workbench to facilitate device maintenance and heat dissipation.
- The workbench location is convenient for taking power and interconnecting the device with other devices.

- The workbench location is convenient for grounding.
- No water pipes or other easily falling objects are placed above the workbench.

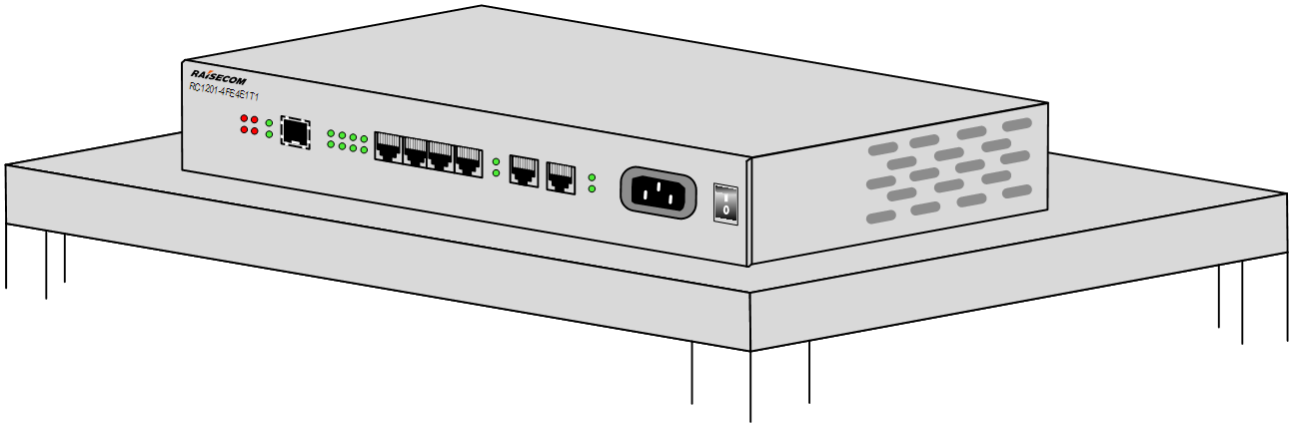
Install the chassis on the workbench as below:

Step 1 Place upside down the chassis carefully, clean chassis backplane with a dry soft cloth to ensure no oil or dust absorption, as shown in Figure 6-8.

Step 2 Lift up the chassis with both hands stably.

Step 3 Place the chassis on the middle of the workbench stably and slowly, as shown in Figure 6-8.

Figure 6-8 Installing chassis on the workbench



Caution

Do not place heavy objects on the chassis.

6.4.5 Connecting power cables

The RC1201-4FE4E1T1 supports DC power and AC power. Before connecting power cables, ensure that the power supply in equipment room has been installed completely and has left interface for this installation.

Note

To ensure the stability of power supply, select the power cable with diameter of 16 AWG or above.

Connecting DC power cable

Warning

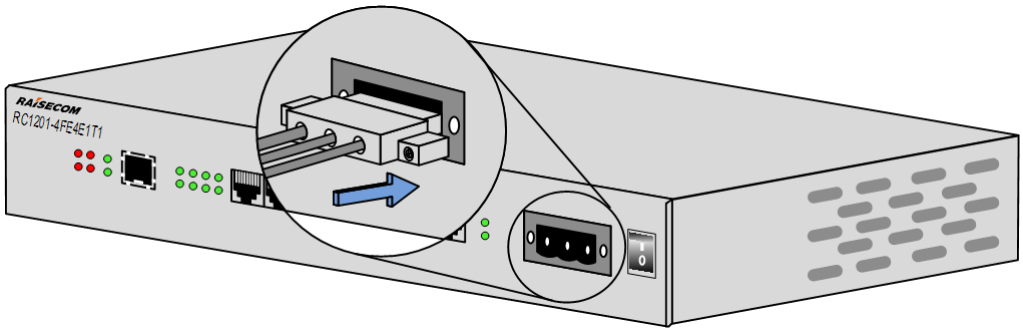
Connection parts of the DC power cable and other unnecessary nudity should be fully insulated.
Disconnect all power supplies before connecting the DC power cable to the device.

Connect the DC power cable as below:

Step 1 Check whether the ground cable has been properly grounded.

