

# MicroRAPTOR - Hardware Installation Guide

*MICRO* R A P T O R<sup>®</sup>

Intelligent Cyber Secure Platform

iMR350



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**i5 COMMUNICATIONS**  
SERVICES • SUPPORT • SECURITY • SOLUTIONS • SYSTEMS

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# Preface

This guide is intended for use of network technical support skilled persons who are responsible for installation, commissioning, and maintenance of the device.

## Alerts



**WARNING** alerts describe hazardous situations that, if not avoided, may result in serious injury and/or equipment damage.

**CAUTION** alerts describe hazardous situations that, if not avoided, may result in equipment damage.



**DANGER** alerts describe imminently hazardous situations that, if not avoided, will result in death or serious injury.



**NOTES** provide additional information and details.



Temperature hazard – above TS2 limits. To be accessible by Skilled Persons only



Multiple power source – redundant power



Protective earthing conductor



Electrical hazard – above ES2 limits. To be accessible by Skilled Persons only

## Related Documents

- 1) *MicroRAPTOR* Quick Start Guide
- 2) *MicroRAPTOR* WebUI Manuals
- 3) *MicroRAPTOR* CLI User Manuals
- 4) *MicroRAPTOR* Configuration Manuals

## Training

Training is a key for customers to continue maintaining and using their iS5Com's device. Customers can select a standard training course or customized training courses at the iS5Com facility or a customer provided facility. Go to <https://is5com.com/training/> to submit your request for training or contact an iS5Com Sales Representative.

# iSUPPORT



## PHONE SUPPORT

Support can be directed to i55Com's Technical Action Center at <https://is5com.com/isupport/> . You can also call Tech Support: +1 844-475-8324



## SERVICE LEVEL AGREEMENTS

Service Level Agreements can be tailored to suit your needs with our standard Service Level Agreement packages or through customized solutions.



## RETURN MANUFACTURING AUTHORIZATION

Return Manufacturing Authorization is easy and simplified for our customers. Contact the support team at <https://is5com.com/isupport/> or call us to complete and submit your repair or replacement request through our Technical Action Centre.

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# 1. Introduction

MicroRAPTOR® iMR350 is an Intelligent Cyber Secure Platform running the iBiome OS. The iBiome is an all-encompassing operating system that supports switching and routing on a single platform. iMR350 is available with four factory configurable line modules.

iMR350 supports Layer 2 and Layer 3 Switching and offers industry specific features such as IEEE 1588v2 precision timing support.

iMR350 has been specifically designed to protect and secure critical infrastructure and substation applications in the harshest of environments. It is compliant with IEC 61850 Ed. 2, and IEEE 1613 standards.

**Figure 1:** iMR350 product view



## 1.1. Key Features and Benefits of iMR350

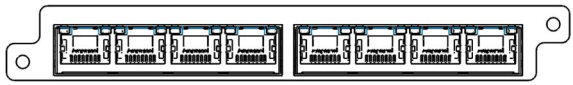
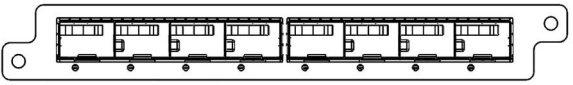
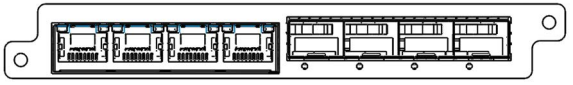
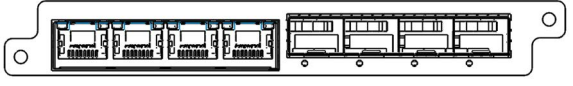

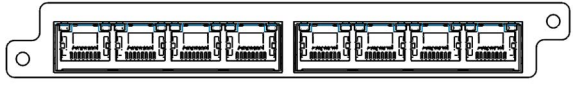
| FEATURES                        | BENEFITS   |
|---------------------------------|--|
| Flexible Compact Layer 3 Switch | The iMR350 supports four factory configurable slots for communications interfaces. Slot options include, 8-port 100Mbps/1Gbps SFP, 8-port 10/100/1000TX RJ45, 4-port 232/422/485 DB9 or 8-port RJ45 serial, 4-port 1/10Gbps SFP. |


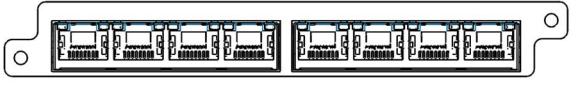
| FEATURES                    |  | BENEFITS  |
|-----------------------------|--|---|
| Simplified GUI- easy to use |  | Allows easy configuration and monitoring with a web-based User Interface; eliminates the need for more complex terminal emulation programs; reduced cost of deployment; one platform—multiple functions |
| Robust industrial design    |  | -40 °C to +85 °C (-40 °F to 185 °F) operating temperature, no fans needed; IP 40  |
| IEEE 1588 Transparent Clock |  | All Ethernet ports on the iMR350 support the IEEE 1588v2 Power Profile for Transparent Clock operation.   |

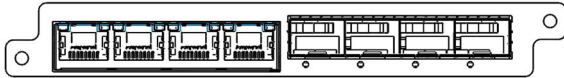
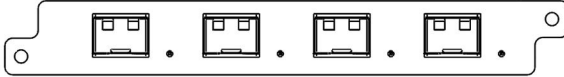
## 2. Factory Configurable Options

### 2.1. Communications Options

Communications line modules are configured on the iMR350 at the factory. They are fixed modules and not customer configurable. A description of the options are below.

| Part #  | Image   | Slots 1-3 Line Modules Description   |
|---------|---|--|
| 8GRJ45  |    | 8 X 10/100/1000Base-T(X) RJ45  |
| 8GSFP   |    | 8 X 100/1000 Mbps SFP Base-X<br>(optical transceivers not included)  |
| 4RJ4SFP |   | 4 X 10/100/1000 Base-T(X) RJ45<br>plus 4 X 100/1000 Mbps SFP Base-X<br>(optical transceivers not included) |
| 2RBX    |  | HSR/PRP with support for 2<br>RedBoxes   |
| 4DB09   |  | 4-ports DB9 Serial   |
| 8SRJ45  |  | 8-port RS232/422/485 serial, RJ45<br>interface   |

| Part # | Image   | Slot 4 Line Modules Description                |
|--------|---|--|
| 4DB09  |  | 4-ports DB9 Serial                             |
| 8SRJ45 |  | 8-port RS232/422/485 serial, RJ45<br>interface |

| Part # | Image   | Slot 4 Line Modules Description                                  |
|--------|---|--|
| 2RBX   |  | HSR/PRP with support for 2 RedBoxes or 1 QuadBox                 |
| 4TGSFP |  | 4-ports 10Gbps Base-X SFP blank slots, transceivers not included |

## 2.2. Notes for 2RBX Option

iRM-2RBX - Support for 2 RedBoxes or 1 QuadBox (supported in slots 1-4)

The numbering convention for the different RedBoxes in the different line module slots are as follows:

**Table 1:** Naming Convention for RedBoxes

| Redundant Switch | LM1   | LM2   | LM3   | LM4   |
|------------------|-------|-------|-------|-------|
| First            | Red 1 | Red 3 | Red 5 | Red 7 |
| Second           | Red 2 | Red 4 | Red 6 | Red 8 |

By default, both redundant switches of the HSR-PRP line card are connected to the main switch through the I-port. However, there may be cases when only one or no redundant switch is required. For these cases it is possible to disable redundancy on a redundant interface so that two Ethernet ports can be used instead, thereby by-passing the redundant switch.

Only half of the possible line card ports are routed to the HSR-PRP line card. It is therefore only possible to get four Ethernet ports to the connectors (or two 1G Ethernet ports in the case of LM4 as HSR-PRP line card does not support 10G). The following port combinations can be achieved for the four different slots:

**Table 2:** LM1 Line Card port description (Sheet 1 of 2)

| LM1 Line Card    | HSR-PRP |         |         |         | 8GRJ45 |
|------------------|---------|---------|---------|---------|--------|
| Red 1 Redundancy | Enable  | Enable  | Disable | Disable | -      |
| Red 2 Redundancy | Enable  | Disable | Enable  | Disable | -      |
| Port 1           | Red 1A  | Red 1A  | Gi 0/1  | Gi 0/1  | Gi 0/1 |
| Port 2           | Red 1B  | Red 1B  | Gi 0/2  | Gi 0/2  | Gi 0/2 |
| Port 3           | Red 2A  | Gi 0/3  | Red 2A  | Gi 0/3  | Gi 0/3 |

**Table 2:** LM1 Line Card port description (Continued) (Sheet 2 of 2)

| LM1 Line Card | HSR-PRP |        |        |        | 8GRJ45 |
|---------------|---------|--------|--------|--------|--------|
| Port 4        | Red 2B  | Gi 0/4 | Red 2B | Gi 0/4 | Gi 0/4 |
| Port 5        | -       | -      | -      | -      | Gi 0/5 |
| Port 6        | -       | -      | -      | -      | Gi 0/6 |
| Port 7        | -       | -      | -      | -      | Gi 0/7 |
| Port 8        | -       | -      | -      | -      | Gi 0/8 |

**Table 3:** LM2 Line Card port description

| LM2 Line Card    | HSR-PRP |         |         |         | 8GRJ45 |
|------------------|---------|---------|---------|---------|--------|
| Red 3 Redundancy | Enable  | Enable  | Disable | Disable | -      |
| Red 4 Redundancy | Enable  | Disable | Enable  | Disable | -      |
| Port 1           | Red 3A  | Red 3A  | Gi 0/1  | Gi 0/1  | Gi 0/1 |
| Port 2           | Red 3B  | Red 3B  | Gi 0/2  | Gi 0/2  | Gi 0/2 |
| Port 3           | Red 4A  | Gi 0/3  | Red 4A  | Gi 0/3  | Gi 0/3 |
| Port 4           | Red 4B  | Gi 0/4  | Red 4B  | Gi 0/4  | Gi 0/4 |
| Port 5           | -       | -       | -       | -       | Gi 0/5 |
| Port 6           | -       | -       | -       | -       | Gi 0/6 |
| Port 7           | -       | -       | -       | -       | Gi 0/7 |
| Port 8           | -       | -       | -       | -       | Gi 0/8 |

**Table 4:** LM3 Line Card port description (Sheet 1 of 2)

| LM3 Line Card    | HSR-PRP |         |         |         | 8GRJ45 |
|------------------|---------|---------|---------|---------|--------|
| Red 5 Redundancy | Enable  | Enable  | Disable | Disable | -      |
| Red 6 Redundancy | Enable  | Disable | Enable  | Disable | -      |
| Port 1           | Red 5A  | Red 5A  | Gi 0/1  | Gi 0/1  | Gi 0/1 |
| Port 2           | Red 5B  | Red 5B  | Gi 0/2  | Gi 0/2  | Gi 0/2 |

**Table 4:** LM3 Line Card port description (Continued) (Sheet 2 of 2)

| LM3 Line Card | HSR-PRP |        |        |        | 8GRJ45 |
|---------------|---------|--------|--------|--------|--------|
| Port 3        | Red 6A  | Gi 0/3 | Red 6A | Gi 0/3 | Gi 0/3 |
| Port 4        | Red 6B  | Gi 0/4 | Red 6B | Gi 0/4 | Gi 0/4 |
| Port 5        | -       | -      | -      | -      | Gi 0/5 |
| Port 6        | -       | -      | -      | -      | Gi 0/6 |
| Port 7        | -       | -      | -      | -      | Gi 0/7 |
| Port 8        | -       | -      | -      | -      | Gi 0/8 |

**Table 5:** LM4 Line Card port description

| LM3 Line Card    | HSR-PRP |             |         |             | 4TGSFP |
|------------------|---------|-------------|---------|-------------|--------|
| Red 7 Redundancy | Enable  | Enable      | Disable | Disable     | -      |
| Red 8 Redundancy | Enable  | Disable     | Enable  | Disable     | -      |
| Port 1           | Red 7A  | Red 7A      | Ex 0/1  | Ex 0/1 (1G) | Ex 0/1 |
| Port 2           | Red 7B  | Red 7B      | -       | -           | Ex 0/2 |
| Port 3           | Red 8A  | Ex 0/3 (1G) | Red 8A  | Ex 0/3 (1G) | Ex 0/3 |
| Port 4           | Red 8B  | -           | Red 8B  | -           | Ex 0/4 |

The HSR-PRP line card has four combo ports consisting of four RJ45 and four SFP interfaces.

Each combo port has one RJ45 and one SFP interface. If an SFP module is detected, the SFP interface is the active combo port interface. If there is no SFP module inserted then the RJ45 interface remains active.

The IEC 62439-3 HSR-PRP standard also requires that Port-A is to the left of Port-B (Raptor) (or above in the case of MicroRaptor). With the line card being flipped up-side-down between odd and even slots the

HSR-PRP line card could have either four RJ45 interfaces followed by four SFP slots or the other way round. To locate the correct interface, information can be obtained through the front-panel LCD:



- RJ45 or SFP link up (Red 5A and Red 8A)
- RJ45 or SFP link down (Red 5B and Gi 0/19)
- SFP can be inserted as RJ45 is being used (Gi 0/20, Ex 0/1)
- Port unavailable (RJ45 port when SFP is detected (Gi 0/19, Red 8A) or no connection possible (Ex 0/2))

The CLI provides a redundancy map to indicate the active ports on the HSR/PRP module as well:

```
iS5comm# show interfaces redundant map

LM3
----
Redundancy switches:
  Red 5 - Enabled - I-port connected to Gi0/17
  Red 6 - By-passed
External connections:
Position:      1      2      3      4      5      6      7      8
Connector:    | SFP  | SFP  | SFP  | SFP  | RJ45 | RJ45 | RJ45 | RJ45 |
SFP Detected: | NO   | NO   | YES  | NO   | -    | -    | -    | -    |
Port:         | X    | X    | Gi0/19 | X    | Red-5A | Red-5B | X    | Gi0/20

LM4
----
Redundancy switches:
  Red 7 - By-passed
  Red 8 - Enabled - I-port connected to Ex0/3
External connections:
Position:      1      2      3      4      5      6      7      8
Connector:    | RJ45 | RJ45 | RJ45 | RJ45 | SFP  | SFP  | SFP  | SFP  |
SFP Detected: | -    | -    | -    | -    | NO   | NO   | YES  | YES  |
Port:         | Ex0/1 | X    | X    | X    | X    | X    | Red-8A | Red-8B

iS5comm#
```

## 2.3. Power Supply Options

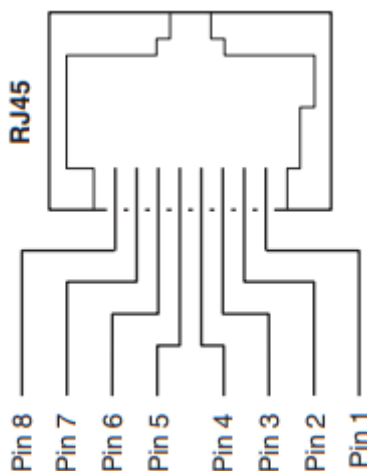
Power supply options are factory configured and not customer changeable. The iMR350 may be equipped with a redundant power supplies.

| Part # | Description              | Nominal Range/ Operating Range  |
|--------|--------------------------|---|
| LV     | Low Voltage Power Module | 24 VDC Nominal <ul style="list-style-type: none"> <li>10-36 VDC Operational</li> <li>50W</li> </ul> |

| Part # | Description                 | Nominal Range/ Operating Range  |
|--------|-----------------------------|---|
| MV     | Medium Voltage Power Module | 48 VDC Nominal <ul style="list-style-type: none"> <li>• 36-72VDC Operational</li> <li>• 50W</li> </ul>  |
| HV     | High Voltage Power Module   | 100-240 VAC Nominal <ul style="list-style-type: none"> <li>• 50/60 Hz</li> <li>• 85-264 VAC Operational</li> <li>• 50W</li> </ul> 100-240VDC Nominal <ul style="list-style-type: none"> <li>• 88-300 VDC Operational</li> <li>• 50VA</li> </ul> |

## 2.4. Serial Interface Pinouts for 4DB09 and 8SRJ45

**Figure 1:** 8SRJ45 - RJ45 Serial Pin Assignment



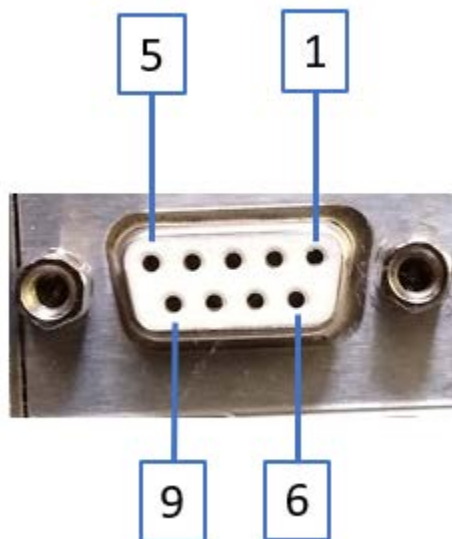
**Table 6:** 8SRJ45 - Serial RJ45 Port Pin Configuration (Sheet 1 of 2)

| RJ45 Pin | RS232 Mode | RS485-half mode | RS422/485 full mode |
|----------|------------|-----------------|---------------------|
| 1        |            |                 |                     |
| 2        |            |                 |                     |
| 3        | GND        | GND             | GND                 |
| 4        | GND        | GND             | GND                 |
| 5        | RX         |                 | RX+                 |
| 6        | TX         | TX+/RX+         | TX+                 |



**Table 6:** 8SRJ45 - Serial RJ45 Port Pin Configuration (Continued) (Sheet 2 of 2)

| RJ45 Pin | RS232 Mode | RS485-half mode | RS422/485 full mode |
|----------|------------|-----------------|---------------------|
| 7        | CTS        |                 | RX-                 |
| 8        | RTS        | TX-/RX-         | TX-                 |

**Figure 2:** 4DB09 - DB9 Serial Pin Assignment**Table 7:** 4DB09 - Serial DB9 Port Pin Configuration

| DB9 Pin | RS232 Mode | RS485-half mode | RS422/485 full mode |
|---------|------------|-----------------|---------------------|
| 1       |            |                 |                     |
| 2       | RX         |                 | RX+                 |
| 3       | TX         | TX+/RX+         | TX+                 |
| 4       |            |                 |                     |
| 5       | GND        | GND             | GND                 |
| 6       | GND        | GND             | GND                 |
| 7       | RTS        | TX-/RX-         | TX-                 |
| 8       | CTS        |                 | RX-                 |
| 9       | GND        | GND             | GND                 |

## 3. Chassis

The terminal blocks and LCD screen on the iMR350 are on different sides of the iMR350. From the factory the iMR350 may be configured such that the LCD display is next to the management ports and the terminal blocks are beside the communication/Ethernet ports. This is shown in

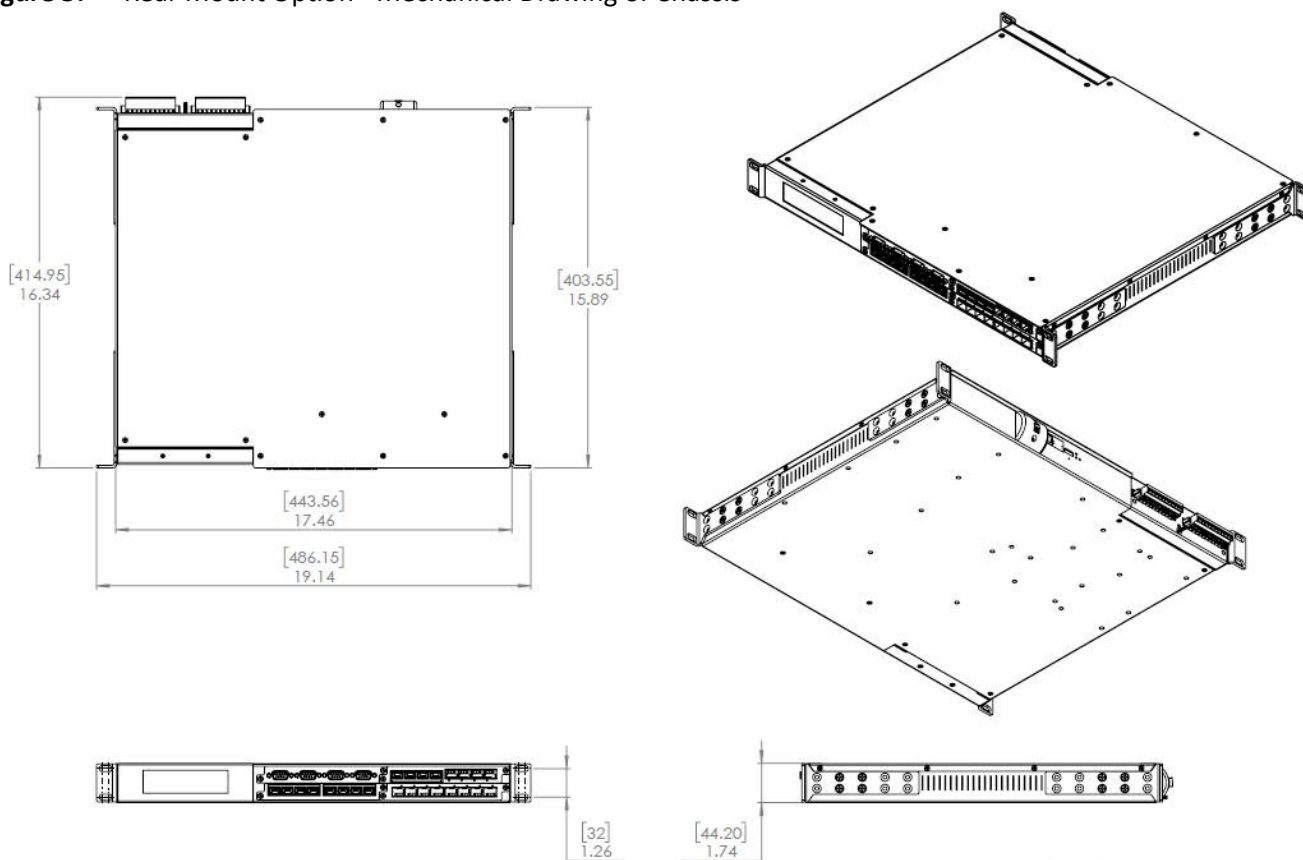
**Figure 1:** Front Mount Option - LCD and Console Port View



**Figure 2:** Front Mount - Terminal Block and Ethernet Ports View

**Figure 3:** Rear Mount - LCD Display and Ethernet Ports View

**Figure 4:** Rear Mount - Console Management Port and Terminal Blocks View

**Figure 5:** Rear Mount Option - Mechanical Drawing of Chassis







**NOTE:** All dimensions are shown in inches (millimeters).

## 4. iMR350 Panels Description

This section contains views of the front and back panels of the iMR350 with both front and rear mounting options. The locations of the power modules, interface module slots, and status indicators are shown.

