

MDS™ Orbit MCR-4G

Managed Connected Router 4G and WiFi



MDS 05-6628A01, Rev. C
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Digital Energy
MDS

Quick-Start instructions for this product are contained in publication 05-6702A01.

Visit our website for downloadable copies of all documentation at **www.gemds.com**.

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RF Safety Notice (English and French)

RF Exposure



Concentrated energy from a directional antenna may pose a health hazard to humans. Do not allow people to come closer to the antenna than the distances listed in the table below when the transmitter is operating. More information on RF exposure can be found online at the following website:

www.fcc.gov/oet/info/documents/bulletins.

l'exposition aux RF



Concentré d'énergie à partir d'une antenne directionnelle peut poser un risque pour la santé humaine. Ne pas permettre aux gens de se rapprocher de l'antenne que les distances indiquées dans le tableau ci-dessous lorsque l'émetteur est en marche. Plus d'informations sur l'exposition aux RF peut être trouvé en ligne à l'adresse suivante: [www.fcc.gov / oet / info / documents et bulletins](http://www.fcc.gov/oet/info/documents/bulletins).

Antennas must not be co-located. All transmission antennas must be at least 20 cm apart to comply with FCC co-location rules.

Orbit Device vs. Minimum RF Safety Distance

Radio Module Type	Minimum Safety Distance from Antenna
MCR-4G	20 cm
MCR-900	23 cm
Other models	Consult factory prior to operation.

FCC Part 15 Notice

Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any unauthorized modification or changes to this device without the express approval of the manufacturer may void the user's authority to operate this device. Furthermore, this device is intended to be used only when installed in accordance with the instructions outlined in this manual. Failure to comply with these instructions may void the user's authority to operate this device.

Industry Canada Notice

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Operational Safety Notices

The MDS Orbit MCR-4G may not be used in an environment where radio frequency equipment is prohibited or restricted in its use. This typically includes aircrafts, airports, hospitals, and other sensitive electronic areas.

Do not operate RF devices in an environment that may be susceptible to radio interference resulting in danger, specifically:

- **Areas where prohibited by law**

Follow any special rules and regulations and obey all signs and notices. Do not use the MCR-4G when you suspect that it may cause interference or danger.

- **Near Medical and life support equipment**

Do not use the MCR-4G in any area where medical equipment, or life support equipment may be located, or near any equipment that may be susceptible to any form of radio interference.

Cellular Operational Bands

The following table shows the bands in which the cellular module operates for each wireless technology.

System	Band	Band Name	Uplink (MHz)	Downlink (MHz)
CDMA	BC0	Cellular	824 – 849	869 – 894
	BC1	pcs	1850 – 1910	1930 – 1990
GPRS/EDGE	850	Cellular	824 – 849	869 – 894
	900	900	880.0 – 914.8	925.0 – 959.8
	1800	DCS	1710.2 – 1784.8	1805.2 – 1879.8
	1900	PCS	1850 – 1910	1930 – 1990
HSPA+	V	Cellular	824 – 849	869 – 894
	VIII	900	880 – 915	925 – 960
	II	PCS	1850 – 1910	1930 – 1990
	I	IMT	1920 – 1980	2110 – 2170
LTE	XIII	Verizon 700	777 – 787	746 – 756
GPS	L1	GPS	NA	1565.19 – 1585.65
	L1	Glomass		1598.06 – 1605.94

FCC IDs of Installed Transmitters

As of the printing date, the following identifiers are assigned to the modules listed below. For the latest, official listings of all agency approvals, please contact your factory representative.

CELL Modem FCC ID: PKRNVWE362, IC ID: 3229B:E362

WIFI Module FCC ID: M4Y-ZCN722MV1, IC ID 3195A-ZCN722MV1

CE Mark and RTTE Notice

This product, using the "WIFI internal radio module" only, is CE marked and compliant with the RTTE directive. Other configurations will be added for EU use in future releases.