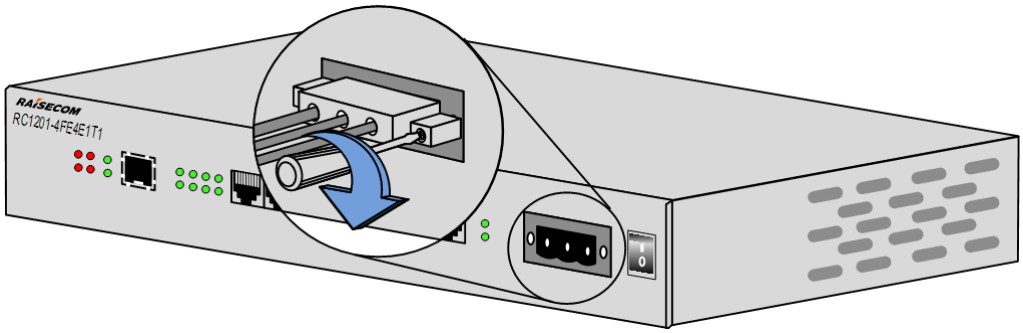
Step 2 Insert the DC cable plug into the power interface on the DC power supply RPD601 on the rear panel and confirm full insertion, as shown in Figure 6-9.

Figure 6-9 Inserting the DC power cable



Step 3 Tighten the spring screws on the DC power interface, as shown in Figure 6-10.

Figure 6-10 Tightening the spring screws on DC power interface



Step 4 Connect the other end of the power cable with power supply in the equipment room.

Connecting AC power cable

Warning

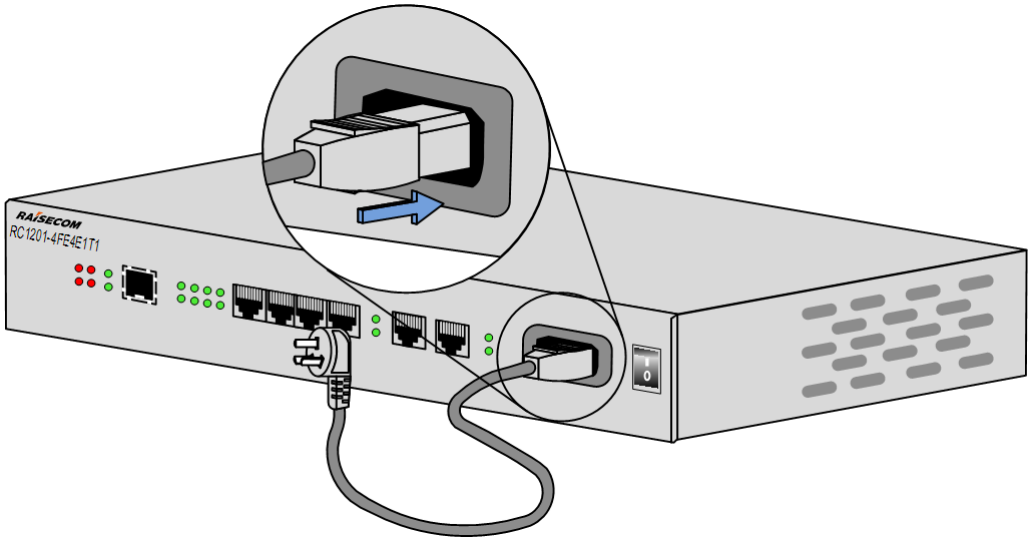
The AC power cable is a high-voltage line power. Before connecting it, power off the power socket of the workbench or rack.
Connection parts of the AC power cable and other unnecessary nudity should be fully insulated.

Connect the AC power cable as below:

Step 1 Check whether the ground cable has been properly grounded.

Step 2 Insert the AC cable into the power interface on the AC power supply RPA601 on the front panel and confirm full insertion, as shown in Figure 6-11.

Figure 6-11 Connecting the AC power cable



Step 3 Connect the other end of the AC power cable with power supply in equipment room.

Warning

Do not touch or tamper with the power before disconnecting the power cable. There is line voltage inside the device even if the power switch (if installed) is off or the fuse is burnt out.

6.4.6 Connecting service cables

The RC1201-4FE4E1T1 supports the E1/T1 cable, Ethernet cable, and fiber. Related interfaces in equipment room should be installed completely in advance.