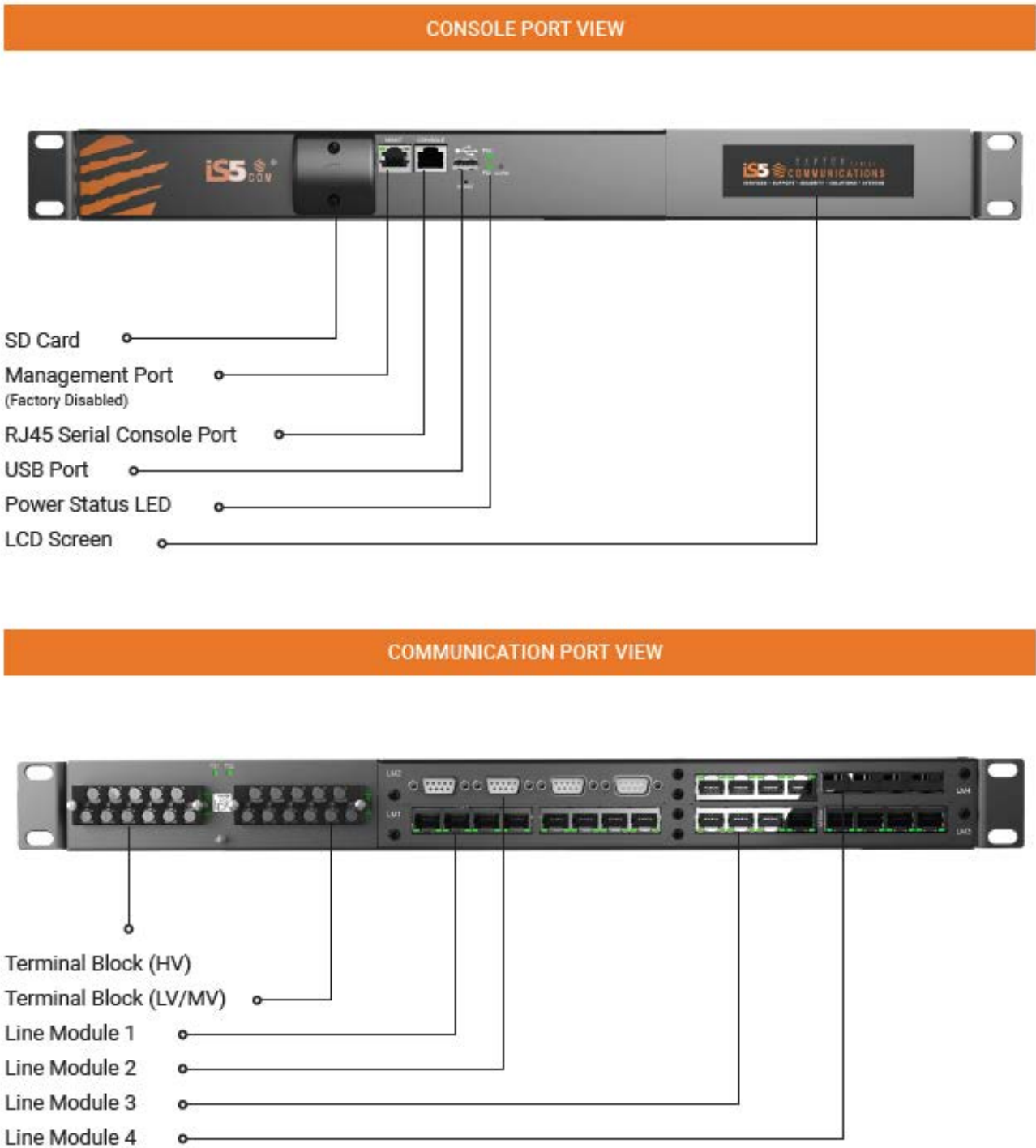
The product label is located at the bottom of the unit.

**Figure 1:** Product Label

|  |  |  |
|--|--|--|
| <br><b>SERVICES • SUPPORT • SECURITY • SOLUTIONS • SYSTEMS</b>  | 5895 Ambler Drive<br>Mississauga, Ontario<br>Canada, L4W 5B7<br><a href="http://www.iS5Com.com">www.iS5Com.com</a> | <br>with domestic and<br>imported parts |
| <b>Model Number</b><br><div>iMR350-HV-HV-X-R-W-8GRJ45-8GSFP-8GRJ45-4TGSFP</div>  |  |  |
| <b>MAC Address</b><br><div>E8E875908701</div>  | <b>Date Manufactured</b><br><div>12/14/2021</div>  |  |
| <b>Serial Number</b><br><div>ENG-ALPHA-022</div>   | <b>Firmware</b><br><div>Ver. 1.10.04</div>   |  |
| <p>This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference. Operation is subject to the following two conditions:<br/>(1) this device may not cause harmful interference, and<br/>(2) this device must accept any interference received, including interference that may cause undesired operation.</p> |  |  |
|      |  |  |

# 4.1. Front Mount Views

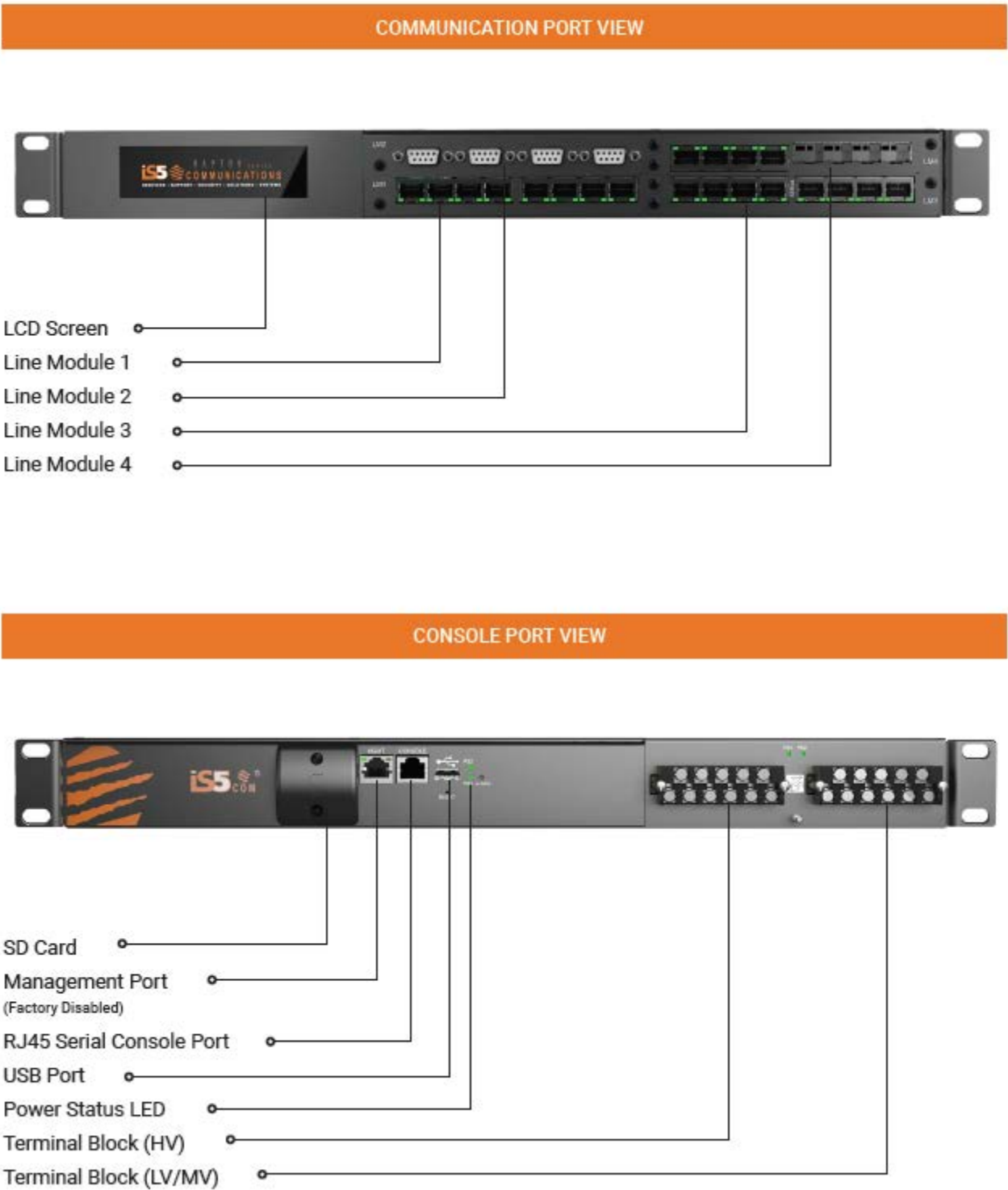
Figure 2: Front Views and their Elements





## 4.2. Rear Mount Views

Figure 3: Rear Views and their Elements



- 1) **Power Status LED**—the light-emitting diode (LED) indicates the status of the power supply modules.
- 2) **Alarm Status LED**—the light-emitting diode (LED) indicates the status of alarms on the iMR350.
- 3) **Factory Reset Button**—this button is used to reset the iMR350. Depressing it for 2 seconds will reboot the iMR350. Depressing the button for 10 seconds will start a reboot and give the opportunity for a user at the console to perform a factory reset. If there is no user intervention at the console after the factory reset button has been held for 10 seconds, the iMR350 will simply reboot.
- 4) **USB Port** can be used to upgrade or back up the *MicroRAPTOR*'s software or configuration files.
- 5) **SD Card** port may be used to store Syslog files.
- 6) **RJ45 Serial Console Port**—this port is for interfacing directly with the device and accessing management functions via serial interface.
- 7) **Slots 1-4**- These slots support Ethernet and Serial Communication line modules.
- 8) **LCD Display**- This display provides the status of communication ports.

### 4.3. LED Indicators Summary

| TYPE    | DESCRIPTION         | Description   |
|---------|---------------------|---|
| PWR     | Power Status LED    | Green: OK; No light: No power   |
| Alarm   | Alarm Indicator LED | Indicates when an alarm condition exists; Red: Alarm is on, No light means no active alarm. |
| Console | LEDs                | Not operational   |

All port status LEDs are as shown on LED display (see below).

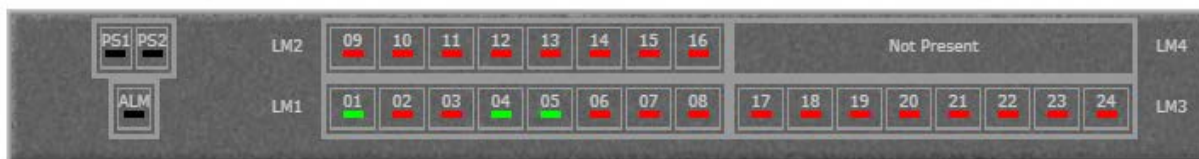
**Figure 4:** iMR350 LED Display



## 4.4. Port Mapping

[Figure 5](#) shows how the ports are numbered on the *MicroRAPTOR*. This graphic was taken from the *MicroRAPTOR* web user interface and is visible on most pages.

**Figure 5:** Port layout on the MicroRAPTOR iMR350



## 5. Mounting and Installing the iMR350

The iMR350 is designed for maximum mounting and display flexibility. It can be equipped with brackets that allow installation in a 48 cm (19 in) rack.

### 5.1. Prevention of Electrostatic Discharge Damage

The device components are prone to electrostatic discharge (ESD) damage. ESD damage, which can cause intermittent or complete component failures, can occur by voltages as low as 30 V. Potentially destructive static voltages can happen during handling of plastic or foam packing material or when moving components across plastic or carpets.

Some guidelines to minimize the potential for ESD damage are:

- Always use an ESD wrist strap when you are working with components that are subject to ESD damage, and make sure that ESD wrist strap is in direct contact with your skin.
- If a grounding strap is not available, then to ground yourself, touch the exposed bare metal of the device with the other hand immediately before inserting the component into the device.



To ensure protection by the ESD strap, periodically check its resistance value.

The measured value must be in the range between 1 and 10 MΩ.

- When handling any component that is subject to ESD damage and is to be removed from the device, make sure the equipment end of your ESD wrist strap is attached to the ESD point on the chassis.
- Avoid contact between the component that is subject to ESD damage and clothing. ESD voltages emitted from fabric can damage components.
- When removing or installing a component that is subject to ESD damage, always place its components upside on an antistatic surface, in an antistatic card rack, or in an antistatic bag. If you are returning a component, place it in an antistatic bag before packing it.

### 5.2. Before Rack Installation

- Ensure that you understand how to prevent ESD damage.
- Place the rack in its permanent location, allowing adequate clearance for airflow and maintenance, and secure it to the structure.
- Remove the switch from the shipping package.
- Ensure that you have all necessary parts and tools needed to mount the switch on the rack.



Do not plan to use the device in a location where children are likely to be present.

## 5.3. Unpacking Device

- Inspect the package for damage before opening.
- Open the package and visually inspect all items for issues.
- Confirm that all items are available.



If there any missing or damaged items, contact iS5Com Support.

## 5.4. Prerequisites for Mounting Device on a Rack



Heat generated by the device is channeled outwards from the enclosure. For improved convectional airflow, make sure that there is at least one rack-unit of space or 44 mm (1.75 in) of space around all sides of the device or between the devices on the rack.

Forced airflow is not required. However, any increase in airflow will result in a reduction of ambient temperature and improve the long term reliability of the equipment mounted in the rack space.

## 5.5. General Procedure for Installing and Starting iMR350

- Review the Compliance Specification for any regulatory requirements.
- Check the equipment ratings, operating instructions and installation instructions before commissioning or maintenance.
- Mount the device.
- Connect the failsafe alarm relay.
- Connect power to the device and ground the device.
- Connect the device to the network.
- Configure the device.



This equipment is intended only for use in a restricted access area.



Caution: Access to Battery located inside the unit is prohibited.

**CAUTION:** Users are prohibited from accessing the battery. The switch is to be returned to the factory for proper disposition.

## 5.6. Electrical / Mechanical Hazards Prevention

- When installing the device in a closed or multi-device rack, be aware that the operating ambient temperature of the rack may be higher than the ambient temperature of the room. Make sure the rack is installed in a suitable environment that can withstand the maximum ambient temperature generated by the rack.
- Do not exceed the maximum number of devices or weight restrictions specified by the rack manufacturer.
- Do not overload the supply circuit. Refer to the overcurrent protection and power supply ratings specified by the rack manufacturer.
- Make sure the rack and all devices have a proper ground-to-Earth connection. Pay particular attention to power supply connections other than direct connections to the branch circuit (e.g. power strips). Ensure that the rack mount adapters are installed on the correct side of the chassis.
- The user shall be responsible for ensuring the integrity of any protective conductor connections before carrying out any other actions.



**Electrocution hazard – risk of death, serious personal injury and/or damage to the device.**



**Caution – Access to wiring terminals and replaceable modules is restricted to Skilled Persons only.**

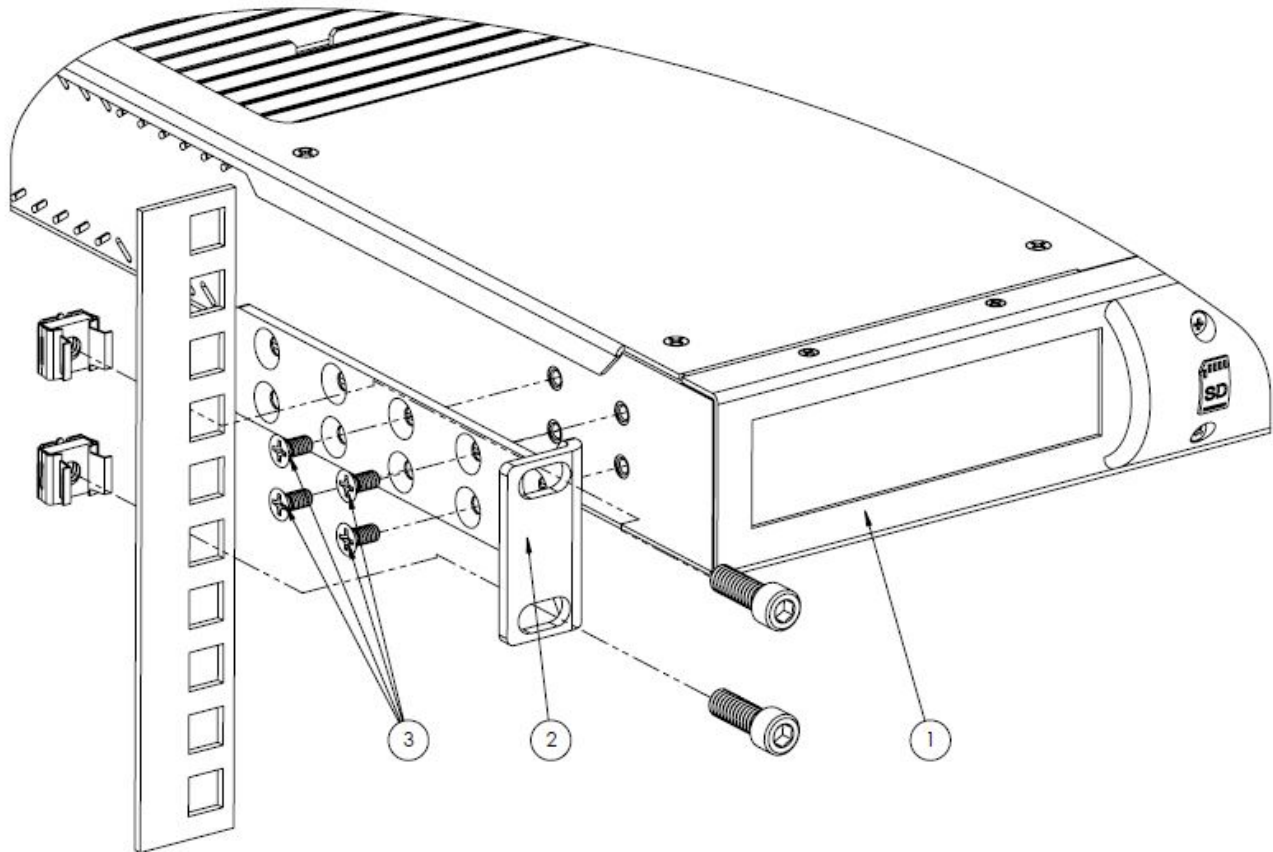
## 5.7. Humidity and Dust Hazards

Do not store the switch in locations where it will be subject excessive dirt and dust and high humidity. Conformal coating is recommended for humid / moist applications.

## 5.8. Mounting iMR350 on a Rack

Ensure that the rack mount brackets are installed on the correct side of the chassis.



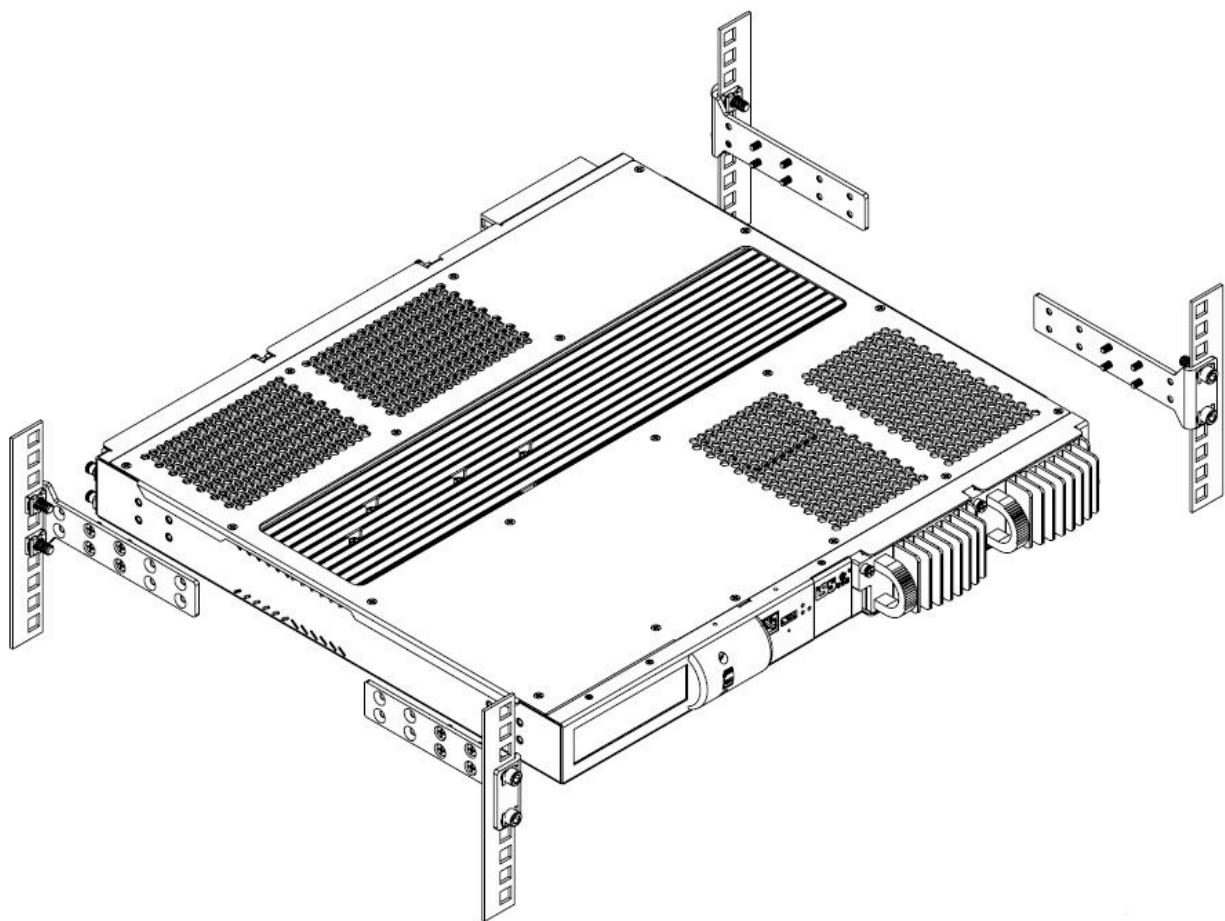
**Figure 1:** Mounting Raptor on a Rack**Legend**

- 1) iMR350 Unit
- 2) Mounting Bracket
- 3) Mounting Screws

To secure the device to a standard 48 cm (19 in) rack, perform the following:

- 1) Install the mounting brackets to the iMR350 using 4 x M4 x 0.7 screws on each side (screws will be provided with the switch). Use minimum of 2 brackets (4 brackets are included). Brackets are to be adjusted based on rack dimensions.
- 2) Place the switch in the rack by tilting the switch at an angle so that the ears will clear the mounting rails. Mount it on the rack using rack screws at the front and rear brackets.

**Figure 2:** Mounting iMR350 on a Rack



**5.9. Equipment Needed for iMR350’s Installation**

| PART # | QTY              | DESCRIPTION              |
|--------|------------------|--------------------------|
| 1      | 16 (included)    | Mounting screw M 4 x 0.7 |
| 2      | 4 (included)     | Mounting bracket         |
| 3      | 1 (not included) | Screwdriver              |

**5.10. Panel Mounting the iMR350**

A panel mount kit may be ordered, as part of the system or separately, that will permit the user to attach four (4) panel mount brackets to the *MicroRAPTOR*. The *MicroRAPTOR* may then be mounted to a flat panel.