Servicing Precautions

No user-serviceable parts are contained inside this equipment. Opening of the unit by unauthorized personnel voids the warranty. All servicing must be performed by an authorized repair facility.

When servicing energized equipment, be sure to wear appropriate Personal Protective Equipment (PPE). During internal service, situations could arise where objects accidentally contact or short circuit components and the appropriate PPE would alleviate or decrease the severity of potential injury. When servicing equipment, all workplace regulations and other applicable standards for live electrical work should be followed to ensure personal safety.

Manual Revision and Accuracy

This manual was prepared to cover a specific version of firmware code. Accordingly, some screens and features may differ from the actual unit you are working with. While every reasonable effort has been made to ensure the accuracy of this publication, product improvements may also result in minor differences between the manual and the product shipped to you. If you have additional questions or need an exact specification for a product, please contact GE MDS using the information at the back of this guide. In addition, manual updates can be found on our web site at www.gemds.com

Environmental Information

The manufacture of this equipment has required the extraction and use of natural resources. Improper disposal may contaminate the environment and present a health risk due to hazardous substances contained within. To avoid dissemination of these substances into our environment, and to limit the demand on natural resources, we encourage you to use the appropriate recycling systems for disposal. These systems will reuse or recycle most of the materials found in this equipment in a sound way. Please contact GE MDS or your supplier for more information on the proper disposal of this equipment.



Battery Disposal—This product may contain a battery. Batteries must be disposed of properly, and may not be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. Batteries are marked with a symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point. For more information see: www.weerohsinfo.com.

Product Test Data Sheets

Test Data Sheets showing the original factory test results for this unit are available upon request from the GE MDS Quality Leader. Contact the factory using the information at the back of this manual. Serial numbers must be provided for each product where a Test Data Sheet is required.

CSA/us Notice

This product is approved for use in Class 1, Division 2, Groups A, B, C & D Hazardous Locations. Such locations are defined in Article 500 of the National Fire Protection Association (NFPA) publication NFPA 70, otherwise known as the National Electrical Code. The transceiver has been recognized for use in these hazardous locations by the Canadian Standards Association (CSA) which also issues the US mark of approval (CSA/us). The CSA Certification is in accordance with CSA STD C22.2 No. 213-M1987.

CSA Conditions of Approval: The transceiver is not acceptable as a stand-alone unit for use in the hazardous locations described above. It must either be mounted within another piece of equipment which is certified for hazardous locations, or installed within guidelines, or conditions of approval, as set forth by the approving agencies. These conditions of approval are as follows: The transceiver must be mounted within a separate enclosure which is suitable for the intended application. The antenna feedline, DC power cable and interface cable must be routed through conduit in accordance with the National Electrical Code. Installation, operation and maintenance of the transceiver should be in accordance with the transceiver's installation manual, and the National Electrical Code. **Tampering or replacement with non-factory components may adversely affect the safe use of the transceiver in hazardous locations, and may void the approval.** A power connector with screw-type retaining screws as supplied by GE MDS must be used.



Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous. Refer to Articles 500 through 502 of the National Electrical Code (NFPA 70) for further information on hazardous locations and approved Division 2 wiring methods.

1.0 INTRODUCTION

This manual describes the MDS Orbit MCR-4G Managed Connected Router ([Figure 1](#)). The unit is a highly secure, industrial grade, wireless communication product for broad-based applications including control center monitoring, well site pad operations, and video surveillance. It serves the need for localized WiFi communications with a cellular back-up or backhaul option, while providing the extended temperature range and industrial-grade packaging inherent to GE MDS products. These features allow the best use of communication options at each installation site.



Figure 1. MCR-4G Unit
(Standard 2E1S configuration shown)

With a common hardware architecture and user interface, the MCR offers flexibility in network design and application, with simplified training, maintenance, and deployment costs. GE MDS provides an array of communication products with multiple interface options and a variety of enclosures to give customers the choice and flexibility to design their communications network to meet geographic and industry specific challenges. Information on other GE MDS products can be found by visiting our website at www.gemds.com.