Connecting E1/T1 cable

The E1/T1 cable is used to connect the RC1201-4FE4E1T1 to other TDM devices. It has two types: RJ45-connector E1 cable and BNC-connector E1 cable.

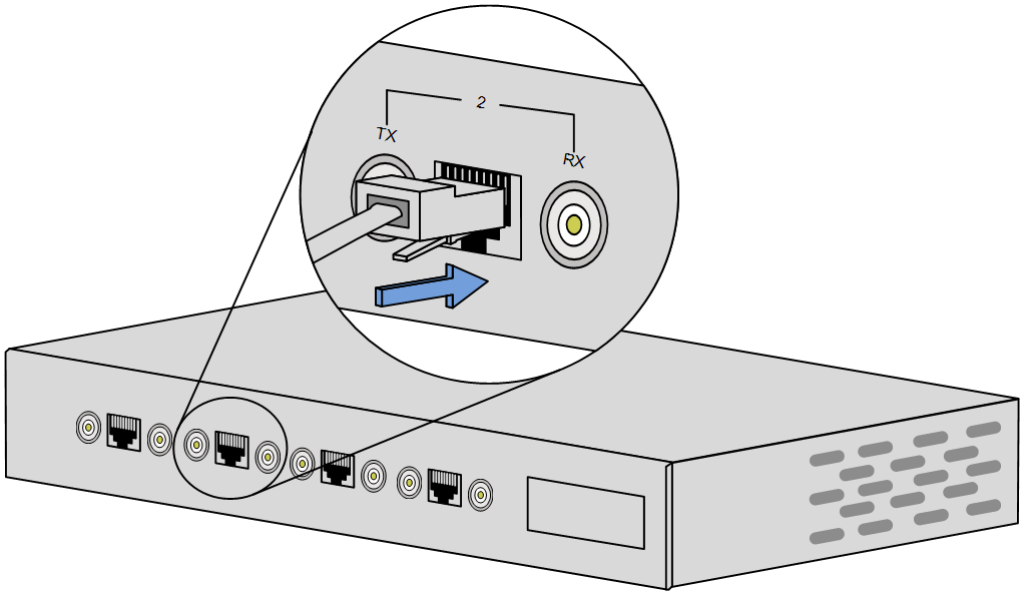
Connect the RJ45-connector E1/T1 cable as below:

Step 1 Make an E1/T1 cable based on an Ethernet cable with a proper length according to cabling path. For details, see Table 2-13Wiring of the E1 cable.

Step 2 Connect one RJ45 connector of the E1/T1 cable to the RJ45 interface on the RC1201-4FE4E1T1, as shown in Figure 6-12.

Step 3 Connect the other connector of the E1/T1 cable to the peer device. Choose the type of the other connector according to the interface type of the peer device in advance.

Figure 6-12 Connecting the RJ45-connector E1 cable



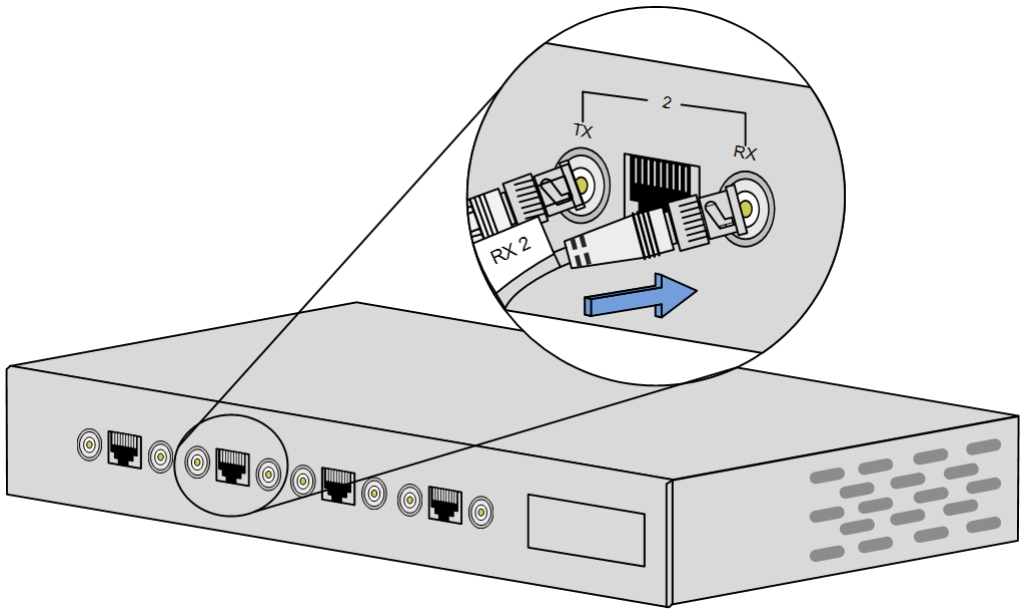
Connect the BNC-connector E1 cable as below:

Step 1 Make an E1 cable based on a coaxial cable with a proper length according to cabling path. For details, see section 2.1.5 Cables.

Step 2 Insert the long BNC male connector of the E1 cable into the E1 BNC female interface on the RC1201-4FE4E1T1, as shown in Figure 6-13.

Step 3 Connect the other connector of the E1 cable to the peer device. Choose the type of the other connector according to the interface type of the peer device in advance.

Figure 6-13 Connecting the BNC-connector E1 cable



Connecting Ethernet cable

The Ethernet cable is used to connect the RC1201-4FE4E1T1 with other devices. It supports 10/100 Mbit/s transmission rate.

- When auto-negotiation is enabled on the Ethernet electrical interface on the RC1201-4FE4E1T1, adaptive wiring is enabled and the Ethernet cable can follow the straight-through or crossover wiring to be connected to other devices.
- When auto-negotiation is disabled on the Ethernet electrical interface on the RC1201-4FE4E1T1, adaptive wiring is disabled and the Ethernet cable must follow the wiring listed in Table 6-5.

Table 6-5 Wiring of the Ethernet cable

Local device	Type of peer device	Wiring
RC1201-4FE4E1T1	Switch	Crossover
	Hub	Crossover
	Router	Straight-through
	NIC	Straight-through

Connecting fiber

Warning

Do not stare at the optical interface connected with laser; or it may injure your eyes.

Caution

- Do not stretch the fiber with force and bend fiber excessively. The curvature radius is equal to or greater than 40 mm.
- In the chassis, the tail fiber determines its routing direction according to the location of components.
- Keep a certain margin of fiber in rack when connecting, and put away the extra tail fiber.
- Tx and Rx interfaces should be connected correctly.
- Ensure that the fiber connector is clean and cover it with a dust cap timely after use.
- Bind single-core tail fiber with a magic tape.
- Do not bind the fiber too tight to affect quality of signal transmission.

Caution

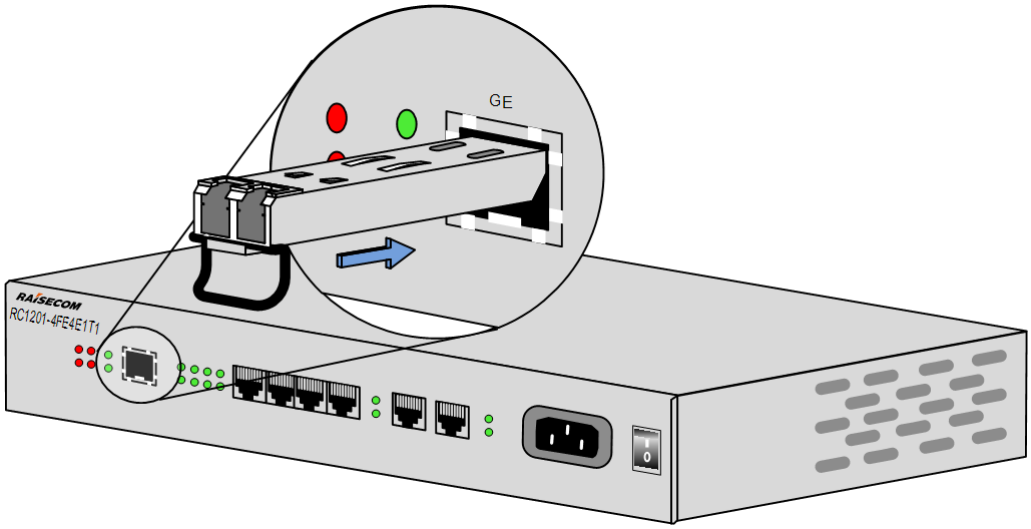
To reduce radiation injury, you must choose Class 1 optical module products in connecting optical fiber.