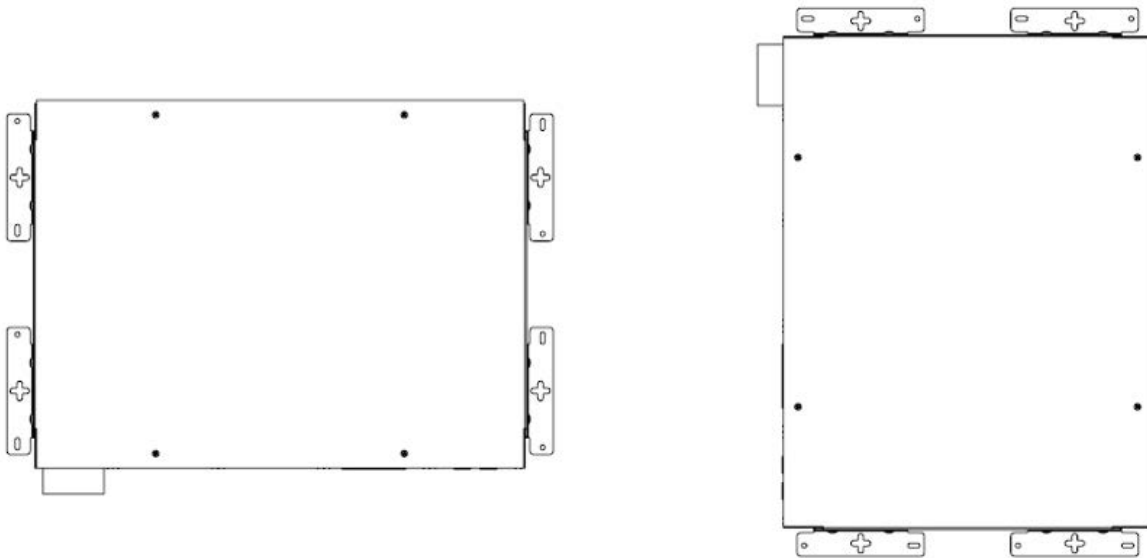


| PART #    | QTY | DESCRIPTION   |
|-----------|-----|---|
| 1900-0032 | 1   | Panel Mount Bracket Kit for the iMX350/iMX950/iMR350.<br>The Panel Mount Kit includes the following:<br>4x Mounting Brackets<br>8x Screws |

## 5.11. Mounting Orientation of Panel Mount

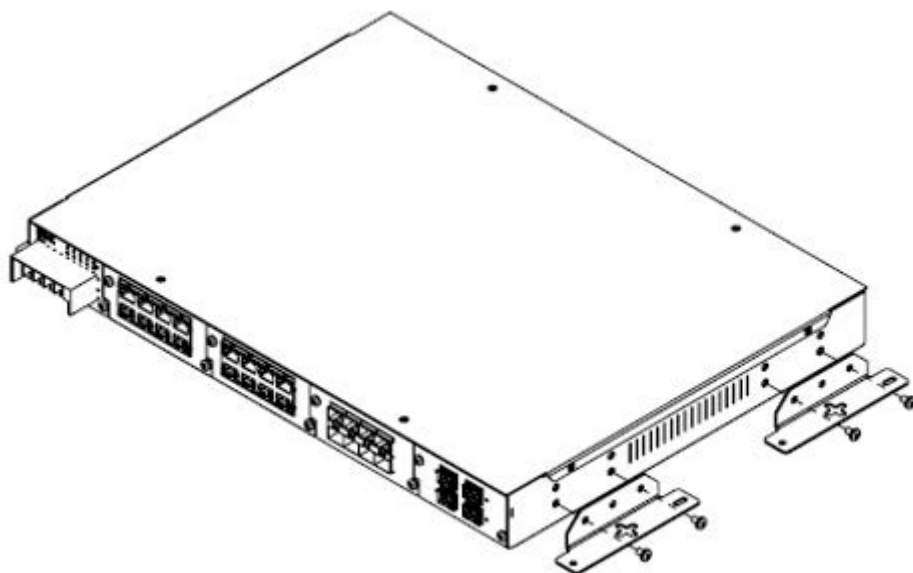
The switch may be mounted with the line modules facing up or down, or the line modules facing either left or right.

Four brackets are needed to secure the switch, with each bracket requiring two screws to secure it to the switch.



**Figure 3:** Mounting orientation

The following illustration provides an example of how the brackets are affixed to the switch.



**Figure 4:** Securing brackets to the switch. Two of the four brackets are shown.

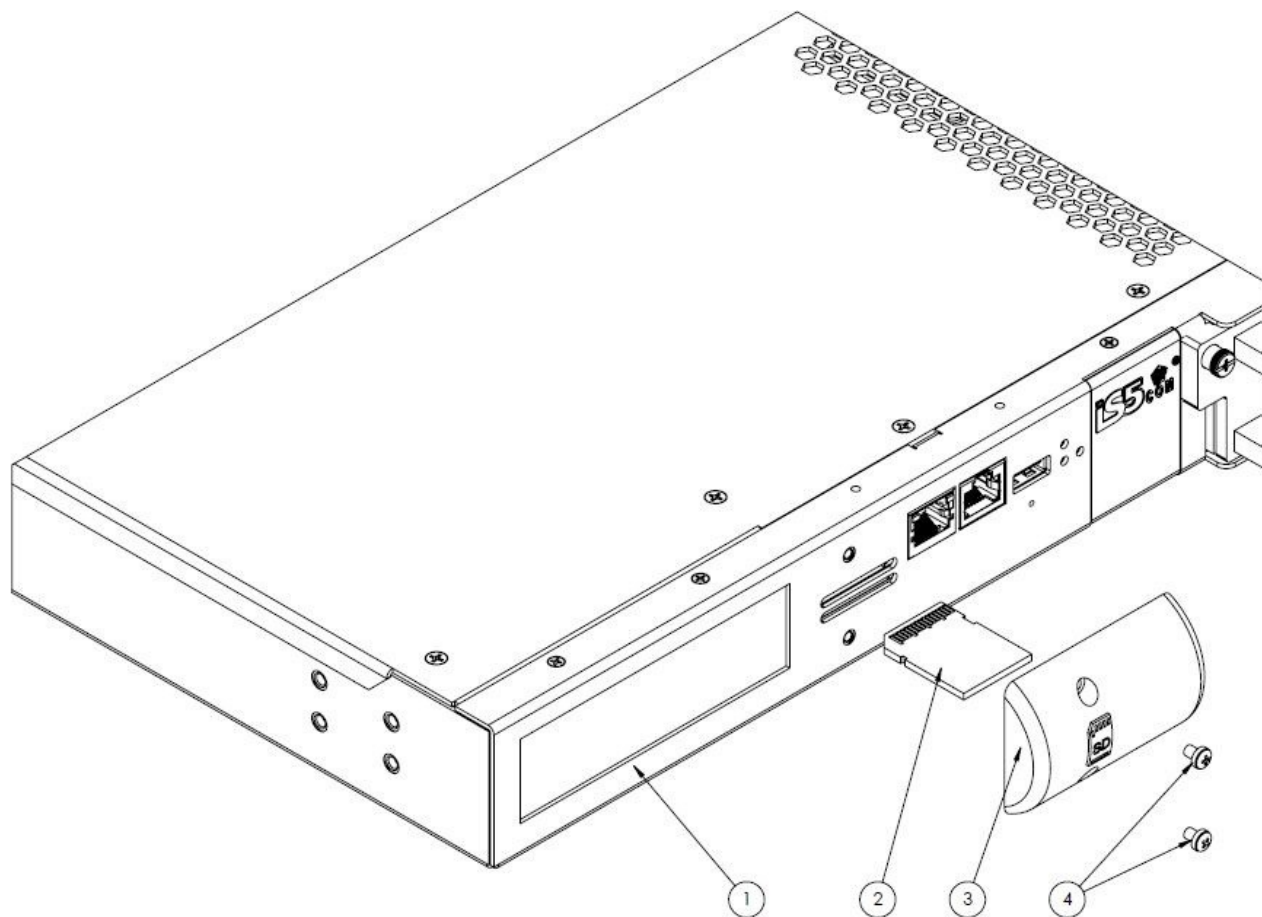
## 6. SD Card Insertion and Removal

The iMR350 has an SD Card slot. SD Cards on the iMR350 are used to save syslog files. This section documents how the SD Card is inserted and removed from the device.

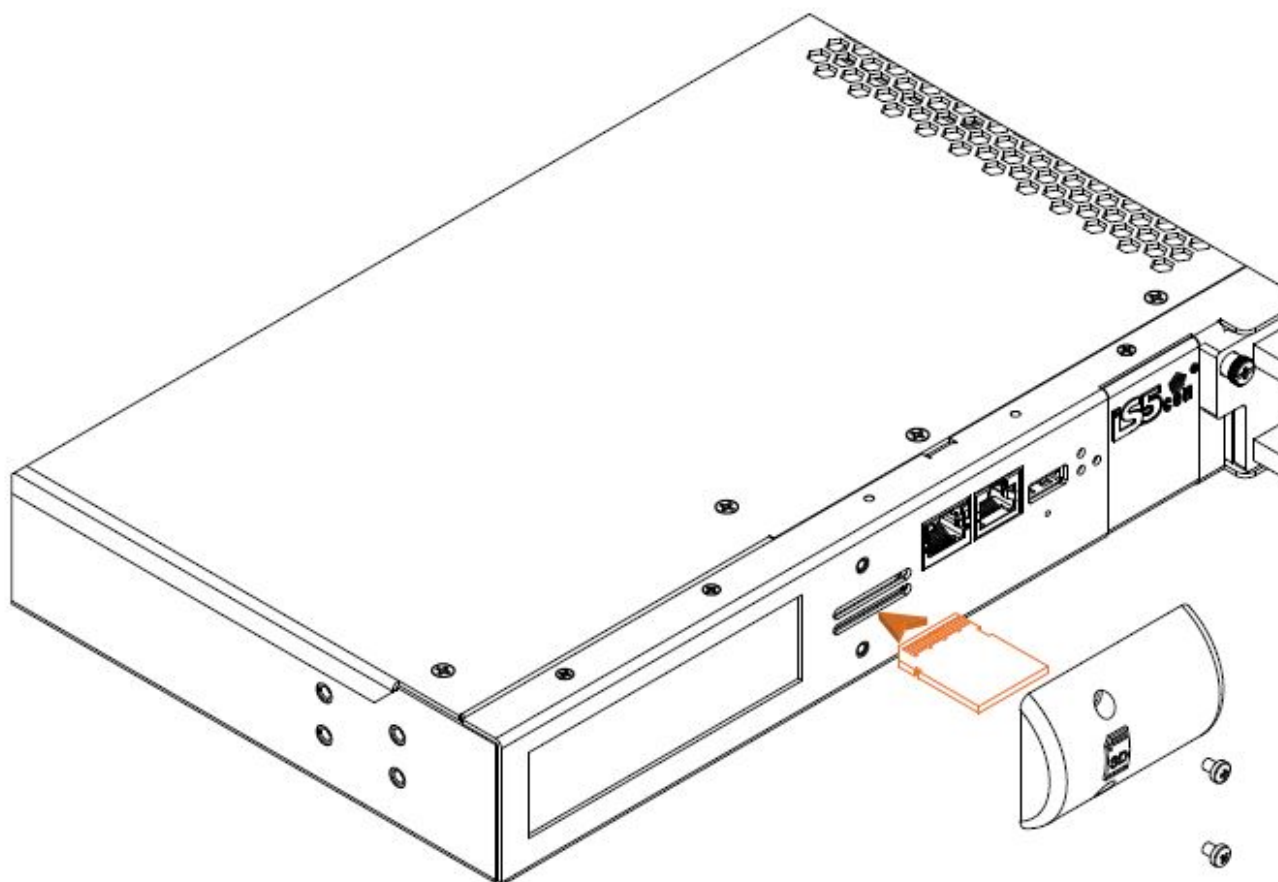
### 6.1. Inserting SD Card in SD Slot

**CONTEXT:** This section describes how to insert the SD Card into the RAPTOR.

**Figure 1:** Inserting SD Card in SD Slot



- 1) iMR350 Unit
- 2) SD Card
- 3) SD Card Cover
- 4) Mounting Screws

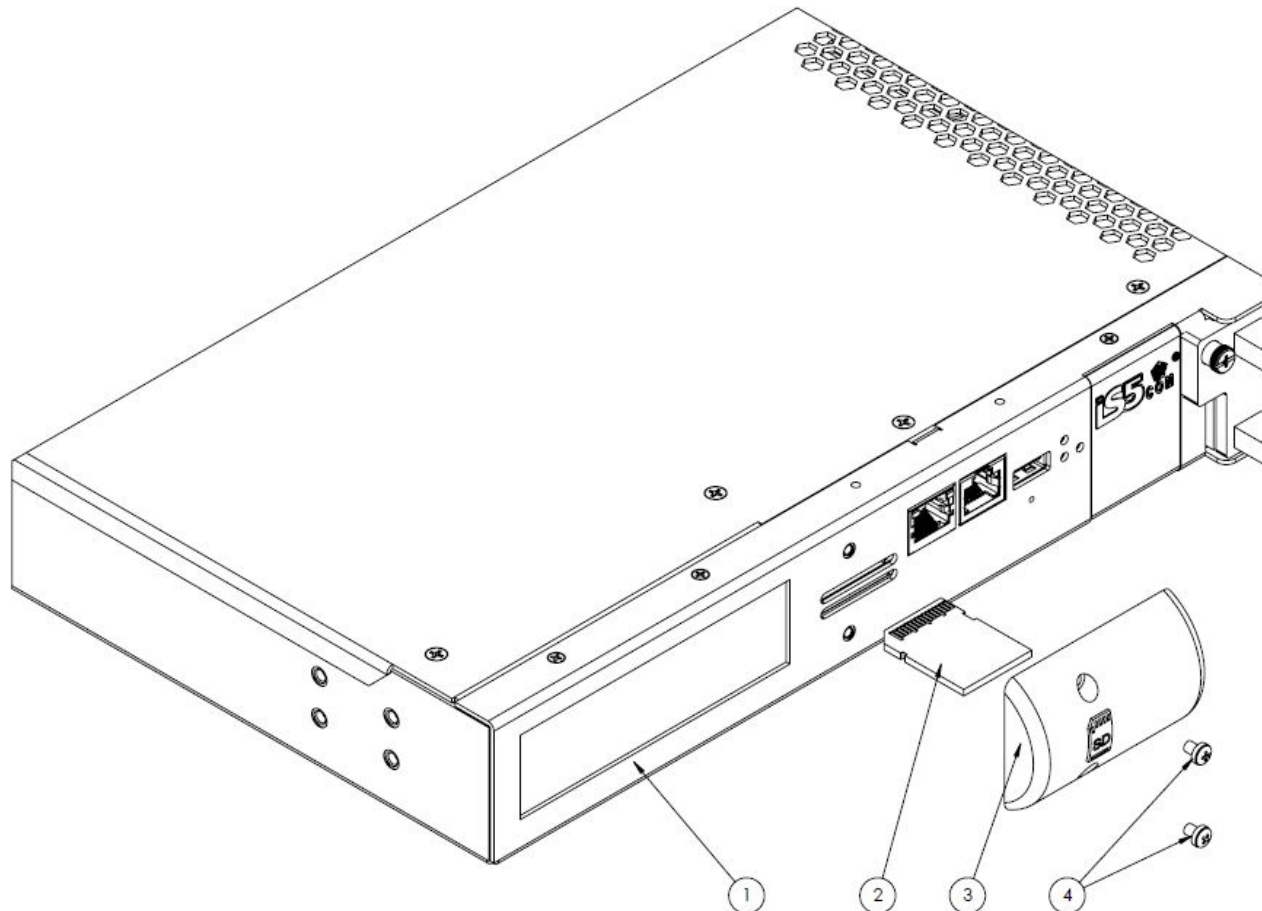


1. Uninstall the SD card cover by removing the screws.
2. Insert the SD card as shown into Slot 2 until a click is heard.

## 6.2. Removing SD Card

CONTEXT: This section describes how to remove the SD Card from the RAPTOR.

**Figure 2:** Removing SD Card



1. Uninstall the SD card cover by removing the screws.
2. Remove the SD card from the slot.

## 7. Electrical Wiring

The iMR350 has two terminal blocks. One serves to connect the HV power supplies, the other supports the LV, and MV options. This section documents how to safely connect a power source to the iMR350.

CONTEXT:



**Electrocution hazard – risk of death, serious personal injury and/or damage to the device.**



**Electrical hazard – risk of damage to equipment. Do not connect AC power cables to a 24 or 48 power supply terminal block. Damage to the power supply may occur.**

**Caution – Access to wiring terminals and replaceable modules is restricted to Skilled Person only.**



**Multiple power source – redundant power. Disconnect all power sources.**



**Different power sources shall be used to achieve the redundancy of power supplies.**

### 7.1. Power Inputs and Fault Relay

The relay contact of the terminal block connector is used to detect user-configured events. The switch provides fail open and fail close contacts to form relay circuits based on requirements. If the device is not powered, or if an active alarm is present, the relay de-energizes, therefore initiating the NO and NC states. The contacts are energized upon power up of the unit and remain energized unless a critical error occurs. One common application for this output is to raise an alarm if a power failure or removal of control power occurs.

### 7.2. Connecting AC Power for Lug Terminal Blocks

PREREQUISITE:

All equipment must be installed according to applicable local wiring codes and standards.

Always use cables that are rated for the operating ambient temperature of 85°C.

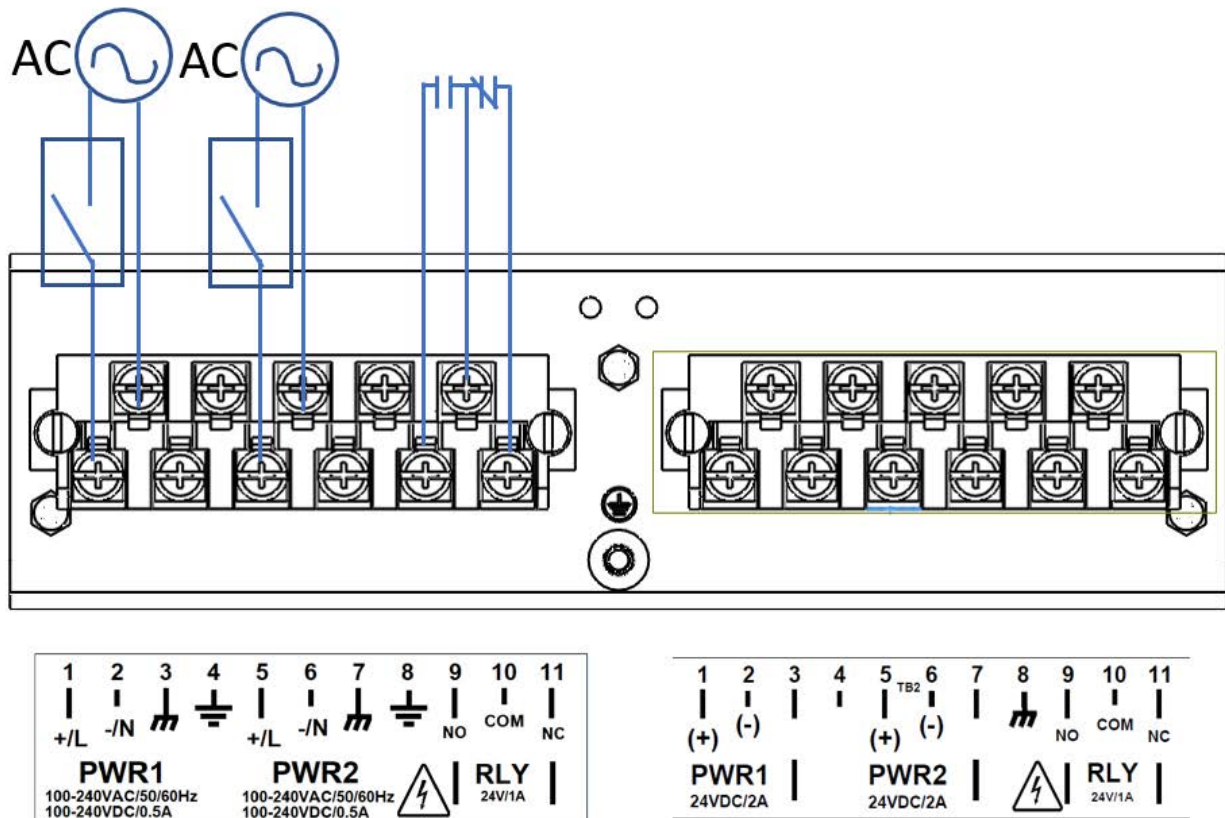
For 100-240 VAC rated equipment, protection for earth fault is provided by max. 20 A branch circuit from AC input in building installation. The protection in the building installation is relied upon for short-circuit backup protection.

- The specification for AC breaker is 5 A, 2P, 277 VAC (min) Circuit breaker, Thermomagnetic or equivalent type.
- The plug connector and wire gauge sizing is to be selected with appropriate design as per the Electrical code for a 60W, 1-phase device.

Note for IT power distribution systems:

- 1) This product is also designed for IT power distribution system with phase-to-phase voltage 230 V.
- 2) This equipment must be connected to an earthed mains socket-outlet.

**Figure 1:** AC Wiring Diagram



L—stands for Live      N—stands for Neutral

NO—Normally Open (open = open circuit = not creating a path for the current)

NC—Normally Closed (closed = short circuit = creating a path for the current)

PE—Protective Earth (earth Ground point in the electrical circuit)



To establish AC power connection with the power source turned off, follow the steps below. When following the instructions, refer to [AC Wiring Diagram](#).

1. Remove the transparent plastic finger safe cover from the face of the terminal block.

If an AC power supply has been installed in PS1, perform steps 2 through 4 on the left hand terminal block. Please note that if there are no DC power supplies installed on the iMR350 then the right hand terminal block will not be populated.

2. Connect the ground from the first power source to GND1 terminal screw (pin 4).
3. Connect the Live from the first power source to the PWR1 +/L terminal screw (pin 1).
4. Connect the Neutral from the first power source to the PWR1 -/N terminal screw (pin 2).

If an AC power supply has been installed in PS2, perform steps 5 through 7.

5. Connect the ground from the second power source to GND2 terminal screw (pin 8).
6. Connect the Live from the first power source to the PWR2 +/L terminal screw (pin 5).
7. Connect the Neutral from the first power source to the PWR2 -/N terminal screw (pin 6).

To keep the wires from pulling loose, use a small flat-blade screwdriver to tighten the wire-clamp screws on the front of the terminal block connector.

8. After wiring is completed, reinsert the transparent plastic finger safe cover back onto the face of the terminal block.
9. Connect pin 3 to the ground of the chassis if Power Supply 1 is in use.
10. Connect pin 7 to the ground of the chassis if Power Supply 2 is in use.

## 7.3. Connecting AC Power for Wire Terminal Blocks

### PREREQUISITE:

All equipment must be installed according to applicable local wiring codes and standards.

Always use cables that are rated for the operating ambient temperature of 85°C.

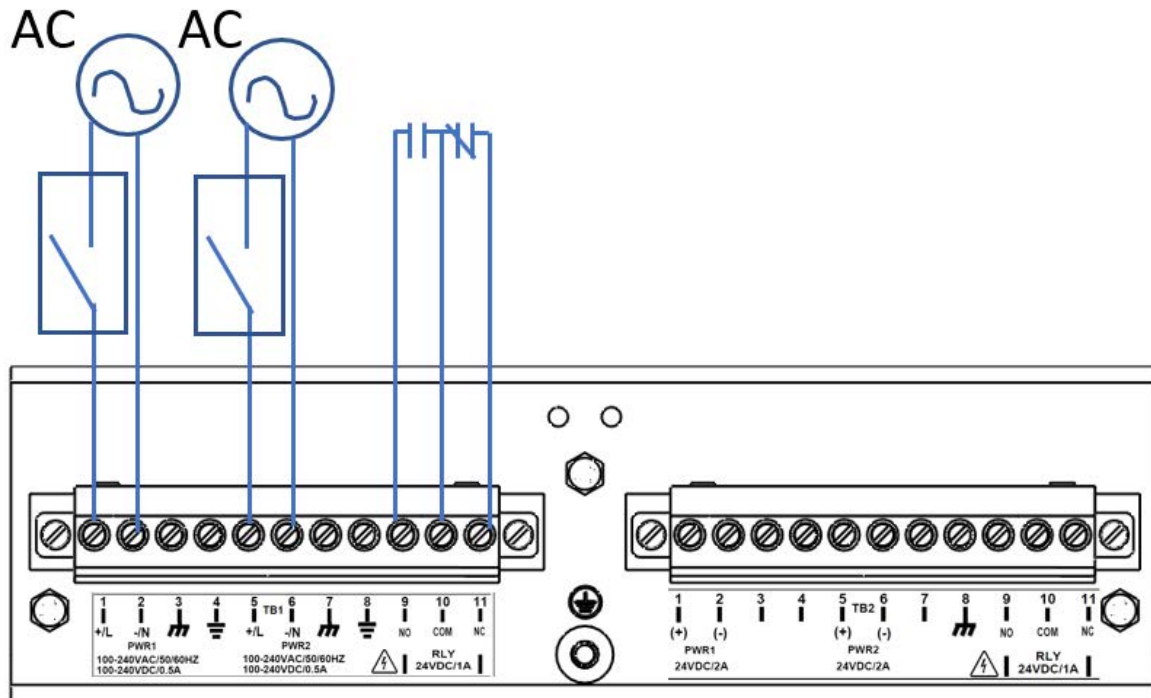
For 100-240 VAC rated equipment, protection for earth fault is provided by max. 20 A branch circuit from AC input in building installation. The protection in the building installation is relied upon for short-circuit backup protection.

- The specification for AC breaker is 5 A, 2P, 277 VAC (min) Circuit breaker, Thermomagnetic or equivalent type.
- The plug connector and wire gauge sizing is to be selected with appropriate design as per the Electrical code for a 60W, 1-phase device.

Note for IT power distribution systems:

- 1) This product is also designed for IT power distribution system with phase-to-phase voltage 230 V.
- 2) This equipment must be connected to an earthed mains socket-outlet.



**Figure 2:** AC Wiring Diagram

L—stands for Live      N—stands for Neutral

NO—Normally Open (open = open circuit = not creating a path for the current)

NC—Normally Closed (closed = short circuit = creating a path for the current)

PE—Protective Earth (earth Ground point in the electrical circuit)

To establish AC power connection with the power source turned off, follow the steps below. When following the instructions, refer to [AC Wiring Diagram](#).

1. Remove the transparent plastic finger safe cover from the face of the terminal block.

If an AC power supply has been installed in PS1, perform steps 2 through 4 on the left hand terminal block. Please note that if there are no DC power supplies installed on the iMR350 then the right hand terminal block will not be populated.

2. Connect the ground from the first power source to GND1 terminal screw (pin 4).
3. Connect the Live from the first power source to the PWR1 +/L terminal screw (pin 1).
4. Connect the Neutral from the first power source to the PWR1 -/N terminal screw (pin 2).

If an AC power supply has been installed in PS2, perform steps 5 through 7.

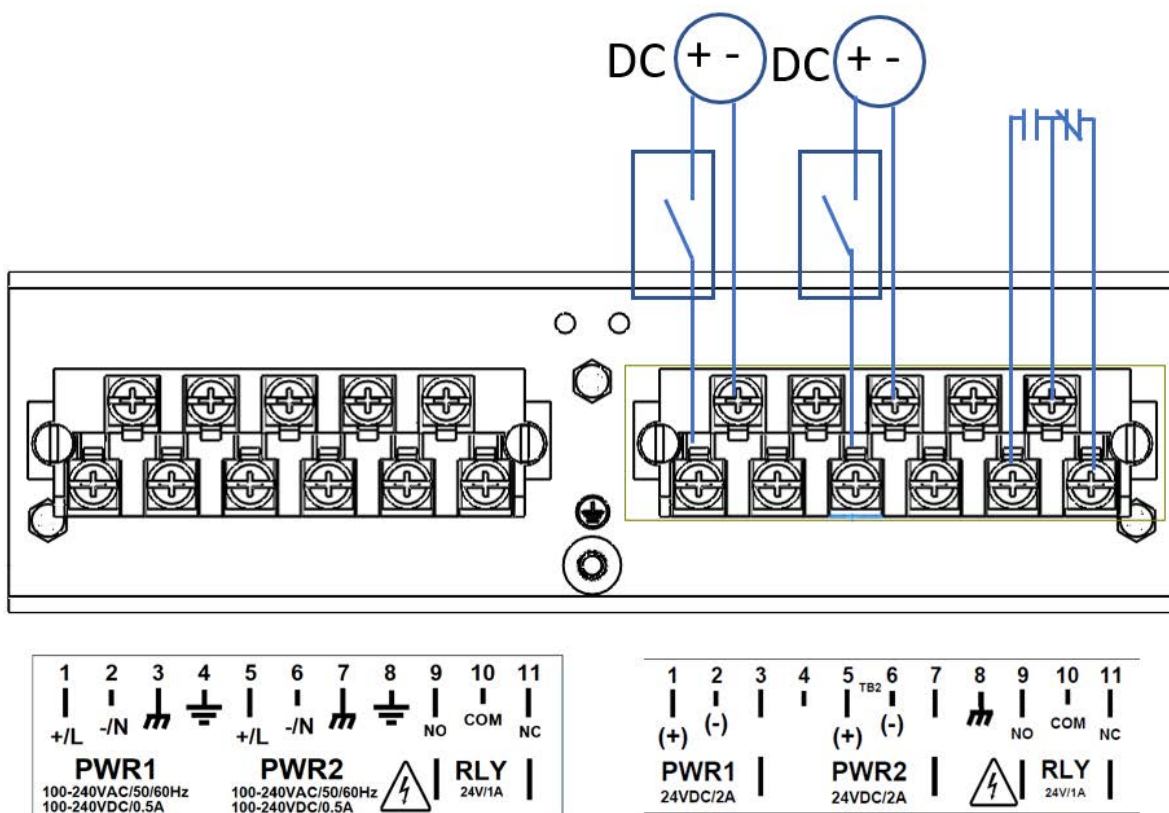
5. Connect the ground from the second power source to GND2 terminal screw (pin 8).
6. Connect the Live from the first power source to the PWR2 +/L terminal screw (pin 5).
7. Connect the Neutral from the first power source to the PWR2 -/N terminal screw (pin 6).

To keep the wires from pulling loose, use a small flat-blade screwdriver to tighten the wire-clamp screws on the front of the terminal block connector.

8. After wiring is completed, reinsert the transparent plastic finger safe cover back onto the face of the terminal block.
9. Connect pin 3 to the ground of the chassis if Power Supply 1 is in use.
10. Connect pin 7 to the ground of the chassis if Power Supply 2 is in use.

## 7.4. Connecting DC Power for Lug Terminal Blocks

CONTEXT: This section explains how to connect the RAPTOR to a DC power supply.



**Figure 3:** DC Wiring Diagram

For 100-240 VDC rated equipment, an appropriately rated DC circuit breaker must be installed.

- The specification for HV DC breaker is 5 A, 2P, 300 VDC (min) Circuit breaker, Thermo magnetic or equivalent type. A recommended option for this circuit breaker is: Model No. CX2-B0-14-450-22A-13G, Molded Case Circuit Breaker, 2 P, 5 A, 250/500 VDC.
- Wire gauge sizing is to be selected with appropriate design as per the Electrical code for a 60 W, 1-phase device.

Equipment must be installed according to applicable local wiring codes and standards.

With the power source turned off, refer to figure and perform the following steps:

For a DC Power Supply in PS1, carry out steps 1 through 2, by wiring the right hand terminal block. Please note that if there are no AC power supplies installed on the iMR350 then the left hand terminal block will not be populated.

1. Connect the positive wire from the power source to the positive (+), screw #1, terminal on the terminal block.
2. Connect the negative wire from the power source to the negative (-), screw #2, terminal on the terminal block.

If a DC Power Supply has been installed in PS2, perform the following steps.

3. Connect the positive wire from the power source to the positive (+), screw #5, terminal on the terminal block.
4. Connect the negative wire from the power source to the negative (-), screw #6, terminal on the terminal block.

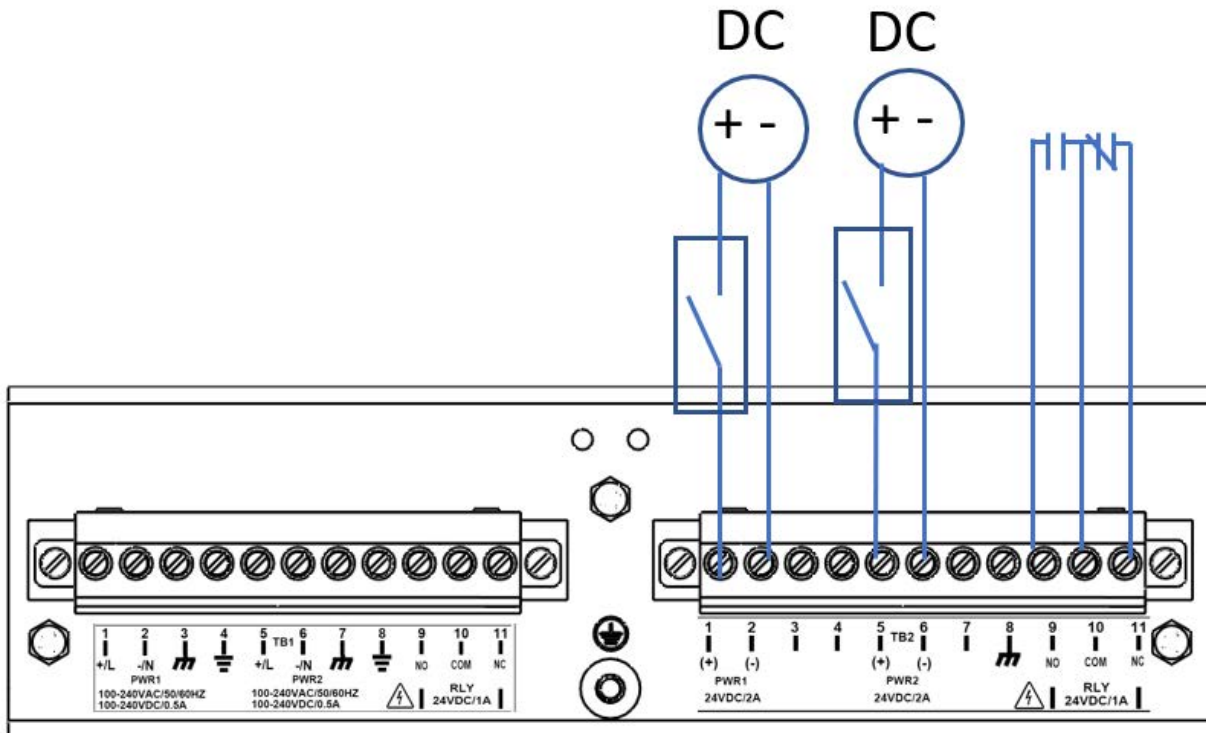
After wiring is completed, perform the following:

5. For screw terminal blocks, install the transparent plastic finger safety cover.
6. Connect pin 8 to the ground of the chassis. The ground terminal is used as the ground conductor for surge and transient suppression circuitry internal to the unit.

## 7.5. Connecting DC Power for Wire Terminal Blocks

CONTEXT: This section explains how to connect the RAPTOR to a DC power supply.

**Figure 4:** DC Wiring Diagram



For 100-240 VDC rated equipment, an appropriately rated DC circuit breaker must be installed.

- The specification for HV DC breaker is 5 A, 2P, 300 VDC (min) Circuit breaker, Thermo magnetic or equivalent type. A recommended option for this circuit breaker is: Model No. CX2-B0-14-450-22A-13G, Molded Case Circuit Breaker, 2 P, 5 A, 250/500 VDC.
- Wire gauge sizing is to be selected with appropriate design as per the Electrical code for a 60 W, 1-phase device.

Equipment must be installed according to applicable local wiring codes and standards.

With the power source turned off, refer to figure and perform the following steps:

For a DC Power Supply in PS1, carry out steps 1 through 2, by wiring the right hand terminal block. Please note that if there are no AC power supplies installed on the iMR350 then the left hand terminal block will not be populated.

1. Connect the positive wire from the power source to the positive (+), screw #1, terminal on the terminal block.
2. Connect the negative wire from the power source to the negative (-), screw #2, terminal on the terminal block.

If a DC Power Supply has been installed in PS2, perform the following steps.

3. Connect the positive wire from the power source to the positive (+), screw #5, terminal on the terminal block.
4. Connect the negative wire from the power source to the negative (-), screw #6, terminal on the terminal block.

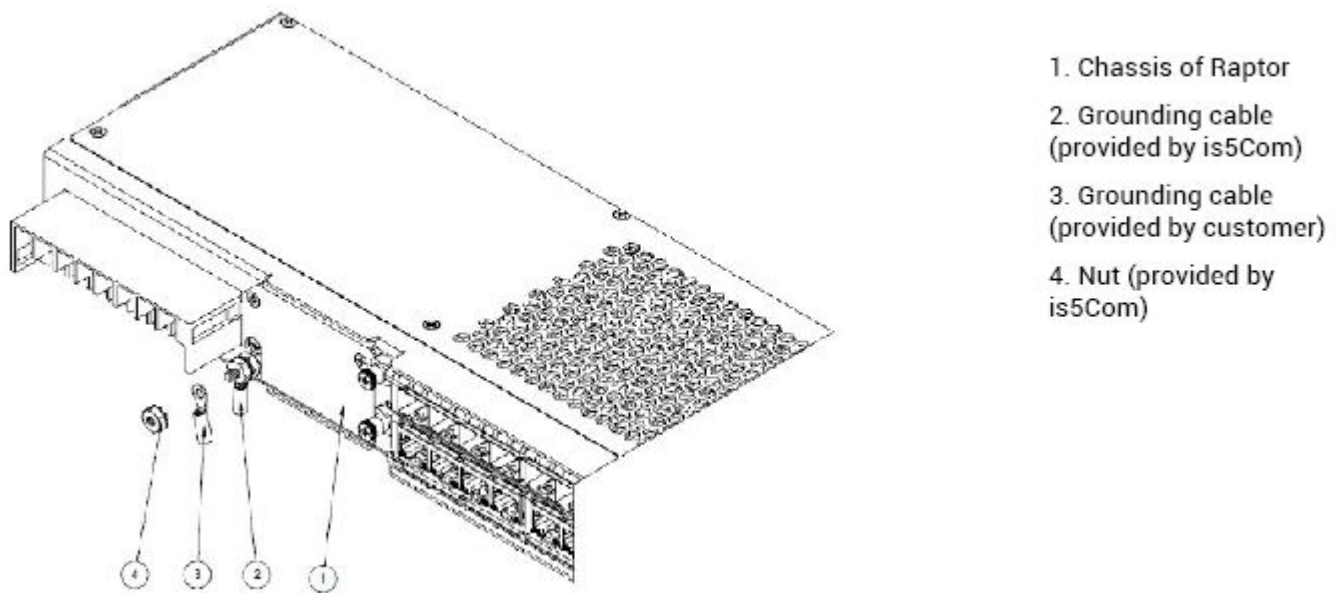
After wiring is completed, perform the following:

5. For screw terminal blocks, install the transparent plastic finger safety cover.
6. Connect pin 8 to the ground of the chassis. The ground terminal is used as the ground conductor for surge and transient suppression circuitry internal to the unit.

## 7.6. Connecting Ground Wire for Safety Precautions

**CONTEXT:** This section explains how to connect the ground wire to the RAPTOR.

**Figure 5:** Connecting Ground Wire



The earth ground connection must be verified by an electrical engineer or a service person skilled in electrical installation and grounding.

If the Raptor is used as cord-connected mains equipment, for reliable earthing, use it as:

- ◆ pluggable equipment type B, or
- ◆ stationary pluggable equipment type A in a location with equipotential bonding or with a permanently connected protective earthing conductor.

**ATTENTION:** The user shall be responsible for ensuring the integrity of any protective conductor connections before carrying out any other actions.

**ATTENTION:** Wire gauge sizing is to be selected with the appropriate design as per the electrical code.

**ATTENTION:** Equipment must be installed according to applicable local wiring codes and standards.

**ATTENTION:** Protective earth connections should not be removed when the equipment is energized.

**ATTENTION:** It is the responsibility of the user to ensure that the equipment is installed, operated and used for its intended function in the manner specified by the manufacturer. If this is not the case, then any safety protection provided by the equipment may be impaired.

1. Using a braided wire or another appropriate grounding wire, connect the chassis ground connection of the device.

## 8. Device Management

### 8.1. Serial Console

**Figure 1:** Serial Console



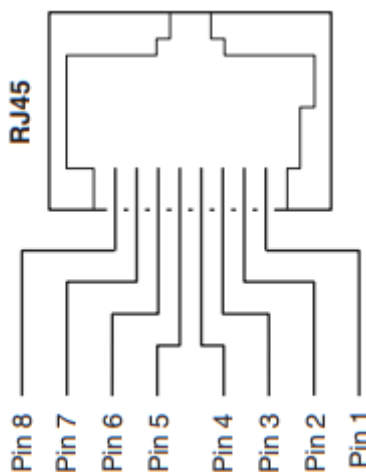
Connect a PC or terminal directly to the serial console to access the boot-time control and RAPTOR's interfaces. The serial console port provides access to the console interface.

The serial console port is RS232 with RJ45 connector with a console cable and port setup of 115200 bps, 8, N.



The serial console is intended to be used only as a temporary connection during initial configuration or troubleshooting.

**Figure 2:** RJ45 Serial Pin Assignment



RS232 RJ-45 pin assignments are as follows:

| PIN # | TYPE  | ASSIGNMENT |
|-------|-------|------------|
| 1     | RS232 | RTS        |
| 2     | RS232 |            |
| 3     | RS232 | TX         |
| 4     | RS232 | GND        |
| 5     | RS232 | GND        |

| PIN # | TYPE  | ASSIGNMENT |
|-------|-------|------------|
| 6     | RS232 | RX         |
| 7     | RS232 |            |
| 8     | RS232 | CTS        |

## 8.2. Ethernet Ports & Communication Cabling

The RAPTOR comes with standard Ethernet ports. According to the link type, the switch uses CAT 3, 4, 5, and 5e UTP cables to connect to any other network devices (computers, servers, switches, routers, or hubs).

For RJ-45 cable specifications, refer to the following table.

| CABLE      | TYPE                            | MAXIMUM LENGHT     |
|------------|---------------------------------|--------------------|
| 10BASE-T   | Cat. 3, 4, 5 100 $\Omega$       | UTP 100 m (328 ft) |
| 100BASE-TX | Cat. 5 100 $\Omega$ UTP         | UTP 100 m (328 ft) |
| 1000BASE-T | Cat. 5/Cat. 5e 100 $\Omega$ UTP | UTP 100 m (328 ft) |

## 8.3. RJ45 Ethernet Pin Assignments

With 10/100/1000BASE-T(X) cables, pins 1 and 2 are used for transmitting data, and pins 3 and 6 for receiving data.

10/100 Base-T(X) RJ-45 pin assignments are as follows:

| PIN # | TYPE             | ASSIGNMENT |
|-------|------------------|------------|
| 1     | 10/100 Base-T(X) | TD+        |
| 2     | 10/100 Base-T(X) | TD-        |
| 3     | 10/100 Base-T(X) | RD+        |
| 4     | 10/100 Base-T(X) | Not used   |
| 5     | 10/100 Base-T(X) | Not used   |
| 6     | 10/100 Base-T(X) | RD-        |
| 7     | 10/100 Base-T(X) | Not used   |
| 8     | 10/100 Base-T(X) | Not used   |



1000 Base-T RJ-45 pin assignments are as follows:

| PIN # | TYPE        | ASSIGNMENT |
|-------|-------------|------------|
| 1     | 1000 Base-T | BI_DA+     |
| 2     | 1000 Base-T | BI_DA-     |
| 3     | 1000 Base-T | BI_DB+     |
| 4     | 1000 Base-T | BI_DC+     |
| 5     | 1000 Base-T | BI_DC-     |
| 6     | 1000 Base-T | BI_DB-     |
| 7     | 1000 Base-T | BI_DD+     |
| 8     | 1000 Base-T | BI_DD-     |

1000 Base-T MDI/MDI-X pin assignments are as follows:

| PIN # | MDI PORT       | MDI-X PORT     |
|-------|----------------|----------------|
| 1     | TD+ (transmit) | RD+ (receive)  |
| 2     | TD- (transmit) | RD- (receive)  |
| 3     | RD+ (receive)  | TD+ (transmit) |
| 4     | Not used       | Not used       |
| 5     | Not used       | Not used       |
| 6     | RD-(receive)   | TD-(transmit)  |
| 7     | Not used       | Not used       |
| 8     | Not used       | Not used       |

1000 Base-T RJ-45 pin assignments are as follows:

| PIN # | MDI PORT | MDI-X PORT |
|-------|----------|------------|
| 1     | BI_DA+   | BI_DB+     |
| 2     | BI_DA-   | BI_DB-     |
| 3     | BI_DB+   | BI_DA+     |
| 4     | BI_DC+   | BI_DD+     |
| 5     | BI_DC-   | BI_DD-     |
| 6     | BI_DB-   | BI_DA-     |
| 7     | BI_DD+   | BI_DC+     |

| PIN # | MDI PORT | MDI-X PORT |
|-------|----------|------------|
| 8     | BI_DD-   | BI_DC-     |

NOTE: “+” and “-” signs represent the polarity of the wires that make each wire pair.

## 8.4. Recommendations for Cables in High Electrical Noise

Constant electrical noise can be due to the predictable 50 or 60 Hz AC 'hum' from power circuits or harmonic multiples of power frequency close to the data communications cable.