The fiber is used to connect the RC1201-4FE4E1T1 and other devices, providing 1000 Mbit/s transmission rate. All connected fibers can be interconnected through the Optical Distribution Frame (ODF).

Connect the fiber as below:

Step 1 Insert the SFP optical module into optical interface on the device, as shown in Figure 6-14.

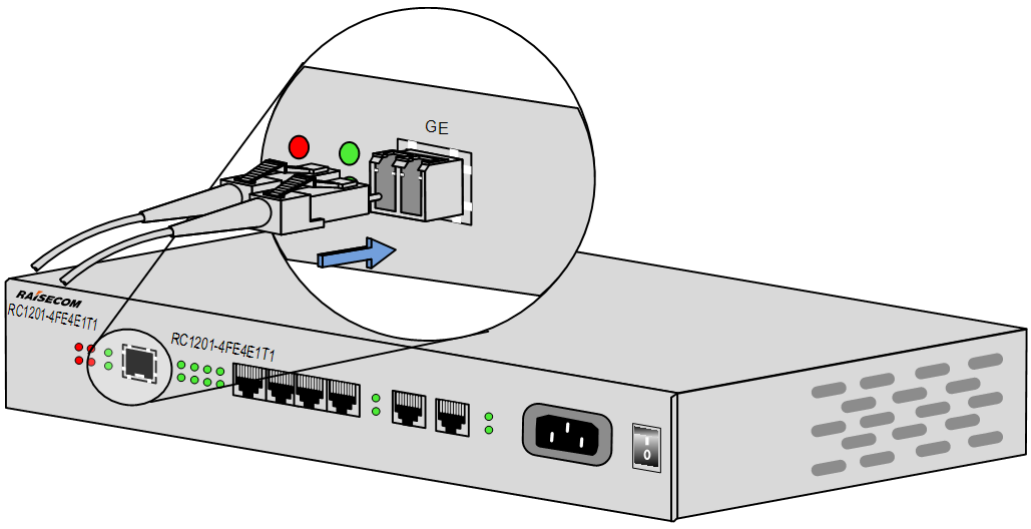
Figure 6-14 Inserting the SFP optical module



Step 2 Make the fiber pass a bellow and fix the bellow.

Step 3 Confirm the Rx and Tx optical interfaces on the service MCC on the local device. Insert one end of the LC connector of one optical fiber into the Rx interface on the SFP optical module on the local device, and the other end connected to the Tx interface on the peer device; insert one end of the other optical fiber into the Tx interface on the SFP optical module on the local device, and the other end connected to the Rx interface on the peer device, as shown in Figure 6-15.

Figure 6-15 Connecting the fiber



Connecting configuration cable

The configuration cable (also known as the Console cable) is an 8-core shielded cable used to connect the Console interface on the RC1201-4FE4E1T1 to the RS-232 serial interface on the PC and transmit configuration data.

With the configuration cable, you can establish an on-site maintenance environment.

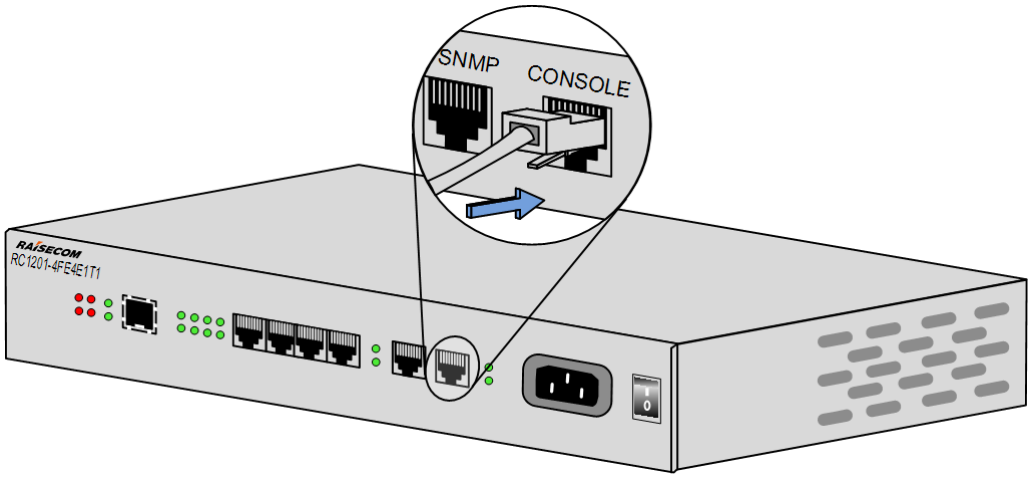
Connect the configuration cable as below:

Step 1 Insert one RJ45 connector of the configuration cable into the Console interface on the RC1201-4FE4E1T1.