Follow these recommendations for copper data cabling in high electrical noise environments:

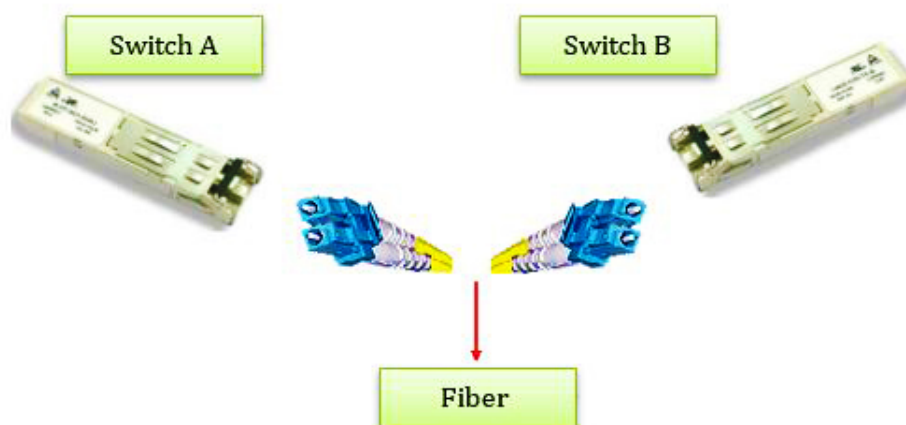
- Data cable lengths should be as short as possible, preferably 3 m (10 ft) in length. Copper data cables should not be used for inter-building communications.
- Power and data cables should not be run in parallel for long distances, and they should be installed in separate conduits. Power and data cables should intersect at 90° angles when necessary to reduce inductive coupling.
- Ground loops which are major cause of noise propagation must be avoided.

## 8.5. SFP

The RAPTOR supports fiber optic ports that can connect to other devices using SFP (Small Form-factor Pluggable) modules. The fiber optical ports are Multimode (MM) or Singlemode (SM) with LC connectors.

Always connect the TX port of Switch A to the RX port of Switch B.

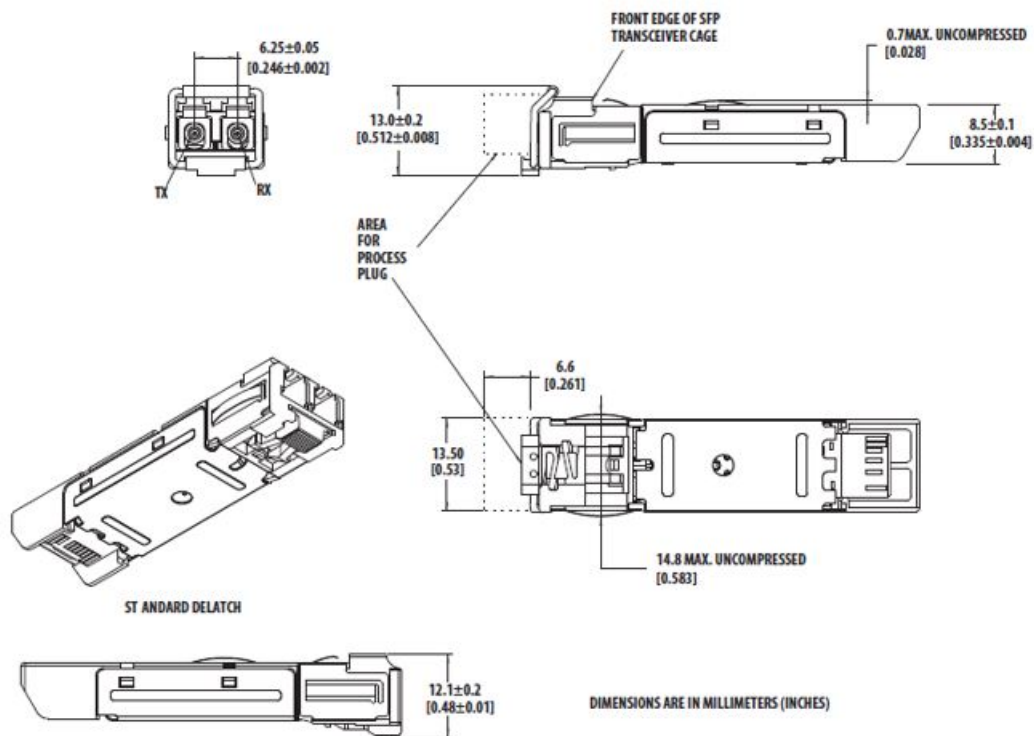
Figure 3: SFP



The SFP modules are available separately from the Accessories list.

## 8.6. Mechanical Dimensions of a SFP module

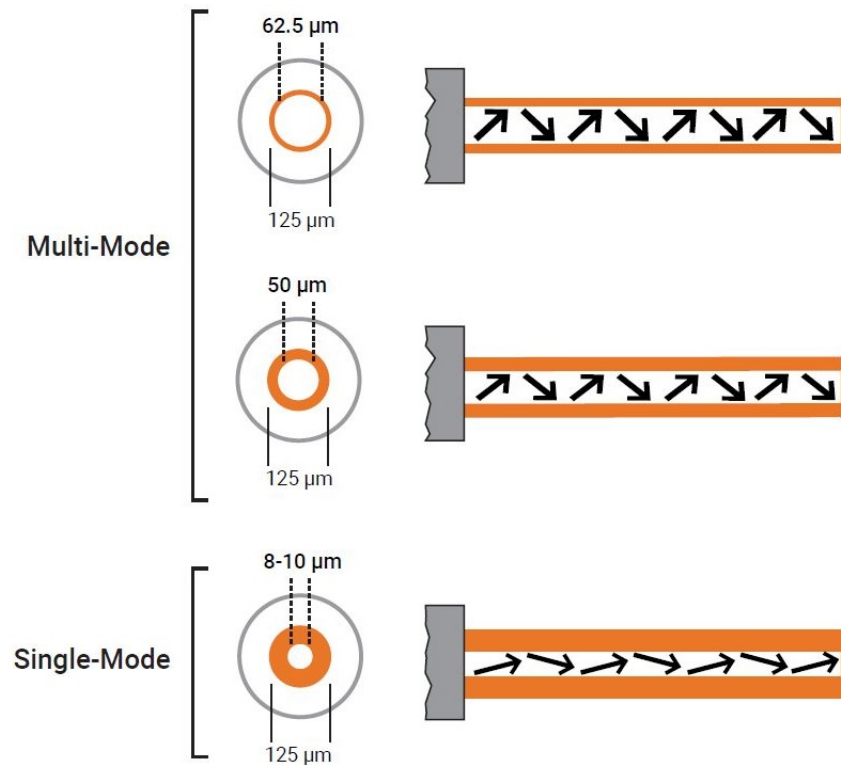
Figure 4: Mechanical Dimensions of a SFP module



The dimensions are in millimeters (inches)

## 8.7. Differences between SM and MM Fibers

The main difference between MM and SM fibers is that the former has much larger core diameter. Typically, MM has a core diameter of 50 or 62.5  $\mu\text{m}$  and a cladding diameter of 125  $\mu\text{m}$ , while a typical SM fiber has a core diameter between 8 and 10  $\mu\text{m}$  and a cladding diameter of 125  $\mu\text{m}$ .

**Figure 5:** SM and MM Fibers

SM fibers are better suited for moving information across longer distances and are routinely used by telecommunications. In comparison, MM fibers are ideal for local networks due to their low cost and greater bandwidth.



**Laser radiation might be emitted from disconnected fibers or connectors. Do not stare into cables.**

## 8.8. General Fiber Optic Cables Handling Instructions

- Wear finger cots or gloves. Your hands may look clean, but dirt and oils on them can damage the fiber and contaminate connectors.
- Never use the fiber pigtail to pick up or support the weight of the device. Keep both the device and the optical connector together in your hand(s).
- The fiber is made of a very pure expensive glass. Treat it with the same care that would be used when handling expensive crystal glass.
- Do not allow kinks or knots to develop in the fiber. Do not pull on the fiber when kinks or knots are present. Pulling will only cause knots, kinks, and curls to tighten and exceed the minimum bend radius.
- Always use the correct tools for stripping and cleaving the fiber. It will save time and reduce breakage caused by scratches.
- Follow all ESD precautions.

## 9. Technical Specifications

### 9.1. Flexible Communications

| Flexible Communications                    |               |
|--|---------------|
| Number of slots for communications modules | Up to 4 slots |

### 9.2. Ports

| Ports                   |   |
|-------------------------|---|
| Ethernet Network Ports  | Slot #1- 3—supports up to 8 x 10/100/1000 RJ45s or 8 x 100/1000 SFPs per slot<br>Slot #4—supports up to 4 x 10GB Base-X or 4x1GB Base-X Uplinks |
| Serial Console Port     | RS-232 in RJ-45 connector with console cable. 115200bps, 8, N, 1  |
| USB Port / SD cards     | USB 2.0 for software and configuration update   |
| Other hardware features | Modular chassis with hot-swappable modules; Redundant hot-swappable power supplies  |
| Alarm                   | Fault Contact: relay output to carry capacity of 1 A at 24 VDC  |

### 9.3. Technology

| Technology        |  |
|-------------------|--|
| MAC Table         | 16K  |
| Priority Queues   | 8  |
| Processing        | Store and Forward  |
| Switch Properties | Switching latency : 7 $\mu$ s<br>Switching bandwidth: 128 Gbps |
| Jumbo Frame       | Up to 9216 bytes   |

## 9.4. Physical Characteristics

| Physical Characteristics |  |
|--------------------------|--|
| Enclosure                | IP 40 Satin Coat Steel   |
| Dimensions               | 443.56 (W) x 414.95 (D) x 44.20 (H) mm (17.46 x 16.34 x 1.74 inches) |
| Weight                   | 5.72 kg (12.6 lbs.)  |

## 9.5. Power

| Power                       |  |
|-----------------------------|--|
| Redundant Input power       | Dual Power Supplies available in any combination of: <ul style="list-style-type: none"><li>• 24 VDC, 2.5 A (Nom.)</li><li>• 48 VDC, 1.25 A (Nom.)</li><li>• 100-240 VAC, 50/60 Hz, 100-240 VDC, 1 A (Nom.)</li></ul> |
| Power Consumption           | <ul style="list-style-type: none"><li>• 50 W for DC Power Supplies</li><li>• 50 VA for AC Power Supplies</li></ul>   |
| Overload Current Protection | Fast Acting Fuse 3.15 A (can only be replaced in the factory).   |
| Class of Equipment          | IEC 61140: Protection against electric shock<br>Insulation Class-I (AC Mains)<br>Insulation Class-III (DC Mains)   |

# 10. Compliance Specifications

## 10.1. Product Safety Tests

| Description              | Specification   | Level  |
|--------------------------|---|--|
| IP Rating                | IEC 61850-3 clause 6.6.2<br>IEC 60529 clause 6.11<br>ISO 20653:2013 | IP40   |
| Clearance and Creepage   | IEC 61850-3 clause 6.6.1<br>IEC 62368-1, clause 6.4.2 & 5.4.3       | Overvoltage Category II<br>Pollution Degree II                                 |
| Impulse Voltage          | IEC 61850-3 clause 6.6.3<br>IEEE 1613 clause 5.3                    | 5kV on auxiliary power supply and digital inputs<br>1kV on station bus ports   |
| Dielectric Voltage       | IEC 61850-3 clause 6.6.4<br>IEEE 1613 clause 5.2                    | 2kV on auxiliary power supply and digital inputs<br>0.5kV on station bus ports |
| Insulation Resistance    | IEC 60255-27 clause 10.6.4.4  | 500VDC   |
| Protective Bonding       | IEC 61850-3 clause 6.6.5  | Less than 0.1 Ohms   |
| Flammability             | IEC 61850-3 clause 6.6.6  | V1   |
| Single Fault Condition   | IEC 61850-3 clause 6.6.7  | 5VDC, 12VDC  |
| Product Safety Standards | IEC 62368-1   | Product Safety Standard for Europe and North America                           |

## 10.2. Electromagnetic Compatibility (EMC) Tests

| Description                   | Specification   | Level  |
|-------------------------------|---|--|
| Radiated Emission             | IEC 61850-3 clause 6.7.4<br>CISPR22 table 5/7   | class A  |
| Conducted Emission            | IEC 61850-3 clause 6.7.4<br>CISPR22 table 1/3   | class A  |
| 1 MHz Damped Oscillatory Wave | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-18<br>EEE 1613 clause 6<br>IEEE 1613.1 clause 5 | 2.5 kV CM, 1.0kV DM<br>HV/Telec.<br>2.5 kV CM, 2.5kV DM Zone A |

| Description   | Specification   | Level   |
|---|---|---|
| Electrostatic Discharges                            | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-2<br>IEEE 1613 clause 8<br>IEEE 1613.1 clause 8 | 8kV contact, 15kV air                                       |
| Radiated Radio Frequency<br>Magnetic Field          | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-3<br>IEEE 1613 clause 7<br>IEEE 1613.1 clause 7 | 20 V/m  |
| Fast Transient/Burst                                | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-4<br>IEEE 1613 clause 6<br>IEEE 1613.1 clause 5 | 4kV   |
| Surge   | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-5<br>IEC 1613.1 clause 6                        | Power Ports: 4kV LE, 2kV LL<br>Signal Ports: 2KV LE, 1KV LL |
| Conducted Disturbance Induced<br>by RF Fields       | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-6<br>IEEE 1613.1 clause 9                       | 0.15-80MHz at 10V<br>27, 68 MHz at 10V                      |
| Main Frequency Voltage,<br>Common-mode Disturbances | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-16<br>IEEE 1613.1 clause 12                     | 30V; cont. 300V; 1s   |
| Power Frequency Magnetic Field                      | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-8<br>IEEE 1613.1 clause 10                      | 100 A/m cont.;<br>1000 A/m 3s                               |
| D.C. Voltage Dips                                   | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-29  | 60%; 0.1s<br>30%; 0.1s                                      |
| A.C. Voltage Dips                                   | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-11  | 60%; 50 c<br>30%; 1c  |
| D.C. Voltage Interruptions                          | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-29  | 100%; 0.05s   |
| A.C. Voltage Interruptions                          | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-11  | 100%; 5/50c   |
| D.C. Ripple   | IEC 61850-3 clause 6.7.3<br>IEC 61000-4-17<br>IEEE 1613 clause 4.2                      | 10% Ur_dc<br>5% content (different<br>calculation method)   |
| Damped Oscillatory Magnetic<br>Field                | IEEE 1613.1 clause 11<br>IEC 61000-4-10   | 100 A/m (peak)  |



## 10.3. Climatic Environmental Tests

| Description             | Specification  | Level                                |
|-------------------------|--|--------------------------------------|
| Dry Heat Operational    | IEC 61850-3 clause 6.9.3.1<br>IEC 60068-2-2, test Bd                           | +85°C; 16 hours                      |
| Dry Heat Operational    | IEEE 1613 clause 3.1.1   | +85°C                                |
| Cold Operational        | IEC 61850-3 clause 6.9.3.2<br>IEC 60068-2-1, test Ad                           | -40°C; 16 hours                      |
| Cold Operational        | IEEE 1613 clause 3.1.1   | -40°C                                |
| Dry Heat Storage        | IEC 61850-3 clause 6.9.3.3<br>IEC 60068-2-2, test Bb                           | +85°C; 16 hours                      |
| Dry Heat Storage        | IEEE 1613 clause 3.1.2   | +85°C                                |
| Cold Storage            | IEC 61850-3 clause 6.9.3.4<br>IEC 60068-2-1, test Ab                           | -40°C; 16 hours                      |
| Cold Storage            | IEEE 1613 clause 3.1.2   | -40°C                                |
| Change of Temperature   | IEC 61850-3 clause 6.9.3.5<br>IEC 60068-2-14 test Nb                           | -40°C; +85°C 3 hours; 5 cycles       |
| Damp Heat, Steady State | IEC 61850-3 clause 6.9.3.6<br>IEC 60068-2-78 test Cab                          | +40°C; 93%, 10 days                  |
| Damp Heat, Cyclic       | IEC 61850-3 clause 6.9.3.7<br>IEC 60068-2-78 test Db<br>IEEE 1613 clause 3.1.3 | +25°C; 55°C 97%; 93% 6 cycles + 55°C |

## 10.4. Mechanical Environmental Tests

| Description        | Specification                               | Level  |
|--------------------|---|--|
| Vibration Response | IEC 61850-3 clause 6.10.1<br>IEC 60255-21-1 | class 1<br>0.5g, 10Hz - 150Hz, 1 Octave/min, 1 sweep cycle in each axis, 8min per perpendicular axis |

| Description                | Specification                               | Level  |
|----------------------------|---|--|
| Vibration Endurance        | IEC 61850-3 clause 6.10.1<br>IEC 60255-21-1 | class 1<br>1g, 10 - 150Hz, 1<br>Octave/min, 20 sweep<br>cycles in each axis, 160min<br>per perpendicular axis  |
| Shock Response             | IEC 61850-3 clause 6.10.2<br>IEC 60255-21-2 | class 1<br>5g, 11ms, half-sine, 3<br>shocks/direction/axis (18<br>total)   |
| Shock Withstand            | IEC 61850-3 clause 6.10.2<br>IEC 60255-21-2 | class 1<br>15g, 11ms, half-sine, 3<br>shocks/direction/axis(18<br>total)   |
| Bump                       | IEC 61850-3 clause 6.10.2<br>IEC 60255-21-2 | class 1<br>10g, 16ms, half-sine, 1000<br>pulses  |
| Seismic, Single Axis Sweep | IEC 61850-3 clause 6.10.3<br>IEC 60255-21-3 | class 1<br>Freq range: Nominal Range<br>5-35Hz, Cross Over:<br>8-9HzPeak Displacement:<br>Below cross-overfrequency:<br>3.5mm[x] x 1.5mm [y]<br>Sweep: 1 Cycle/Axis (x,y,z), 1<br>Octave/min |
| Vibration                  | IEEE 1613 clause 9                          | V.S.3  |
| Shock                      | IEEE 1613 clause 9                          | 100 mm   |

## 10.5. Altitude

| Description | Specification   | Level  |
|-------------|---|--|
| Altitude    | IEC 61850-3 section 4, table 1<br>IEC 61850-3 section 7.2, table 25 | less than or equal to 2000m<br>86 kPa to 106 kPa |

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# GLOSSARY ENTRIES

## **802.1D**

IEEE 802.1D is the Ethernet MAC bridges standard which includes Bridging, Spanning Tree and others. It is standardized by the IEEE 802.1 working group. It includes details specific to linking many of the other 802 projects including the widely deployed 802.3 (Ethernet), 802.11 (Wireless LAN) and 802.16 (WiMax) standards.

Bridges using virtual LANs (VLANs) have never been part of 802.1D, but were instead specified in separate standard, 802.1Q originally published in 1998.

By 2014, all the functionality defined by IEEE 802.1D has been incorporated into either IEEE 802.1Q (Bridges and Bridged Networks) or IEEE 802.1AC (MAC Service Definition).

## **802.1Q**

IEEE 802.1Q, often referred to as DOT1Q or 1Q, is the networking standard that supports virtual LANs (VLANs) on an IEEE 802.3 Ethernet network. It is the most widely used encapsulation method for VLAN tagging.

## **802.1X**

IEEE 802.1X is an IEEE Standard for port-based Network Access Control (PNAC). 802.1X authentication requires a client, an authenticator, and an authentication server. The client is a device that wants to connect to the network.

## **802.1W**

IEEE 802.1W feature provides rapid traffic reconvergence for point-to-point links within a few milliseconds (0-500 milliseconds), following the failure of bridge or bridge point. This reconvergence occurs more rapidly than the reconvergence provided by the 802.1F spanning Tree Protocol (STP) or by RSTP.

## **AAA**

Authentication, Authorization and Accounting (AAA) functionalities. AAA are provided by TACACS+. TACACS+ is used because it provides independently separate and modular authentication, authorization, and accounting (AAA) facilities achieved by a single access control server (the TACACS+ daemon).

## **AARP**

AppleTalk Address Resolution Protocol (AARP). The AARP maps computers' physical hardware addresses to their temporarily assigned AppleTalk network addresses. AARP is functionally equivalent to Address Resolution Protocol (ARP). The AARP table permits management of the address mapping table on the managed device. This protocol allows Apple computers' AppleTalk hosts to generate their own network addresses

## **ABR**

Area Border Router (ABR)

## **ACK**

ACK stands for acknowledgment. ACK is one of the TCP flags.

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TCP flags are various types of flag bits present in the TCP header. Each of them has its own significance. They initiate connections, carry data, and tear down connections. The commonly used TCP flags are SYN, ACK, RST, FIN, URG, PSH.

- SYN (synchronize): Packets that are used to initiate a connection.
- ACK (acknowledgment): Packets that are used to confirm that the data packets have been received, also used to confirm the initiation request and tear down requests.
- RST (reset): Signify the connection is down or maybe the service is not accepting the requests.
- FIN (finish): Indicate that the connection is being torn down. Both the sender and receiver send the FIN packets to gracefully terminate the connection.
- PSH (push): Indicate that the incoming data should be passed on directly to the application instead of getting buffered.
- URG (urgent): Indicate that the data that the packet is carrying should be processed immediately by the TCP stack

### ACL

An access-control list (ACL) is a list of permissions associated with a system resource (object). An ACL specifies which users or system processes are granted access to objects, as well as what operations are allowed on given objects. Each entry in a typical ACL specifies a subject and an operation. For instance, if a file object has an ACL that contains (Admin: read, write; guest 1: read), this would give Admin permission to read and write the file, and only give guest 1 permission to read it.

### AES

The Advanced Encryption Standard (AES) is a symmetric-key block cipher algorithm and U.S. government standard for secure and classified data encryption and decryption.

### AH

The Authentication Header (AH) protocol provides data origin authentication, data integrity, and replay protection. However, AH does not provide data confidentiality, which means that all of your data is sent in the clear.

AH ensures data integrity with the checksum that a message authentication code, like MD5, generates. To ensure data origin authentication, AH includes a secret shared key in the algorithm that it uses for authentication. To ensure replay protection, AH uses a sequence number field within the AH header. It is worth noting here, that these three distinct functions are often lumped together and referred to as authentication. In the simplest terms, AH ensures that your data has not been tampered with en route to its final destination.

Although AH authenticates as much of the IP datagram as possible, the values of certain fields in the IP header cannot be predicted by the receiver. AH does not protect these fields, known as mutable fields. However, AH always protects the payload of the IP packet.

The Internet Engineering Task Force (IETF) formally defines AH in Request for Comment (RFC) 4302, IP Authentication Header.

### AO

*Authentication Option (AO). TCP-AO specifies the use of stronger Message Authentication Codes (MACs), protects against replays even for long-lived TCP connections, and provides more details on the association of security with TCP connections than TCP MD5. TCP-AO is compatible with either a static Master Key Tuple (MKT) configuration or an external, out-of-band MKT management mechanism; in either case, TCP-AO also protects connections when using the same MKT across repeated*

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*instances of a connection, using traffic keys derived from the MKT, and coordinates MKT changes between endpoints.*

#### **ARAP**

Apple Remote Access Protocol (ARAP); the Apple Remote Access Protocol (ARAP) sends traffic based on the AppleTalk protocol across PPP links and ISDN switched-circuit networks. ARAP is still pervasive in the Apple market, although the company is attempting to transition into an Apple-specific TCP stack for use over a PPP link.

#### **ARP**

ARP (Address Resolution Protocol). The ARP is a communication protocol used for discovering the link layer address, such as a MAC address, associated with a given Internet layer address, typically an IPv4 address.

#### **AS**

Autonomous System (AS)

#### **ASBR**

Autonomous Border System Router (ASBR)

#### **Asdot**

Asdot format is used when the 4-byte ASN are represented by their decimal value e.g. 100.1. BGP uses AS numbers as a fundamental part of its routing process. Because conventional 2-byte public AS numbers were becoming exhausted, the IANA increased the AS numbers by introducing a 4-byte AS numbers. The Asdot notation to represent these AS numbers is as follows. For values between 0 and 65535, Asdot notation is simply the decimal value of the AS number. These values take up to 16 bits to express in binary. Examples include:

- 5
- 25
- 196
- 65000
- 65535

For values above 65536, Asdot notation splits the 32 bit binary value into two 16 bit values. These values are represented as two decimal numbers separated by a dot. Examples include:

- 0.65536
- 15.418
- 65535.8520
- 65535.65535

You will notice that for values of up to 65535, the Asdot is the same as the Asplain notation, and for values of 65536 and above, the Asdot is the same as the Asdot+ notation.

#### **ASN**

Autonomous System Number (ASN)

#### **BDR**

BDR stands for Backup Designated Router.

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**BFD**

Bidirectional Forwarding Detection (BFD) is a super fast protocol that is able to detect link failures within milliseconds or even microseconds. BFD runs independent from any other (routing) protocols. Once it's up and running, you can configure protocols like OSPF, EIGRP, BGP, HSRP, MPLS LDP etc. to use BFD for link failure detection instead of their own mechanisms. When the link fails, BFD will inform the protocol

**BGP**

BGP (Border Gateway Protocol) is an Inter AS (Autonomous Systems) Routing Protocol that manages the distribution of Network Layer Reachability Information (NLRI) across AS. It is used to build an AS connectivity graph that is used to prune routing loops and enforce policies at AS level

**BGP**

BGP-4 is an extension of BGP-3 (BGP version 3), and it is the current version of BGP. BGP4 was published as RFC 4271 in 2006. Its major enhancement is the support for Classless Inter-Domain Routing (CIDR) and use of route aggregation to decrease the size of routing tables. The new RFC allows BGP4 to carry a wide range of IPv4 and IPv6 "address families".

**BIDIR-PIM**

Bi-directional Sparse Mode (PIM-SM); Derived from PIM-SM, BIDIR-PIM builds and maintains a bidirectional RPT, which is rooted at the RP and connects the multicast sources and the receivers. Along the bidirectional RPT, the multicast sources send multicast data to the RP, and the RP forwards the data to the receivers. Each router along the bidirectional RPT needs to maintain only one (\*, G) entry, saving system resources.

Another difference between PIM sparse mode and PIM bidirectional mode is that with sparse mode traffic only flows down the shared tree. Using PIM bidirectional mode, traffic will flow up and down the shared tree. When the multicast packets arrive at the RP, they will be forwarded down the shared tree (if there are receivers) or dropped (when we don't have receivers).

**BMS**

Best Master Clock (BMS); The ordinary clock executes the port state machine and BMC (Best Master Clock) algorithm to select the *PTP* port state.

**BOOTP**

The Bootstrap Protocol (BOOTP) is a computer networking protocol used in Internet Protocol networks to automatically assign an IP address to network devices from a configuration server. The BOOTP was originally defined in RFC 951.

**BPDU**

Bridge Protocol Data Units (BPDUs) are frames that contain information about the spanning tree protocol (STP). A switch sends BPDUs using a unique source MAC address from its origin port to a multicast address.

There are two kinds of BPDUs for 802.1D Spanning Tree:

- Configuration BPDU, sent by root bridges to provide information to all switches.
- TCN (Topology Change Notification), sent by bridges towards the root bridge to notify changes in the topology, such as port up or port down.

**BPS**

BPS (Bits-per-second)

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**BR**

Border Router (BR)

**BSD**

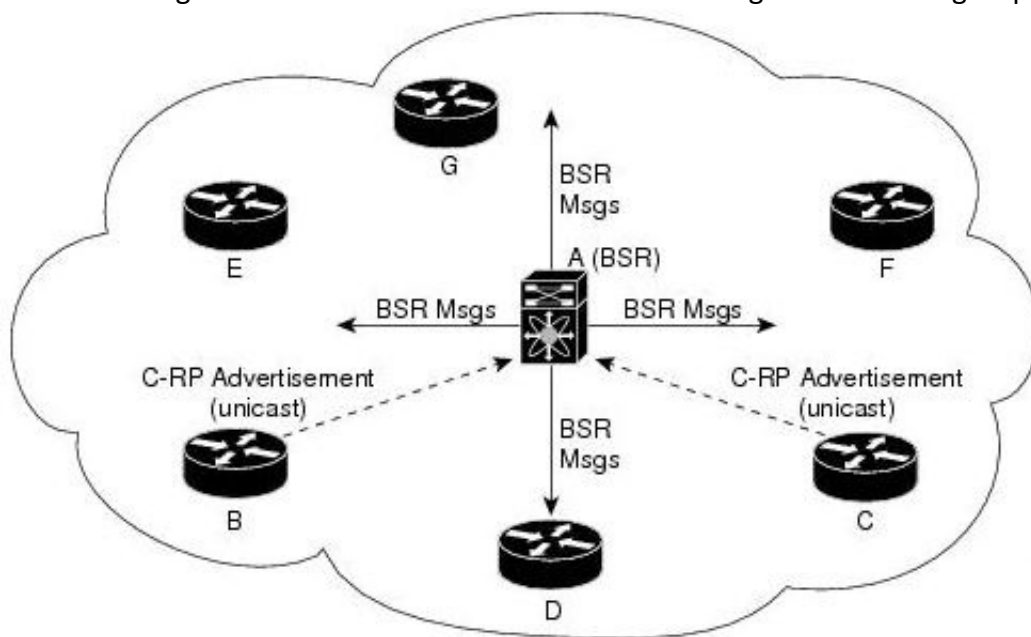
Berkeley Software Distribution (BSD)

**BSR**

The bootstrap router (BSR) ensures that all routers in the PIM domain have the same RP cache as the BSR. You can configure the BSR to help you select an RP set from BSR candidate RPs. The function of the BSR is to broadcast the RP set to all routers in the domain. You select one or more candidate BSRs to manage the RPs in the domain. Only one candidate BSR is elected as the BSR for the domain.

This figure shows the BSR mechanism. Router A, the software-elected BSR, sends BSR messages out all enabled interfaces (shown by the solid lines in the figure). The messages, which contain the RP set, are flooded hop by hop to all routers in the network. Routers B and C are candidate RPs that send their candidate-RP advertisements directly to the elected BSR (shown by the dashed lines in the figure).

The elected BSR receives candidate-RP messages from all the candidate RPs in the domain. The bootstrap message sent by the BSR includes information about all of the candidate RPs. Each router uses a common algorithm to select the same RP address for a given multicast group.

**CA**

Certificate Authorization (CA)

**CBP**

Customer Backbone Port (CBP)

**CBS**

Committed burst size (CBS). During periods of average traffic rates below the Committed information rate (CIR), any unused bandwidth capacity accumulates up to a maximum amount defined by the CBS. Short periods of bursting traffic (back-to-back traffic at average rates that exceed the CIR) are also categorized as green provided that unused bandwidth capacity is available.

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**CEP**

Customer Edge Port (CEP). The Customer Edge Port (CEP) and each Provider Edge Port are treated as separate Bridge Ports by the spanning tree protocol. If the C-VLAN component connects to the S-VLAN component with a single Provider Edge Port, and the associated service instance supports no more than two customer interfaces, then all frames (including Spanning Tree BPDUs) addressed to the Bridge Group Address may be relayed between the two Ports of the C-VLAN component without modification. Otherwise, the Spanning Tree Protocol Entity shall execute the Rapid Spanning Tree Protocol (RSTP, Clause 17 of IEEE Std 802.1D), as modified by the provisions of this subclause.

**CFI**

Canonical Format Identifier (CFI). If Drop Eligible Indicator (DEI) bit is enabled in 802.1ad header or has Canonical Format Identifier (CFI) bit enabled in 802.1q header on an arriving packet, such packets will be dropped using QoS.

**MS-CHAP**

CHAP stands for Challenge Handshake Authentication Protocol. MS-CHAP is the Microsoft version of the Challenge-Handshake Authentication Protocol, CHAP. The protocol exists in two versions, MS-CHAPv1 (defined in RFC 2433) and MS-CHAPv2 (defined in RFC 2759). MS-CHAPv2 provides mutual authentication between peers by piggybacking a peer challenge on the Response packet and an authenticator response on the Success packet.

**CIDR**

Classless Inter Domain Routing (CIDR).

**CIR**

Committed information rate (CIR) is defines the guaranteed bandwidth for traffic arriving at or departing from the interface under normal line conditions.

**CIST**

The Common and Internal Spanning Tree (CIST) is a collection of the ISTs in each MST region.

**CLI**

Command line interface (CLI) is a text-based interface that is used to operate software and operating systems while allowing the user to respond to visual prompts by typing single commands into the interface and receiving a reply in the same way

**CLKIWF**

CLKIWF is short for Clock InterWorking Function.

**CoS**

Output queue scheduling defines the class-of-service (CoS) properties of output queues. Based on certain types of traffic are preferred. The level of service is determined by the egress port queue to which the traffic is assigned. When traffic is queued for transmission, the rate at which it is serviced depends on how the queue is configured and possibly the amount of traffic present in other queues for that port.

Some traffic is classified for service (i.e., packet marking) before it arrives at the switch. If you decide to use these classifications, you can map this traffic to egress queues by setting the CoS in the Queue table.



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**CPLD**

A Complex Programmable logic device (CPLD) is a logic device with completely programmable AND/OR arrays and macrocells. Macrocells are the main building blocks of a CPLD, which contain complex logic operations and logic for implementing disjunctive normal form expressions. AND/OR arrays are completely reprogrammable and responsible for performing various logic functions.

**CPU**

The central processing unit (CPU) is the primary component of a computer that processes instructions. It runs the operating system and applications, constantly receiving input from the user or active software programs. It processes the data and produces output.

**CRT**

CRT stands for "Internet security certificate.

**CSR**

Certificate Signing Request (CSR)

**CST**

common spanning tree (CST); The common spanning tree (CST) that interconnects the MST regions and single spanning trees

**CTS**

CTS stands for Clear to Send. Request to Send (RTS)/CTS Flow Control is another flow control mechanism that is part of the RS232 standard.

**CVID**

The C-VID registration table is as follows:

**Table 1:** C-VID registration table

| C-VID Registration Table | Description  |
|--------------------------|--|
| Cvid value               | The value of the Customer VLAN id on the Customer edge port. (Table key)   |
| Svid Value               | The S-VLAN tag. Auto creates an S-VLAN component and the CNP and PNP and links the PEP of the C-VLAN component to the CNP. |
| Untagged-pep             | A boolean indicating frames for this C-VLAN should be forwarded untagged through the Provider Edge Port (PEP).             |
| Untagged-cep             | A boolean indicating frames for this C-VLAN should be forwarded untagged through the Customer Edge Port (CEP).             |

**CVLAN**

Set of ports & inner VLANs (CVLAN); or C-VLAN or Customer Bridge (CB)

**DB9**

DB9 refers to a common connector type from the D-Subminiatures (D-Sub) connector family, which when introduced, was among the smallest connectors used on computer systems. DB9 houses 9 pins (for the male connector) or 9 holes (for the female connector). DB9 connectors were once very

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common on PCs and servers. Today, the DB9 has mostly been replaced by more modern interfaces such as USB, PS/2, Firewire, and others.

**DB25**

The DB25 connector is an analog socket, with 25 pins, from the D-Subminiatures (D-Sub) connector family. The prefix “D” represents the D-shape of the connector shell. The DB25 connector is mainly used in serial and parallel ports, allowing asynchronous data transmission according to the RS-232 standard (RS-232C).

**DCD**

DCD stands Data Carrier Detect. The description is modem connected to another.

**DEC**

Digital Equipment Corporation (DEC)

**DEI**

Drop Eligible Indicator (DEI). If DEI bit is enabled in 802.1ad header or has Canonical Format Identifier (CFI) bit enabled in 802.1q header on an arriving packet, such packets will be dropped using QoS.

**DES**

The Advanced Encryption Standard (AES) is a symmetric-key block cipher algorithm and U.S. government standard for secure and classified data encryption and decryption.

**DF**

Designated Forwarder (DF).

**DH**

Diffie and Hellman (*DH*) describe a method for two parties to agree upon a shared secret number, called *ZZ*, in such a way that the secret will be unavailable to eavesdroppers. This method requires that both the sender and recipient of a message have key pairs (private and public). By combining one's private key and the other party's public key, both parties can compute the same shared secret number *ZZ*.

**DHCP**

Dynamic Host Configuration Protocol (DHCP)

**DITA**

Darwin Information Typing Architecture (DITA); the DITA specification defines a set of document types for authoring and organizing topic-oriented information, as well as a set of mechanisms for combining, extending, and constraining document types.

**D-LAG**

Distributed Link Aggregation (D-LAG or DLAG)

**DLF**

The Destination Lookup Failure (DLF). When a packet arrives at the device and the device doesn't have an entry for the destination MAC address in its MAC address table, the packet is classified as a Destination Lookup Failure (DLF)

**DM**

DM stands for Dense Mode. Protocol-Independent Multicast Dense Mode (PIM-DM) uses dense multicast routing.

## DNAT

Destination network address translation (DNAT) is a technique for transparently changing the destination IP address of an end route packet and performing the inverse function for any replies.

## DNS

Domain Name System

## DOT1Q

IEEE 802.1Q, often referred to as DOT1Q or 1Q, is the networking standard that supports virtual LANs (VLANs) on an IEEE 802.3 Ethernet network. It is the most widely used encapsulation method for VLAN tagging.

## Dot1x

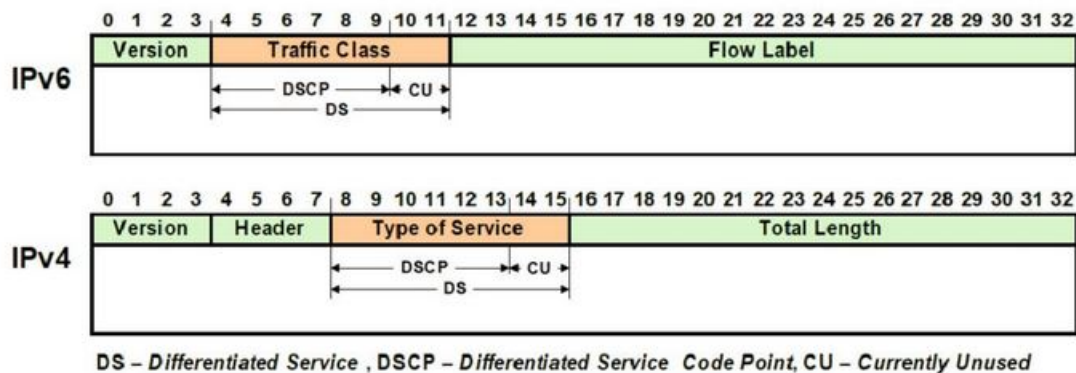
Dot1x Authentication is enabled when dot1x system-auth-control is enabled, and aaa authentication dot1x default is local. If you enable authentication on a port by using the default setting of dot1x port-control, which is force-authorized, it disables 802.1X authentication and causes the port to transition to the authorized state without any authentication exchange required. The port transmits and receives normal traffic without 802.1X-based authentication of the client

## DR

The Designated Router (DR) is the router that will forward the PIM join message from the receiver to the RP (rendezvous point).

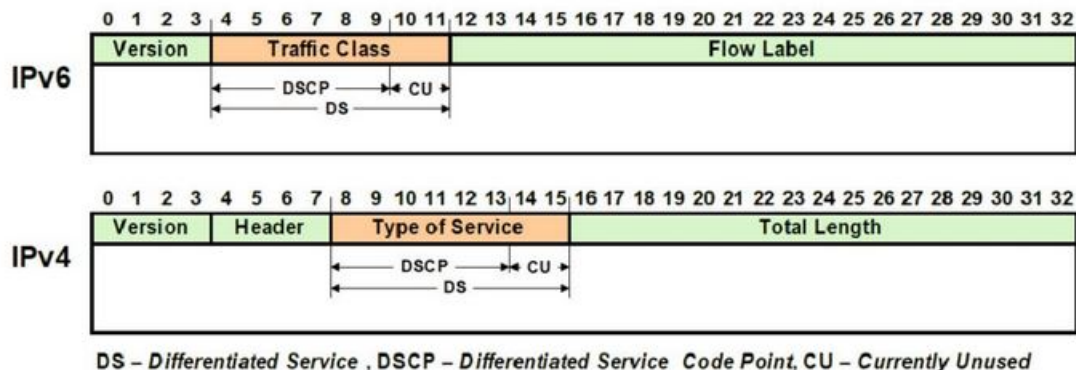
## DS

Differentiated Services (DS).



## DSCP

A Differentiated Services Code Point (DSCP) is a packet header value that can be used to request (for example) high priority or best effort delivery for traffic.



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**DSR**

DSR stands Data Set Ready. The description is ready to communicate.

**DST**

Daylight Saving Time (DST) is a system of setting clocks ahead so that both sunrise and sunset occur at a later hour. The effect is additional daylight in the evening. Many countries observe DST, although most have their own rules and regulations for when it begins and ends. The dates of DST may change from year to year

**DTR**

DTR stands Data Terminal Ready. The description is ready to communicate.

**DUT**

Device under Test (DUT)

**DVMRP**

Distance Vector Multicast Routing Protocol (DVMRP)

**E2E**

End-to-end (E2E) transparent clock for Precision Time Protocol (PTP). With an E2Etransparent clock, only the residence time is included in the timestamp in the packet.

**EAP**

Extensible Authentication Protocol (EAP) is an authentication framework frequently used in network and Internet connections. EAP is usually tunnelled over RADIUS between the Authenticator and the Authentication Server. 802.1x uses EAP.

EAP is an authentication framework, not a specific authentication mechanism. Commonly used modern methods capable of operating in wireless networks include EAP-TLS, EAP-SIM, EAP-AKA, LEAP and EAP-TTLS. Requirements for EAP methods used in wireless LAN authentication are described in RFC 4017.

The Lightweight Extensible Authentication Protocol (LEAP) method was developed by Cisco Systems prior to the IEEE ratification of the 802.11i security standard.

**EAPoL**

Extensible Authentication Protocol (EAP) over LAN (EAPoL) is used between the Supplicant (software on your laptop) and the Authenticator (switch)

**EBGP**

External *BGP* (EBGP); EBGP runs between two BGP routers in different Autonomous System (AS).

**EBS**

The Excess Burst size (EBS) specifies how much data above the committed burst size (CBS) a user can transmit. The EBS is the size up to which the traffic is allowed to burst without being discarded. EBS allows for moderate periods of bursting traffic that exceeds both the committed information rate (CIR) and the committed burst size (CBS).

**ECN**

Explicit Congestion Notification (ECN)

**EGP**

Exterior Gateway Protocol (EGP) is a defunct routing protocol used in autonomous systems to exchange data between surrounding gateway sites. Border Gateway Protocol (BGP) supplanted EGP, widely utilized by research institutes, universities, government agencies, and commercial

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companies (BGP). EGP is built on poll instructions to request update answers and periodic message exchange polling for neighbor reachability.

### **EIGRP**

Enhanced Interior Gateway Routing Protocol (EIGRP) is a network protocol that enables routers to exchange information more efficiently than earlier network protocols, such as Interior Gateway Routing Protocol (IGRP) or Border Gateway Protocol (BGP), and provides intelligent traffic sharing.

### **EIR**

The excess information rate (EIR) specifies the rate above the CIR (committed information rate) at which traffic is allowed into the network and that may get delivered if the network is not congested. The EIR has an additional parameter associated with it called the excess burst size (EBS). The EBS is the size up to which the traffic is allowed to burst without being discarded.

### **ESD**

ElectroStatic Discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

### **EXEC**

*exec:* Protocol

Commands that are invoked using the *exec:* protocol must be executable as standalone commands. Commands that are built into a command interpreter or other program cannot be executed directly, but must be executed (if possible) within the context of the application that provides them. For example, the following seed URL would not work on Microsoft Windows systems because the *dir* command is built into the Windows command interpreter (*cmd.exe*):

*exec: dir e:\data*

To use the *exec* protocol with commands that are built into the Windows command interpreter, you must do something as the following:

*exec: cmd /c dir 'e:\data'*

### **ESP**

Encapsulation Security Protocol (ESP); the ESP protocol provides data confidentiality, and also optionally provides data origin authentication, data integrity checking, and replay protection. The difference between ESP and the Authentication Header (AH) protocol is that ESP provides encryption, while both protocols provide authentication, integrity checking, and replay protection. With ESP, both communicating systems use a shared key for encrypting and decrypting the data they exchange.

### **EVB**

Edge Virtual Bridge (EVB) is an IEEE standard that involves the interaction between virtual switching environments in a hypervisor and the first layer of the physical switching infrastructure. The EVB enhancements are following 2 different paths – 802.1qbg and 802.1qbh.

### **EVC**

Ethernet Virtual Connection (EVC).

### **FCS**

A frame check sequence (FCS) is an error-detecting code added to a frame in a communication protocol. Frames are used to send payload data from a source to a destination.

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**FDB**

Forwarding Database (FDB)

**FID**

Filtering ID (FID)

**FHRP**

First Hop Redundancy Protocol (FHRP)

**FPGA**

The Field Programmable Gate Array (FPGA) is a programmable logic device that can have its internal configuration set by the firmware.

**FTP**

The File Transfer Protocol (FTP) is a standard communication protocol used for the transfer of computer files from a server to a client on a computer network. FTP is built on a client–server model architecture using separate control and data connections between the client and the server.[1] FTP users may authenticate themselves with a clear-text sign-in protocol, normally in the form of a username and password, but can connect anonymously if the server is configured to allow it. For secure transmission that protects the username and password, and encrypts the content, FTP is often secured with SSL/TLS (FTPS) or replaced with SSH File Transfer Protocol (SFTP).

**GARP**

GARP (Generic Attribute Registration Protocol) is a local area network (LAN) protocol that defines procedures by which end stations and switches can register and deregister attributes, such as network identifiers or addresses, with each other. Every end station and switch thus has a record, or list, of all the other end stations and switches that can be reached at any given time.

When an attribute for an end station or switch is registered or deregistered according to GARP, the set of reachable end stations and switches, called participants, is modified according to specific rules. The defined set of participants at any given time, along with their attributes, is a subset of the network topology called the reachability tree. Data frames are propagated only to registered end stations. This prevents attempts to send data to end stations that are not reachable.

**GGP**

Gateway-to-Gateway Protocol (GGP) is an obsolete protocol defined for routing datagrams between Internet gateways. It was first outlined in 1982. The GGP was designed as an IP datagram service similar to the TCP and the UDP.