Step 2 Insert the other end with the DB-25 connector and DB-9 connector into the RS-232 serial interface on the PC (or configuration terminal).

Step 3 You can choose one connector according to the actual situation of the PC (or configuration terminal), as shown in Figure 6-16.

Figure 6-16 Connecting the configuration cable



6.5 Checking installation

6.5.1 Checking equipment room and surrounding environment

Check the equipment room and surrounding environment after installation, as listed in Table 6-6.

Table 6-6 Checking the equipment room and surrounding environment

Item	Requirement
Cable	Strap or splice the surplus cables to fix them to the reserve place inside the rack to be expanded to facilitate the future expansion maintenance and avoid loss.
Plug	Protect the unused plugs and cover them with protective caps.
Equipment room environment	Keep clean and tidy, clear the obsolete packing boxes and other sundries. Stack the remaining spares neatly and reasonably. The value of grounding resistance should be smaller than 1 Ω, and also comply with the national or local standards.

6.5.2 Checking chassis or workbench

Check the chassis or workbench after installation, as listed in Table 6-7.

Table 6-7 Checking chassis or workbench

Item	Requirement
Chassis	• Auxiliary parts are installed correctly and reliably. The door and lock should work properly. • All other connection bolts are installed correctly and reliably. The flat washer and spring washer are installed in a correct order. • The installation location meets engineering design document. • The installation is fixed and reliable and consistent with the anti-seismic requirements described in engineering design document. • The ground cable is correctly and reliably installed. • The ESD wrist strap is connected to the ESD jack on the rack.
Workbench	• The installation location meets the engineering design document. • The installation is fixed and reliable and consistent with the anti-seismic requirements described in engineering design document. • The ground cable is correctly and reliably installed. • The ESD wrist strap is connected to the ESD jack on the rack.

6.5.3 Checking device

After installation is complete, check that the RC1201-4FE4E1T1 is located steadily with enough space for heat dissipation, operation, and maintenance, and the ground cable is correctly connected.

6.5.4 Checking cables

After installation is complete, check cables listed in Table 6-8.

Table 6-8 Checking cables

Item	Requirement
Power cable and ground cable	• The connection is correct and reliable. The power cable inside the rack, ground cable, and signal cable are laid separately. The distance among the power cable outside the rack, ground cable, and signal line meet the design requirements, generally greater than 3 cm. • Wrap the wire nose handle and bare wire required with heat-shrinkable tubing or insulating tape. There is no bare copper wire at the wire nose and connection terminal. The flat washer and spring washer are installed correctly. • Bind the cables straightly and neatly, and all the cable clips should be aligned toward the same direction.

Item	Requirement
Other cables	• The rack alignment is correct. • No damage, breakage, and middle connector • The plug is clean and without damage; plugs made on site should be proper and plugs connection is correct and reliable. • Cabling complies with the engineering design manual, easy for maintenance and capacity expansion. • Fibers, optical interfaces, and flange plates should be connected reliably. • Take protective measure for laying tail fiber outside the cabinet, such as adding bellows or channels.

6.5.5 Power-on check

Conduct power-on check, as listed in Table 6-9.

Table 6-9 Power-on check

Item	Requirement
DC and AC power	• Check that the positive and negative polarities of DC power are correctly connected. Use a multi-meter to test DC power, ensuring that the DC power voltage is between -36 to -72 VDC or +18 to +36 V. • Use a multi-meter to test AC power, ensuring that the AC power voltage is 176–264 VAC. • The power fuse capacity must allow the normal operation of the RC1201-4FE4E1T1 under the maximum power consumption.
Optical power	• Use an optical power meter to measure the SFP optical module and mark its optical power as P1. Compare P1 with the SFP parameters to confirm that SFP optical module is working normally. • Connect fibers at the ODF side to an optical power meter, and mark the measured optical power as P2. If the difference between P2 and P1 is smaller than 1 dB, the optical fiber is connected normally.