**GMRP**

GARP Multicast Registration Protocol (GMRP) is a Generic Attribute Registration Protocol (GARP) application that provides a constrained multicast flooding facility similar to IGMP snooping.

**GND**

Ground

**GPS**

Global Positioning System

**GR**

Graceful Restart (GR)

**GRE**

Generic routing encapsulation (GRE) is an IP encapsulation protocol which is used to transport IP packets over a network. In GRE, an IP datagram is tunnelled (encapsulated) within another IP data-

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gram. One great advantage of GRE is that it allows routing of IP packets between private IPv4 networks which are separated over public IPv4 Internet. GRE also supports encapsulating IPv4 broadcast and multicast traffic.

### **GVRP**

GVRP (GARP VLAN Registration Protocol or Generic VLAN Registration Protocol) is a protocol that facilitates control of virtual local area networks (VLANs) within a larger network. GVRP conforms to the IEEE 802.1Q specification, which defines a method of tagging frames with VLAN configuration data

### **HA**

High Availability (HA)

### **HDMI**

HDMI (High-Definition Multimedia Interface) is a digital interface capable of transmitting high-quality and high-bandwidth streams of audio and video between devices

### **HOL**

Head-Of-Line (HOL) blocking should be prevented on a port. HOL blocking happens when HOL packet of a buffer cannot be switched to an output port (i.e. HOL occurs when a line of packets is held up by the first packet).

### **HSR**

High-availability Seamless Redundancy (HSR) is a network protocol for Ethernet that provides seamless failover against failure of any single network component. PRP and HSR are standardized by the IEC 62439 and are suited for applications that request high availability and no switchover time.

### **HTTP**

Hyper Text Transfer Protocol (HTTP)

### **HTTPS**

Hyper Text Transfer Protocol Secure (HTTPS)

### **IANA**

Internet Assigned Numbers Authority (IANA)

### **IBGP**

Internal BGP (iBGP) is the protocol used between the routers in the same autonomous system (AS). iBGP is used to provide information to your internal routers. iBGP requires all the devices in same AS to form full mesh neighborhood or either of Route reflectors and Confederation for prefix learning.

### **ICMP**

Internet Control Message Protocol

### **IDPR**

Inter-domain Routing Protocol (IDPR). The objective of IDPR is to construct and maintain routes, between source and destination administrative domains, that provide user traffic with the requested services within the constraints stipulated for the domains transited.

### **IETF**

Internet Engineering Task Force (IETF) is an open standards organization, which develops and promotes voluntary Internet standards, in particular the technical standards that comprise the Internet protocol suite (TCP/IP).

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**IGMP**

The Internet Group Management Protocol (IGMP) is a communications protocol used by hosts and adjacent routers on IPv4 networks to establish multicast group memberships. IGMP is an integral part of IP multicast and allows the network to direct multicast transmissions only to hosts that have requested them.

**IGP**

Interior Gateway Protocol (IGP) is a type of routing protocol used for exchanging routing table information between gateways (commonly routers) within an autonomous system (for example, a system of corporate local area networks). This routing information can then be used to route network-layer protocols like IP.

**IGRP**

Interior Gateway Routing Protocol (IGRP) is a proprietary distance vector routing protocol that manages the flow of routing information within connected routers in the host network or autonomous system. The protocol ensures that every router has routing tables updated with the best available path. IGRP also avoids routing loops by updating itself with the changes occurring over the network and by error management.

**IGS**

The Internet Group Management Protocol (IGMP) Snooping (IGS) is designed to prevent hosts on a local network from receiving traffic for a multicast group they have not explicitly joined. It provides switches with a mechanism to prune multicast traffic from links that do not contain a multicast listener (an IGMP client). Essentially, IGS is a layer 2 optimization for the Layer 3 IGMP.

**IKE**

Internet Key Exchange (IKE)

**IP**

Internet Protocol (IP).

**IPSec**

IPSec (Internet Protocol Security) is a suite of protocols that provides security to Internet communications at the IP layer. The most common current use of IPSec is to provide a Virtual Private Network (VPN), either between two locations (gateway-to-gateway) or between a remote user and an enterprise network (host-to-gateway); it can also provide end-to-end, or host-to-host, security.

**IPv4**

IPv4 and IPv6 are Internet protocol version 4 and Internet protocol version 6. IPv4 supports:

- IPv4 has a 32-bit address length
- IPv4 binary bits are separated by a dot(.) whereas IPv6 binary bits are separated by a colon(:).
- IPv4 is a numeric addressing method whereas IPv6 is an alphanumeric addressing method
- It Supports Manual and DHCP address configuration
- In IPv4 end to end, connection integrity is Unachievable
- It can generate  $4.29 \times 10^9$  address space
- Fragmentation performed by Sender and forwarding routers
- In IPv4 Packet flow identification is not available
- In IPv4 checksum field is available
- It has broadcast Message Transmission Scheme



- 
- In IPv4 Encryption and Authentication facility not provided
  - IPv4 has a header of 20-60 bytes.

### **IPv6**

IPv6 stands for Internet protocol version 6. An IPv6 address consists of eight groups of four hexadecimal digits. An example of IPv6 address is as follows

3001:0da8:75a3:0000:0000:8a2e:0370:7334

there are different types of IPv6 addresses:

- Unicast addresses—it identifies a unique node on a network and usually refers to a single sender or a single receiver.
- Multicast addresses—it represents a group of IP devices and can only be used as the destination of a datagram.
- Anycast addresses—it is assigned to a set of interfaces that typically belong to different nodes.

### **IRDP**

ICMP Router Discovery Protocol (IRDP) allows hosts to locate routers that can be used as a gateway to reach IP-based devices on other networks. When the device running IRDP operates as a router, router discovery packets are generated. When the device running IRDP operates as a host, router discovery packets are received. ICMP stands for Internet Control Message Protocol.

### **IRTP**

Internet Reliable Transaction Protocol (IRTP) is a transport level host to host protocol designed for an Internet environment. It provides reliable, sequenced delivery of packets of data between hosts and multiplexes / demultiplexes streams of packets from/to user processes representing ports.

### **ISAKMP**

Internet Security Association and Key Management Protocol (ISAKMP)

### **ISDN**

Integrated Services Digital Network (ISDN)

### **ISL**

ISL stands for Inter-Switch Link which is one of the VLAN protocols. The ISL is proprietary of Cisco and is used only between Cisco switches. It operates in a point-to-point VLAN environment and supports up to 1000 VLANs and can be used over Fast Ethernet and Gigabit Ethernet links only.

### **ISP**

Internet service provider (ISP)

### **ISS**

Intelligent Switch Solution (ISS).

### **IST**

The Internal Spanning Tree (IST) instance receives and sends BPDUs to the CST. The IST can represent the entire MST region as a CST virtual bridge to the outside world.

### **IVL**

Independent VLAN Learning (IVL)

### **IVR**

Inter VLAN Routing (IVR)

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**IWF**

InterWorking Function (IWF).

**KDF**

Key Derivation Functions (KDFs); TCP-AO's Traffic\_Keys are derived using KDFs. As per RFC5926, when invoked, a KDF generates a string of length Output\_Length bit based on the Master\_Key and context value. This result may then be used as a cryptographic key for any algorithm that takes anOutput\_Length length key. A KDF MAY specify a maximum Output\_Length parameter.

**L2GP**

Layer 2 Gateway Port (L2GP)

**LA**

Link Aggregation

**LACP**

Link Aggregation Control Protocol

**LAG**

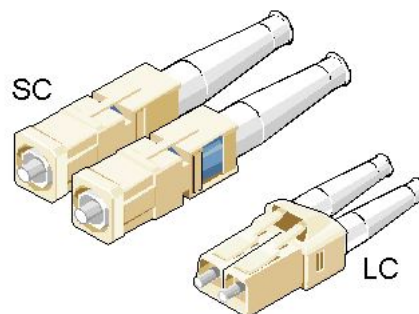
Link Aggregation Group

**LAN**

Local Area Network

**LC**

LC (Lucent Connector) is a miniaturized version of the fiber-optic SC (Standard Connector) connector. It looks somewhat like the SC, but is half the size with a 1.25mm ferrule instead of 2.5mm.



**SC and LC Connectors**

**LED**

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment.

**LLDP**

Link Layer Discovery Protocol (LLDP)

**LM**

Line Module (LM)

**LSA**

Link State Advertisement (LSA)

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**LSDB**

link state database (LSDB)

**LSR**

Link State Routing (LSR)

**MAC**

Media access control (MAC) is a sublayer of the data link layer in the seven-layer OSI network reference model. MAC is responsible for the transmission of data packets to and from the network-interface card, and to and from another remotely shared channel.

**MAU**

Medium Attachment Unit (MAU)

**MD5**

Message Digest Algorithm 5 (MD5) is a cryptographic hash algorithm that can be used to create a 128-bit string value from an arbitrary length string.

A hash function provides encryption using an algorithm and no key. A variable-length plaintext is “hashed” into a (typically) fixed-length hash value (often called a “message digest” or simply a “hash”). Hash functions are primarily used to provide integrity; if the hash of a plaintext changes, the plaintext itself has changed.

Common older hash functions include Secure Hash Algorithm 1 (SHA-1), which creates a 160-bit hash and Message Digest 5 (MD5), which creates a 128-bit hash.

Although there has been insecurities identified with MD5, it is still widely used, and its most common use is to verify the integrity of files.

**MDI**

Media Independent Interface (MDI) and Media Independent Interface with Crossover (MDIX) are basically ports on a computer and a network switch, router, or hub, respectively.

**MDIX**

Media Independent Interface with Crossover (MDIX) and Media Independent Interface (MDI) are basically ports on a computer and a network switch, router, or hub, respectively.

**MED**

- 1) Media Endpoint Discovery (MED); LLDP does not contain the capability of negotiating additional information such as PoE management and VLAN assignments. This capability was added as an enhancement known as Media Endpoint Discovery or MED, resulting in the enhanced protocol LLDP-MED. The MED enhancement has been standardized by the Telecommunications Industry Association in standard number ANSI/TIA-1057.
- 2) Multi Exit Discriminator (MED) for routes received from different autonomous systems; MED is one of the parameters considered for selecting the best path among many alternative paths. The path with a lower MED is preferred over a path with a higher MED.

**MHRP**

Multipath Hybrid Routing Protocol (MHRP) is a multipath routing protocol for hybrid Wireless Mesh Network (WMN), which provides security and uses technique to find alternate path in case of route failure.

**MIB**

Management Information Base (MIB) is the hierarchical database used by the simple network management protocol (SNMP) to describe the particular device being monitored.

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**MIB OID**

Management Information Base (MIB) is the hierarchical database used by the simple network management protocol (SNMP) to describe the particular device being monitored.

MIB Object Identifier (OID), as known as a MIB object identifier in the SNMP, is a number assigned to devices in a network for identification purposes. OID numbering is hierarchical. Using the IETF notation of digits and dots, resembling very long IP addresses, various registries such as ANSI assign high-level numbers to vendors and organizations. They, in turn, append digits to the number to identify individual devices or software processes.

**MIC**

Media redundancy Interconnection Client (MIC) is a member node of a MRP Interconnect ring.

**MIM**

Media redundancy Interconnection Manager (MIM) is a node in a MRP Interconnect ring which acts a redundancy manager.

**MLDS**

Multicast Listener Discovery Snooping (MLDS) constrains the flooding of IPv6 multicast traffic on VLANs. When MLDS is enabled on a VLAN, a device examines MLD messages between hosts and multicast routers and learns which hosts are interested in receiving traffic for a multicast group. On the basis of what it learns, the device then forwards multicast traffic only to those interfaces in the VLAN that are connected to interested receivers instead of flooding the traffic to all interfaces.

**MKT**

Master Key Tuple (MKT). TCP-AO uses cryptographic algorithms to convert MKTs, which can be shared across connections, into unique traffic keys for each connection.

**MM**

MultiMode (MM) Mode is in optical fiber with a larger core than singlemode fiber. Typically, MM has a core diameter of 50 or 62.5  $\mu\text{m}$  and a cladding diameter of 125  $\mu\text{m}$ .

**MIC**

Media redundancy Interconnection Client (MIC) is a member node of a MRP Interconnect ring.

**MPLS**

Multiprotocol Label Switching (MPLS) is a routing technique in telecommunications networks that directs data from one node to the next based on short path labels rather than long network addresses, thus avoiding complex lookups in a routing table and speeding traffic flows. The labels identify virtual links (paths) between distant nodes rather than endpoints. MPLS can encapsulate packets of various network protocols, hence the "multiprotocol" reference on its name.

**MRA**

Media Redundancy Automanager (MRA). To configure a Media Redundancy Automanager (MRA), the node or nodes elect an MRM by a configured priority value.

**MRC**

Media Redundancy Client (MRC) is a member node of a MRP ring.

**MRM**

Media Redundancy Manager (MRM) is a node in the network which acts a redundancy manager.

**MRP**

Media Redundancy Protocol (MRP) is a networking protocol designed to implement redundancy and recovery in a ring topology.

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**MSR**

- 1) MSR (MIB Save and Restore).
- 2) Model-Specific Register (*MSR*)

**MST**

MST (Multiple Spanning Tree) is the version of STP that allows multiple VLANs to a single instance. It is the standard based protocol defined with IEEE 802.1s. Unlike other spanning tree protocols, in which all the spanning tree instances are independent, MST establishes and maintains IST, CIST, and CST spanning trees.

**MSTI**

Multiple spanning trees, called MSTIs; inside an MST region, multiple spanning trees, called MSTIs, are calculated. Among these MSTIs, MSTI 0 is the IST.

**MSTP**

Multiple Spanning-Tree Protocol

**MTU**

Maximum Transmission Unit (MTU)

**MVLAN**

Multicast VLANs (MVLAN)

**NAP**

Network Access Protection (NAP)

**NAPT**

Network address port translation (NAPT) is a variation of the traditional *NAT*. NAPT extends the notion of translation one step further by also translating transport identifiers (e.g., TCP and UDP port numbers, ICMP query identifiers).

**NAS**

The Network Access Server (NAS) is the front line of authentication – it's the first server that fields network authentication requests before they pass through to the RADIUS. The NAS Identifier (NAS-ID) is a feature that allows the RADIUS server to confirm information about the sender of the authentication request.

**NAT**

Network address translation (NAT) is a method of mapping an IP address space into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device.

**NBMA**

NBMA (Non Broadcast Multi Access)

**NBNS**

NetBIOS Name Server where NetBIOS stands for Network Basic Input / Output System.

**NC**

NC (normally closed) is a closed (short) circuit creating a path for the current.

**ND**

Neighbor Discovery (ND); the Virtual Router Redundancy Protocol (*VRRP*) for IPv6 provides a much faster switchover to an alternate default router than can be obtained using standard neighbor discovery (ND) procedures.

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**NETBIOS**

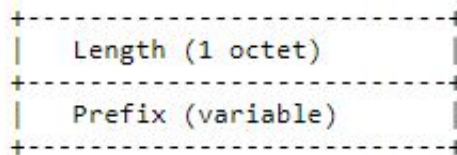
Network Basic Input / Output System (NETBIOS)

**NIP**

This set of fields are a vector of N IP unicast addresses, where the value N corresponds to the Number or Sources (N) field.

**NLRI**

Network Layer Reachability Information (NLRI). The Network Layer Reachability information is encoded as one or more 2-tuples of the form <length, prefix>, whose fields are described below.

**NMS**

Network Management System (NMS)

**NO**

NO (normally open) is an open circuit not creating a path for the current.

**NPS**

Network Policy Server (NPS)

**NSSA**

Not-so-stubby Area (NSSA)

**NTP**

Network Time Protocol (NTP)

**NVP**

Network Voice Protocol (NVP) was a pioneering computer network protocol for transporting human speech over packetized communications networks. It was an early example of Voice over Internet Protocol technology.

**NVRAM**

Non-volatile random-access memory (NVRAM) is random-access memory that retains data without applied power. This is in contrast to dynamic random-access memory (DRAM) and static random-access memory (SRAM), which both maintain data only for as long as power is applied, or such forms of memory as magnetic tape, which cannot be randomly accessed but which retains data indefinitely without electric power.

**OID**

Object Identifier

**ORF**

Outbound Route Filter (ORF); the BGP Prefix-Based ORF feature uses BGP ORF send and receive capabilities for minimizing the number of BGP updates that are sent between BGP peers. Configuring this feature can help reduce the amount of system resources required for generating and processing routing updates by filtering out unwanted routing updates at the source.

**OSPF**

Open Shortest Path First routing protocol

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**OUI**

organization unique identifiers (OUI)s. LLDP enables defining optional *TLV* units by using organization unique identifiers (OUIs) or organizationally-specific TLVs. An OUI identifies the category for a *TLV* unit depending on whether the OUI follows the IEEE 802.1 or IEEE 802.3 standard.

**P2P**

Peer-to-peer (P2P) transparent clock for Precision Time Protocol (PTP).

**PAE**

Port Access Entity (PAE). 802.1X-2001 defines two logical port entities for an authenticated port—the "controlled port" and the "uncontrolled port". The controlled port is manipulated by the 802.1X PAE (Port Access Entity) to allow (in the authorized state) or prevent (in the unauthorized state) network traffic ingress and egress to/from the controlled port. The uncontrolled port is used by the 802.1X PAE to transmit and receive EAPOL frames.

**PAP**

Password Authentication Protocol (PAP) is a password-based authentication protocol used by Point to Point Protocol (PPP) to validate users. PAP stops working after establishing the authentication; thus, it can lead to attacks on the network.

**PBB**

Provider backbone bridging (PBB) extends Layer 2 Ethernet switching to provide enhanced scalability, quality-of-service (QoS) features, and carrier-class reliability.

**PC**

Personal Computer

**PCB**

Provider Core Bridge (PCB) or S-VLAN Bridge; PCB integrates only one S-VLAN component. It is capable of providing single service on a port.

**PDU**

A Protocol Data Unit (PDU) is a single unit of information transmitted among peer entities of a computer network. A PDU is composed of protocol-specific control information and user data.

**P/E**

Program/Erase (P/E). Writing a byte to flash memory involves two steps: Program and Erase (P/E). P/E cycles can serve as a criterion for quantifying the endurance of a flash storage device.

**PEB**

Provider Edge Bridge (PEB); Provider Edge Bridge integrates one S-VLAN component with zero or many C-VLAN components as well as integrates each C-VLAN (up to 4094 C-VLANs) individually with a different S-VLAN (up to 4094 S-VLANs).

**PEM**

PEM (originally "Privacy Enhanced Mail") is the most common format for X.509 certificates, CSRs, and cryptographic keys. A PEM file is a text file containing one or more items in Base64 ASCII encoding, each with plain-text headers and footers (e.g. -----BEGIN CERTIFICATE----- and -----END CERTIFICATE-----). A single PEM file could contain an end-entity certificate, a private key, or multiple certificates forming a complete chain of trust. Most certificate files downloaded from SSL.com will be in PEM format

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**PEP**

Provider Edge Port (PEP). The Customer Edge Port and each Provider Edge Port are treated as separate Bridge Ports by the spanning tree protocol. If the C-VLAN component connects to the S-VLAN component with a single Provider Edge Port, and the associated service instance supports no more than two customer interfaces, then all frames (including Spanning Tree BPDUs) addressed to the Bridge Group Address may be relayed between the two Ports of the C-VLAN component without modification. Otherwise, the Spanning Tree Protocol Entity shall execute the Rapid Spanning Tree Protocol (RSTP, Clause 17 of IEEE Std 802.1D), as modified by the provisions of this subclause.

**PFS**

Perfect Forward Secrecy (PFS) means that a piece of an encryption system automatically and frequently changes the keys it uses to encrypt and decrypt information, such that if the latest key is compromised, it exposes only a small portion of the user's sensitive data.

If PFS is specified in the IPsec policy, a new Diffie-Hellman exchange is performed with each quick mode, providing keying material that has greater entropy (key material life) and thereby greater resistance to cryptographic attacks. Each Diffie-Hellman exchange requires large exponentiations, thereby increasing CPU use and exacting a performance cost.

**PHB**

PHB (Per Hop Behavior) is a term used in differentiated services (DiffServ) or multiprotocol label switching (MPLS). It defines the policy and priority applied to a packet when traversing a hop (such as a router) in a DiffServ network.

**PHY**

A PHY, an abbreviation for "physical layer", is an electronic circuit, usually implemented as an integrated circuit, required to implement physical layer functions of the OSI model in a network interface controller. A PHY connects a link layer device (often called MAC as an acronym for medium access control) to a physical medium such as an optical fiber or copper cable. A PHY device typically includes both physical coding sublayer (PCS) and physical medium dependent (PMD) layer functionality. PHY may also be used as a suffix to form a short name referencing a specific physical layer protocol, for example M-PHY.

**PIM**

Protocol-Independent Multicast (PIM) is a family of multicast routing protocols for Internet Protocol (IP) networks that provide one-to-many and many-to-many distribution of data over a LAN, WAN or the Internet. It is termed protocol-independent because PIM does not include its own topology discovery mechanism, but instead uses routing information supplied by other routing protocols. PIM is not dependent on a specific unicast routing protocol; it can make use of any unicast routing protocol in use on the network. PIM does not build its own routing tables. PIM uses the unicast routing table for reverse-path forwarding.

There are four variants of PIM:

- PIM Sparse Mode (PIM-SM) explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source. PIM-SM generally scales fairly well for wide-area usage.
- PIM Dense Mode (PIM-DM) uses dense multicast routing. It implicitly builds shortest-path trees by flooding multicast traffic domain wide, and then pruning back branches of the tree where no receivers are present. PIM-DM is straightforward to implement but generally has poor scaling prop-



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erties. The first multicast routing protocol, DVMRP used dense-mode multicast routing. See the PIM Internet Standard RFC 3973.

- Bidirectional PIM (Bidir-PIM) explicitly builds shared bi-directional trees. It never builds a shortest path tree, so may have longer end-to-end delays than PIM-SM, but scales well because it needs no source-specific state. See Bidirectional PIM Internet Standard RFC 5015, 70–73.
- PIM Source-Specific Multicast (PIM-SSM) builds trees that are rooted in just one source, offering a more secure and scalable model for a limited number of applications (mostly broadcasting of content). In SSM, an IP datagram is transmitted by a source *S* to an SSM destination address *G*, and receivers can receive this datagram by subscribing to channel (*S,G*). See informational RFC 3569

### **Bidirectional (Bidir) PIM**

Bidirectional PIM (Bidir-PIM) explicitly builds shared bi-directional trees. It never builds a shortest path tree, so may have longer end-to-end delays than PIM-SM, but scales well because it needs no source-specific state. See Bidirectional PIM Internet Standard RFC 5015, 70–73.

### **PIM-DM**

Protocol-Independent Multicast Dense Mode (PIM-DM) uses dense multicast routing. It implicitly builds shortest-path trees by flooding multicast traffic domain wide, and then pruning back branches of the tree where no receivers are present. PIM-DM is straightforward to implement but generally has poor scaling properties.

### **PIM-SM**

Protocol-Independent Multicast Sparse Mode (PIM-SM) explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source. PIM-SM generally scales fairly well for wide-area usage.

### **PING**

Packet INternet Groper (PING or Ping)

### **PIP**

Provider Instance Port (PIP)

### **PIR**

Peak Information Rate (PIR) is a burstable rate set on routers and/or switches that allows throughput overhead. Related to committed information rate (CIR) which is a committed rate speed guaranteed/capped.

### **PMBR**

*PIM* Multicast Border Router (PMBR)

### **PMTU**

Path Maximum Transmission Unit (PMTU)

### **PNAC**

Port Based Network Access Control (PNAC), or 802.1X, authentication requires a client, an authenticator, and an authentication server. The client is a device that wants to connect to the network.

### **PNP**

Provider Network Ports (PNP)

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**PoE**

Power over Ethernet (PoE) is distributing power over an Ethernet network. Because the power and signal are on the same cable, PoE enables remote network devices such as ceiling-mounted access points, surveillance cameras and LED lighting to be installed far away from AC power sources.

**PPP**

- Point-to-Point Protocol (PPP); The user or machine sends a request to a Network Access Server (NAS) to gain access to a particular network resource using access credentials. The credentials are passed to the NAS device via the data link layer (L2) protocol—for example, Point-to-Point Protocol (PPP) in the case of many dial up or DSL providers or posted in an HTTPS secure web form.
- Protocol Packet Processing (PPP)

**PPVID**

Port and Protocol *VLAN* ID (PPVID)

**PRP**

Parallel Redundancy Protocol (PRP) is a network protocol standard for Ethernet that provides seamless failover against failure of any network component. This redundancy is invisible to the application. PRP nodes have two ports and are attached to two separated networks of similar topology. This is in contrast to the companion standard HSR (IEC 62439-3 Clause 5), with which PRP shares the operating principle.

**PS**

Power Supply

**PTP**

Precision Timing Protocol

**PVID**

Port *VLAN* ID (PVID)

**PVLAN**

Private *VLAN* (PVLAN); Private *VLAN*, also known as port isolation, is a technique in computer networking where a *VLAN* contains switch ports that are restricted such that they can only communicate with a given uplink. The restricted ports are called private ports

**PVRST**

Per *VLAN* Rapid Spanning-Tree

**PVRSTP**

Per *VLAN* Rapid Spanning-Tree Protocol

**PW**

An Ethernet pseudowire (PW) is used to carry Ethernet/802.3 Protocol Data Units (PDUs) over an MPLS network. See RFC 4448 for details.

**Q-in-Q**

802.1Q tunneling (Q-in-Q) is a technique often used by Ethernet providers as a layer 2 VPN for customers. During 802.1Q (or dot1q) tunneling, the provider will put an 802.1Q tag on all the frames that it receives from a customer with a unique *VLAN* tag. By using a different *VLAN* tag for each customer we can separate the traffic from different customers and also transparently transfer it throughout the service provider network.

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**QoS**

Quality of Service (QoS) refers to traffic prioritization and resource reservation control mechanisms rather than the achieved service quality. QoS defines the ability to provide different priorities to different applications, users, or data flows or the ability to guarantee a certain level of performance to a data flow.

**QRV**

Querier's Robustness Variable (QRV).

**RADIUS**

Remote Authentication Dial-In User Service

**RAM**

Random-access memory (RAM) is a form of computer memory that can be read and changed in any order, and typically is used to store working data and machine code.

**RARP**

The Reverse Address Resolution Protocol (RARP) is an obsolete computer communication protocol used by a client computer to request its Internet Protocol (IPv4) address from a computer network, when all it has available is its link layer or hardware address, such as a MAC address.

**RBAC**

Role Based Authentication (RBAC)

**RED**

- 1) Random early detection (RED) is where a single queue may have several different sets of queue thresholds.
- 2) Redundant interface (RED) or Red (e.g. RED 1 or RED 2).

**RFD**

A flapping route is an unstable route that is advertised and withdrawn over and over again. Every time a flap occurs, a BGP UPDATE message is sent. When routers have to process many BGP UPDATE messages, their CPU load increases.

BGP route dampening can be used to prevent installing flapping BGP routes and forwarding them to other BGP routers. This decreases the CPU load of routers and increases network stability. Nowadays, routers are powerful enough to process BGP updates so dampening isn't considered a best practice anymore

RFP has 5 attributes - the default values are shown

- Penalty
- Suppress-Limit - 2000
- Half-Life - 900 secs
- Reuse limit - 750
- Maximum Suppress-Limit -3600 secs (60 min)

When the route exceeds the suppress limit, the route is dampened. Once the route is dampened, the router won't install the route in the routing table nor advertise it to other BGP neighbor.

If for example the penalty is 4000 and the half-life time is 15 minutes. After 15 minutes the penalty will be 2000, after another 15 minutes, the penalty is 1000, and after another 15 minute, the penalty is 500. Once the penalty is below the reuse limit of 750, the route can be used again and

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advertised to other BGP routers. When the penalty is below 50% of the reuse limit, the penalty is removed from the route.

The maximum suppress limit ensures that a route won't be dampened forever. The maximum suppress time is 3600 secs or 60 minutes by default.

#### **RFL**

Route Reflector Client (RFL); The route reflector allows all IBGP speakers within your autonomous network to learn about the available routes without introducing loops

#### **RIB**

Routing Information Base (RIB); Routing and routing functions in enterprise and carrier networks are typically performed by network devices (routers and switches) using an RIB. Protocols and configuration push data into the RIB and the RIB manager installs state into the hardware for packet forwarding.

#### **RIP**

**RIP** (Routing Information Protocol) sends routing-update messages at regular intervals and when the network topology changes. When a router receives a routing update that includes changes to an entry, it updates its routing table to reflect the new route. The metric value for the path is increased by 1, and the sender is indicated as the next hop. RIP routers maintain only the best route (the route with the lowest metric value) to a destination. After updating its routing table, the router immediately begins transmitting routing updates to inform other network routers about the change. These updates are sent independently of the regularly scheduled updates that RIP routers send. RIP uses a hop count as a way to determine network distance. Each host with a router in the network uses the routing table information to determine the next host to route a packet for a specified destination.

#### **RMON**

Remote network monitoring (RMON) is the process of monitoring network traffic on a remote Ethernet segment for detecting network issues such as dropped packets, network collisions, and traffic congestion

#### **RP**

Rendezvous point (RP)

#### **RPF**

RPF stands for Reverse Path Forwarding. PIM uses reverse-path forwarding (RPF) to prevent multicast routing loops by leveraging the unicast routing table on the virtual router. When the virtual router receives a multicast packet, it looks up the source of the multicast packet in its unicast routing table to see if the outgoing interface associated with that source IP address is the interface on which that packet arrived. If the interfaces match, the virtual router duplicates the packet and forwards it out the interfaces toward the multicast receivers in the group. If the interfaces don't match, the virtual router drops the packet. *This is called a RPF failure.*

#### **RPT**

Root Part Tree (RPT)

#### **RRD**

Route Redistribution (RRD)

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## **RSVP**

Resource Reservation Protocol (RSVP) is a transport layer protocol designed to reserve resources across a network using the integrated services model. RSVP operates over an IPv4 or IPv6 and provides receiver-initiated setup of resource reservations for multicast or unicast data flows.

## **RS-232**

RS-232 is a short range connection between a single host and a single device (such as a PC to a modem) or another host (such as a PC to another PC). The standard uses a single TX line, a single RX line, numerous modem handshaking lines and a ground line with the option of DB9 and DB25 connectors. A minimal 3-wire RS-232 connection consists only the TX, RX, and ground lines, but if flow control is required a minimal 5-wire RS-232 is used adding the RTS and CTS lines. The RS-232 standard has been commonly used in computer serial ports and is still widely used in industrial communication devices.

## **RS-422**

RS-422 was meant as a replacement for RS-232 as it offered much higher speeds, better immunity to noise and allow for longer cable lengths making it better suited to industrial environments. The standard uses the same signals as the RS-232 standard, but used differential twisted pair so requires double the number of wires as RS-232. Connectors are not specified in the standard so block or DB connectors are commonly used. RS-422 cannot implement a true multi-point communications network since there can be only one driver on each pair of wires. However, one driver can fan-out to up to ten receivers.

## **RS-485**

RS-485 standard addresses some short coming of the RS-422 standard. The standard supports inexpensive local networks and multidrop communication links, using the same differential signalling over twisted pairs as RS-422. The main difference being that in RS-485 drivers use three-state logic allowing the individual transmitters to deactivate while not transmitting, while RS-422 the transmitter is always active therefore holding the differential lines. Up to 32 devices can be connected, but with repeaters a network with up to 256 devices can be achieved. RS-485 can be used in a full-duplex 4-wire mode or half-duplex 2-wire mode. With long wires and high baud-rates it is recommended that termination resistors are used at the far ends of the network for signal integrity

## **RST**

RST stands for reset. RST is one of the TCP flags.

TCP flags are various types of flag bits present in the TCP header. Each of them has its own significance. They initiate connections, carry data, and tear down connections. The commonly used TCP flags are SYN, ACK, RST, FIN, URG, PSH.

- SYN (synchronize): Packets that are used to initiate a connection.
- ACK (acknowledgment): Packets that are used to confirm that the data packets have been received, also used to confirm the initiation request and tear down requests.
- RST (reset): Signify the connection is down or maybe the service is not accepting the requests.
- FIN (finish): Indicate that the connection is being torn down. Both the sender and receiver send the FIN packets to gracefully terminate the connection.
- PSH (push): Indicate that the incoming data should be passed on directly to the application instead of getting buffered.
- URG (urgent): Indicate that the data that the packet is carrying should be processed immediately by the TCP stack.

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**RSTP**

Rapid Spanning-Tree Protocol

**RT**

Route Target (RT) value; RT can be used to share routes among them. We can apply route targets to a VRF to control the import and export of routes among it and other VRFs. When you configure RT import, it imports all prefixes that match the configured RT value as one of the attributes in the BGP update. So in any-any VRF, it is common to see all PE configured with same RT value

**RTM**

Routing Table Manager (RTM). The RTM is the central repository of routing information for all routing protocols that operate under the routing and remote access service (RRAS). It provides routing information to all interested clients, such as routing protocols, management programs, and monitoring programs. The RTM also determines the best route to each destination network that is known to the routing protocols. The determination of this route is based on routing protocol priorities and on the metrics associated with the routes.

**RTS**

Request to Send (RTS)/CTS Flow Control is another flow control mechanism that is part of the RS232 standard.

**RX**

Receive

**SA**

Security Associations (SA). A SA is a relationship between two or more entities that describes how the entities will utilize security services to communicate securely. In endpoint-to-endpoint Transport Mode, both end points of the IP connection implement IPSec.

**SAN**

Singly attached nodes (SAN); singly attached nodes don't have the same redundancy as the doubly attached nodes since they still have just one connection that could fail.

**SEM**

State Event Machines (SEM)

**SFP**

SFP (Small Form-factor Pluggable) is a small transceiver that plugs into the SFP port of a network switch and connects to fibre channel and gigabit Ethernet (GbE) optical fiber cables at the other end. The SFP converts the serial electrical signals to serial optical signals and vice versa. SFP modules are hot swappable and contain ID and system information for the switch.

**SFTP**

SSH File Transfer Protocol (SFTP)

**SHA**

Secure Hash Algorithm is the name of a series of hash algorithms.

A hash function provides encryption using an algorithm and no key. A variable-length plaintext is "hashed" into a (typically) fixed-length hash value (often called a "message digest" or simply a "hash"). Hash functions are primarily used to provide integrity; the hash of a plaintext changes, the plaintext itself has changed.

Common older hash functions include Secure Hash Algorithm 1 (SHA-1), which creates a 160-bit hash and Message Digest 5 (MD5), which creates a 128-bit hash.

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**SIP**

Session Initiation Protocol (SIP) is mostly well known for establishing voice and video calls over the Internet. To initiate such sessions, SIP uses simple request and response messages. For example, the INVITE request message is used to invite a user to begin a session and ACK confirms the user has received the request. The response code 180 (Ringing) means the user is being alerted of the call and 200 (OK) indicates the request was successful. Once a session has been established, BYE is used to end the communication.

**SISP**

Switch Instance Shared Port (SISP)

**SLA**

Service-level agreements (SLA).

**SLIP**

Serial Line Internet Protocol (SLIP); SLIP is the predecessor protocol of Point-to-Point Protocol (PPP). SLIP does not provide authentication, is a static IP addressing assignment, and data is transferred in synchronous form.

**SM**

State Machine

**SNAT**

Static Network Address Translation (SAT, SNAT) performs one-to-one translation of internal IP addresses to external ones.

**SNMP**

Simple Network Management Protocol

**SNTP**

Simple Network Time Protocol (SNTP)

**SPT**

Shortest path tree (SPT) is used for multicast transmission of packets with the shortest path from sender to recipients.

**SR**

State Refresh (SR) message. For a given (S,G) tree, SR messages will be originated by all routers that use an interface directly connected to the source as the RPF interface for the source. Ref: IETF "State Refresh in PIM-DM"

**SRM**

State Refresh Message (SRM). For a given (S,G) tree, SRM will be originated by all routers that use an interface directly connected to the source as the RPF interface for the source. Ref: IETF "State Refresh in PIM-DM"

**SSD**

SSD (Solid State Drive) is an all-electronic, non-volatile random access storage drive.

**SSH**

(Secure SHell) is a security protocol for logging into a remote server. SSH provides an encrypted session for transferring files and executing server programs on all platforms. Also serving as a secure client/server connection for applications such as database access and email, SSH supports a variety of authentication methods.

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**SSL**

Secure Sockets Layer

**SSM**

Source-Specific Multicast (SSM)

**SST**

Single Spanning Tree (SST); SST is formed in either of the following situations:

- A switch running STP or RSTP belongs to only one spanning tree.
- An MST region has only one switch.

**STP**

Spanning Tree Protocol (STP) is a Layer 2 protocol that runs on bridges and switches. The specification for STP is IEEE 802.1D. The main purpose of STP is provide path redundancy while preventing undesirable loops in the network.

**SVL**

Shared VLAN Learning (SVL)

**S-VLAN**

Stacked VLAN (S-VLAN)

**TAC**

Taxonomy Access Control (TAC) allows the user administrator to control access to nodes indirectly by controlling which roles can access which categories.

**TACACS**

Terminal Access Controller Access-Control System

**TAI**

International Atomic Time (TAI); if the port is in the master state, the local clock is synchronized to an external source of time traceable to TAI (International Atomic Time) and UTC (Universal Coordinated Time) such as GPS (Global Positioning System) system.

**TB**

Token Bucket (TB). The TB algorithm is based on an analogy of a fixed capacity bucket into which tokens, normally representing a unit of bytes or a single packet of predetermined size, are added at a fixed rate. When a packet is to be checked for conformance to the defined limits, the bucket is inspected to see if it contains sufficient tokens at that time. If so, the appropriate number of tokens, e.g. equivalent to the length of the packet in bytes, are removed ("cached in"), and the packet is passed, e.g., for transmission. The packet does not conform if there are insufficient tokens in the bucket, and the contents of the bucket are not changed.

**TC**

TC (Topology Change); once the Root Bridge is aware of a change in the topology of the network, it sets the Topology Change (TC) flag on the sent BPDs.

**TCN**

TCN (Topology Change Notification), a kind of BPDU, is sent by bridges towards the root bridge to notify changes in the topology, such as port up or port down.

**TCP**

Transmission Control Protocol



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## TCP-AO

TCP-AO MKT (Transmission Control Protocol Authentication Option). TCP-AO uses cryptographic algorithms to convert MKTs, which can be shared across connections, into unique traffic keys for each connection.

## TCP-AO MKT

TCP-AO MKT (Transmission Control Protocol Authentication Option Master Key Tuple). TCP-AO uses cryptographic algorithms to convert MKTs, which can be shared across connections, into unique traffic keys for each connection.

## TFTP

Trivial File Transfer Protocol

## TLS

Transport Layer Security (TLS), the successor of the now-deprecated Secure Sockets Layer (SSL), is a cryptographic protocol designed to provide communications security over a computer network.

## TLV

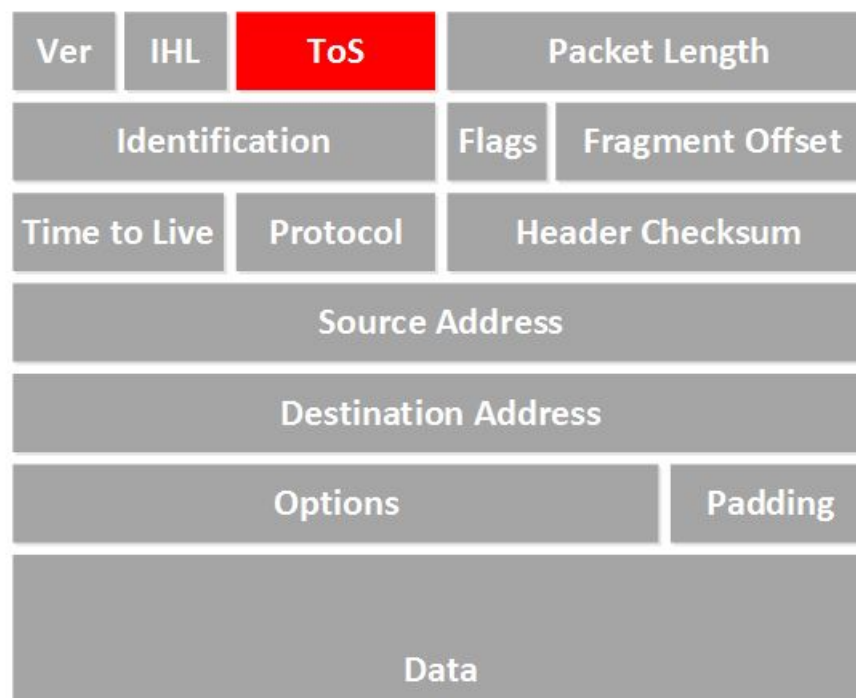
type, length, and value (TLV) traces

## TN

Telnet (TN) is a networking protocol and software program used to access remote computers and terminals over the Internet or a TCP/IP computer network. Upon providing correct login and sign-in credentials, a user may access a remote system's privileged functionality. Telnet sends all messages in clear text and has no specific security mechanisms.

## TOS

Type of Service (TOS). IP packets have a field called the Type of Service field (also known as the TOS byte).



## TPID

Tag Protocol Identifier (TPID)

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**TTL**

TTL (time to live). Under IP, TTL is an 8-bit field. In the IPv4 header, TTL is the 9th octet of 20. In the IPv6 header, it is the 8th octet of 40. The maximum TTL value is 255, the maximum value of a single octet. A recommended initial value is 64.

**TX**

Transmit

**UAP**

Uplink Access Port (UAP); when a tagged LLDP is enabled, the LLDP packets with destination address as 'nearest bridge address (01-80-c2-00-00-0E)' will be replicated for all S-Channels emulated over that UAP.

**UART**

UART (Universal Asynchronous Transmitter Receiver) is the most common protocol used for full-duplex serial communication. It is a single LSI (large scale integration) chip designed to perform asynchronous communication. This device sends and receives data from one system to another system.

**UDP**

User Datagram Protocol

**UFD**

Uplink failure detection (UFD)

**URM**

Unified Route Map (URM)

**USM**

USM stands for User based Security Model; USM (User based Security Model) and VACM (View-based Access Control Model) are the main features added as a part of the SNMPv3 specification. USM provides both encryption and authentication of the SNMP PDUs, while VACM specifies a mechanism for defining access policies for different users with different MIB trees.

**UTC**

Coordinated Universal Time (UTC); If the port is in the master state, the local clock is synchronized to an external source of time traceable to TAI (International Atomic Time) and UTC (Universal Coordinated Time) such as GPS (Global Positioning System) system.

**UTP**

Unshielded Twisted Pair (UTP) is a pair of wires that are twisted around each other to minimize interference. Ethernet cables are common example of UTP wires.

**UUID**

A Universally Unique Identifier (UUID) is a 128-bit domain UUID unique to a MRP domain/ring. All MRP instances belonging to the same ring must have the same domain ID.

**VACM**

VACM stands for View-based Access Control Model; USM (User based Security Model) and VACM (View-based Access Control Model) are the main features added as a part of the SNMPv3 specification. USM provides both encryption and authentication of the SNMP PDUs, while VACM specifies a mechanism for defining access policies for different users with different MIB trees.

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**Varbind**

A Variable Binding (Varbind) represents a set of Oid/Value pairs. Individual Variable Bindings are stored in the Vb class. Individual Variable Bindings are stored in the Vb class.

Create a variable binding and add the Object identifier in string format:

```
Vb vb = new Vb("1.3.6.1.2.1.1.0")
```

Create a variable binding and add the Object identifier in Oid format:

```
Oid oid = new Oid("1.3.6.1.2.1.1.0");
```

```
Vb vb = new Vb(oid);
```

**VFI**

Virtual Forwarding Interface (VFI)

**VID**

Management VLAN ID (VID)

**VINES**

Virtual Integrated Network Service (VINES)

**VLAN**

Virtual Local Area Network (VLAN) is a logical subgroup within a local area network that is created via software rather than manually moving cables in the wiring closet.

**VPN**

Virtual Private Network (VPN)

**VRF**

Virtual Routing and Forwarding (VRF). In IP-based computer networks, VRF is a technology that allows multiple instances of a routing table to co-exist within the same router at the same time. One or more logical or physical interfaces may have a VRF and these VRFs do not share routes; therefore, the packets are only forwarded between interfaces on the same VRF. VRFs are the TCP/IP layer 3 equivalent of a VLAN. Because the routing instances are independent, the same or overlapping IP addresses can be used without conflicting with each other.

**VRRP**

**VRRP** (Virtual Router Redundancy Protocol) is an election protocol that dynamically assigns responsibility for one or more virtual router(s) to the VRRP router(s) on a LAN, allowing several routers on a multi-access link to utilize the same virtual IP address. A VRRP router is configured to run the VRRP protocol in conjunction with one or more other routers attached to a LAN. In a VRRP setup, one router is elected as the virtual router master, and the other routers are acting as backups in case of the failure of the virtual router master. VRRP is designed to eliminate the single point of failure inherent in the static default routed environment

**VSA**

Vendor Specific Attribute (VSA)

**WAN**

A wide area network is a telecommunications network that extends over a large geographic area for the primary purpose of computer networking.

**Web UI**

Web User Interface (Web UI) is a control panel in a device presented to the user via the Web browser. Network devices such as gateways, routers, and switches typically have such control panel

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that is accessed by entering the IP address of the device into a Web browser in a computer on the same local network.

#### **WINS**

Windows Internet Naming Service (WINS)

#### **WRED**

*WRED* (Weighted Random Early Detection) is a queueing discipline for a network scheduler suited for congestion avoidance. It is an extension to random early detection (RED) where a single queue may have several different sets of queue thresholds.

#### **WRR**

Weighted Round Robin (WRR) is one of the scheduling algorithms used by the device. In WRR, there is a number of queues and to every queue is assigned weight ( $w$ ). In a classical WRR, the scheduler cycles over the queues, and when a queue with weight  $w$  is visited, the scheduler can send consequently a burst of up to  $w$  packets. This works well for packets with the same size.

#### **XNS**

Xerox Network Systems (XNS)

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