7 Appendix

This chapter includes the following sections:

- Compliant standards and protocols
- Terms
- Acronyms and abbreviations

7.1 Compliant standards and protocols

- MEF Technical Specification MEF 6.1Ethernet Services Definitions - Phase 2
- MEF Implementation Agreement, MEF 8 Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet networks
- MEF Technical Specification, MEF 10.1Ethernet Services Attributes - Phase 2
- MEF Technical Specification, MEF 11 User Network Interface (UNI) Requirements and Framework
- MEF Technical Specification, MEF 13 User Network Interface (UNI) Type 1 Implementation Agreement
- MEF Technical Specification, MEF 17 Service OAM Requirements & Framework
- MEF Technical Specification, MEF 20 User Network Interface (UNI) Type 2 Implementation Agreement
- IEEE 802.1D-2004Part 3: Media Access Control (MAC) Bridges
- IEEE 802.1Q-2005 - Standard for Local and Metropolitan Area Networks - Virtual Bridged Local Area Networks
- IEEE 802.1s-2002 - Amendment to 802.1Q Virtual Bridged Local Area Networks: Multiple Spanning Trees
- IEEE 802.3-2005Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications
- IEEE 802.1ag: Virtual Bridged Local Area Networks Amendment 5: Connectivity Fault Management
- IEEE 1588-2008 Standard for a Precision Clock Synchronization Protocol for Network Measurement and Control Systems
- ITU-T Y.1541 Network Performance Objectives For IP-Based Services
- ITU-T Y.1731 OAM Functions and Mechanisms for Ethernet based networks

- ITU-T G 703 Physical/electrical characteristics of hierarchical digital interfaces
- ITU-T G.8031 Ethernet linear protection switching
- ITU-T G.8032 Ethernet ring protection switching
- ITU-T G.8261 Timing and Synchronization Aspects in Packet Networks
- ITU-T G.8262 Timing Characteristics of Synchronous Ethernet Equipment Slave Clock(EEC)
- ITU-T G.823 The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy
- ITU-T G.824 The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy
- ITU-T G.825 The control of jitter and wander within digital networks which are based on synchronous digital hierarchy (SDH)
- RFC1349 Type of Service in the Internet Protocol Suite
- RFC2474 Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers
- RFC2475 An Architecture for Differentiated Services
- RFC2597 Assured Forwarding PHB Group
- RFC2598 An Expedited Forwarding PHB
- RFC2698 A Two Rate Three Color Marker
- RFC3086 Definition of Differentiated Services Per Domain Behaviors and Rules for their Specification
- RFC3140 Per Hop Behavior Identification Codes
- RFC3246 An Expedited Forwarding PHB (Per-Hop Behavior)
- RFC3247 Supplemental Information for the New Definition of the EF PHB (Expedited Forwarding Per-Hop Behavior)
- RFC3248 A Delay Bound alternative revision of RFC 2598
- RFC3260 New Terminology and Clarifications for Diffserv
- RFC3289 Management Information Base for the Differentiated Services Architecture
- RFC3290 An Informal Management Model for Diffserv Routers
- RFC3317 Differentiated Services Quality of Service Policy Information Base
- RFC3985 Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture
- RFC4553 Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP)
- RFC5086 Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN)

7.2 Terms

C

Control word	The control word is a 4-byte TDM service data encapsulation packet header, used for circuit emulation services. The control word is mainly used to indicate a packet sequence number, link faults, shorter encapsulation packet, and encapsulation packet type.

Connectivity Fault Management (CFM)	CFM, defined by ITU-Y.1731 and IEEE802.1ag, is an end-to-end service-level Ethernet OAM technology. This function is used to actively diagnose faults for Ethernet Virtual Connection (EVC), provide cost-effective network maintenance solutions, and improve network maintenance.

J

Jitter buffer	The jitter buffer on the destination can reduce the impact from change of frame delay. It buffers early or late frames. If its capacity is high, buffer will not easily overflow but longer delay is introduced. If its capacity is low, buffer will easily overflow. Its capacity should be set properly.

L

Link aggregation	With link aggregation, multiple physical Ethernet ports are combined to form a logical aggregation group. Multiple physical links in one aggregation group are taken as a logical link. Link aggregation helps share traffic among members in an aggregation group. In addition to effectively improve the reliability on links between devices, link aggregation can help gain higher bandwidth without upgrading hardware.
Link-state tracking	Link-state tracking is used to provide interface linkage scheme for specific application and it can extend range of link backup. By monitoring uplinks and synchronizing downlinks, add uplink and downlink interfaces to a link-state group. Therefore, the fault of the upstream device can be informed to the downstream device to trigger switching. Link-state tracking can be used to prevent traffic loss due to failure in sensing the uplink fault by the downstream device.

M

Mobile Backhaul	It is used to solve communication problems from BTS to BSC for 2G and from NodeB to RNC for 3G. In 2G times, mobile backhaul is realized through TDM microwave or SDH/PDH device since voice services play a primary role and there is no high requirement on the bandwidth. In 3G times, IP services are involved since lots of data services like HSPA and HSPA+ exist, and voice services tend to change to IP services, namely, IP RAN. To solve mobile backhaul problems of IP RAN, you need to establish a backhaul network, which can meet requirements for both data backhaul and voice transmission over IP (clock synchronization).

Q

QinQ	802.1Q in 802.1Q (QinQ), also called Stacked VLAN or Double VLAN, is extended from 802.1Q and defined by IEEE 802.1ad recommendation. This VLAN feature allows the equipment to add a VLAN tag to a tagged packet. The implementation of QinQ is to add a public VLAN tag to a packet with a private VLAN tag, making the packet encapsulated with two layers of VLAN tags. The packet is forwarded over the ISP's backbone network based on the public VLAN tag and the private VLAN tag is transmitted as the data part of the packet. In this way, the QinQ feature enables the transmission of the private VLANs to the peer end transparently. There are two QinQ types: basic QinQ and selective QinQ.

7.3 Acronyms and abbreviations

A

AAL1	ATM Adaptation Layer of type 1
AAL2	ATM Adaptation Layer of type 2
AC	Attachment Circuit
ACH	Associated Channel
ACL	Access Control List
AIS	Alarm Indication Signal
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode

B

BC	Boundary Clock
BER	Bit Error Rate
BSC	Base Station Controller
BTS	Base Transceiver Station

C

CAS	Channel Associated Signaling
CCS	Common Channel Signaling
CE	CONFORMITE EUROPEENNE
CE	Customer Edge
CES	Circuit Emulation Service

CESoPSN	Structure-Aware TDM Circuit Emulation Services over Packet Switch Network
CoS	Class of Service

D

DSCP	Differentiated Services Code Point
DS	Differentiated Services

E

ECID	Emulated Circuit Identifier
EMC	Electromagnetic Compatibility
ES	Errored Second
E-Tree	Ethernet-Tree
ETS	European Telecommunications Standards
ETSI	European Telecommunications Standards Institute

I

IP	Internet Protocol
IPDV	IP Packet Delay Variation
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
IWF	Inter-working Function

L

LACP	Link Aggregation Control Protocol
LB	Loop Back
LOF	Loss of Frame
LOM	Loss of Multiframe
LOP	Loss of Pointer
LOS	Loss of Signal
LSA	Link Status Advertisement

M

MAC	Medium Access Control
MEF	Metro Ethernet Forum
MIB	Management Information Base
MPLS	Multi-Protocol Label Switching

N

NNI	Network to Network Interface
NNM	Network Node Management

O

OAM	Operation, Administration and Maintenance
OOS	Out of Service

P

PDU	Protocol Data Unit
PE	Provider Edge
PSN	Packet Switched Network
PTN	Packet Transport Network
PVC	Permanent Virtual Circuit
PW	Pseudo Wire
PWE3	Pseudo Wire Emulation Edge-to-Edge

Q

QoS	Quality of Service

R

RH	Relative Humidity
RNC	Radio Network Controller
ROS	Raisecom Operating System
RTP	Real-time Transport Protocol

S

SAToP	Structure-Agnostic TDM over Packet

SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
SFP	Small Form-factor Pluggable
SNMP	Simple Network Management Protocol
STM	Synchronous Transport Module

T

TDM	Time Division Multiplex
ToS	Type of Service
TTL	Time to Live
TDMoP	Time Division Multiplex over Packet

U

UAS	Unavailable Seconds
UNI	User Network Interface

V

VPN	Virtual Private Network

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