1.1 About This Manual

This manual is intended for systems engineers, network administrators, and others responsible for planning, commissioning, using, and troubleshooting the wireless system. Installation steps are *not* included in this publication. For installation instructions, refer to the companion *MCR-4G Setup Guide*, part no. 05-6702A01. Electronic copies of all user documentation are available free of charge at www.gemds.com.



The MCR-4G Setup Guide, Part no. 05-6702A01, contains installation instructions, as well as basic startup information for this product.

All GE MDS user manuals and updates are available online at www.gemds.com.

1.1.1 Software Command Notations

The product is designed for software control via a connected PC. As such, there are no external controls or adjustments present. To show the names of software commands, keyboard entries, or other information displayed on a PC screen, a bolded font is used throughout the manual. In the case of tabular data displayed on a PC screen, a variation on this font is used to maintain proper layout. (See examples that follow.)

Bolded font example (used in text for software commands and keyboard entries)

Bolded font example (used to show tables displayed on a PC screen)

In the Device Management section of this manual (Section 3.0), there are a number of command strings where information is presented by the unit, and a reply is required from the user. In such cases, information from the unit is shown in a non-bolded font, and the user response is shown in bold. For example:

(none) login: **admin**

Further, in some cases, command lines will be shown with non-bolded, *italicized* text contained within the string. Such text indicates the need for user-supplied variable parameters, such as the name of an item. For example:

set interfaces interface *myBridge* virtual-type bridge

In the above example, you would enter the specific name of your bridge to complete the entry.

NOTE: The software commands and responses shown in this manual were obtained from a unit operating in a lab environment. The information displayed may differ from field service conditions.



2.0 PRODUCT DESCRIPTION

The MCR-4G is a rugged networking router providing comprehensive solutions for IP/Ethernet, serial, and machine-to-machine wireless communication. This industrial package provides integrated 4G LTE wireless technology and connectivity for Ethernet and serial devices requiring secure operation.

2.1 Key Features

MCR units include the following key features:

- **Security**—The unit uses industry-leading security features to protect data while maintaining compatibility with deployed infrastructures. Features include AAA user access with passwords and lock-out protection, VPNs, signed firmware, secure booting, integrity management, and more.

NOTE: The Orbit MCR device is designed for high security environments. As such, management of the device does not support Telnet, but instead implements the more secure SSH protocol.

- **Small Form Factor**—The unit is housed in a rugged enclosure suited for operation in harsh industrial environments. It requires only protection from direct exposure to the weather, and may be easily mounted inside a NEMA enclosure for outdoor applications when required.
- **Network Interfaces**—Several network interfaces are present to provide connectivity for a variety of equipment and applications. Ethernet, serial, and WiFi interfaces provide local connections while a cellular interface provides access to public carrier networks.
- **User Interface**—Multiple user interfaces are provided for configuration and monitoring of the unit. These include local serial console, web, SSH, USB, and NETCONF.

NOTE: When the unit is installed in hazardous locations, use only the serial or Ethernet connections on the unit's front panel. Do *not* use the USB port in hazardous locations.

- **NETCONF**—A next-generation management protocol is used that provides an array of features for device configuration and monitoring.
- **Network Management System**—The PulseNET Network Management System allows administering and monitoring the operation of small-to-large scale deployments.

2.2 Interface Types

MCR units are offered in two external interface offerings; 2 Ethernet/1 Serial (2E1S), or 2 Serial/1 Ethernet (2S1E). The 2E1S configuration ([Figure 1](#)) is the standard model and is the focus of this manual. Most information applies equally to both configurations, however.

2.3 Typical Application

The unit provides flexibility in network communications and may be used in a wide variety of applications. In a common scenario, it provides cellular connectivity to locally-connected devices that are located on a local/internal/private LAN or WiFi network. The unit acts as an Access Point on the WiFi interface to provide connectivity to WiFi clients. [Figure 2](#) shows an example network in which the unit provides connectivity to multiple end devices. The end devices are connected via Ethernet, serial, and WiFi links.

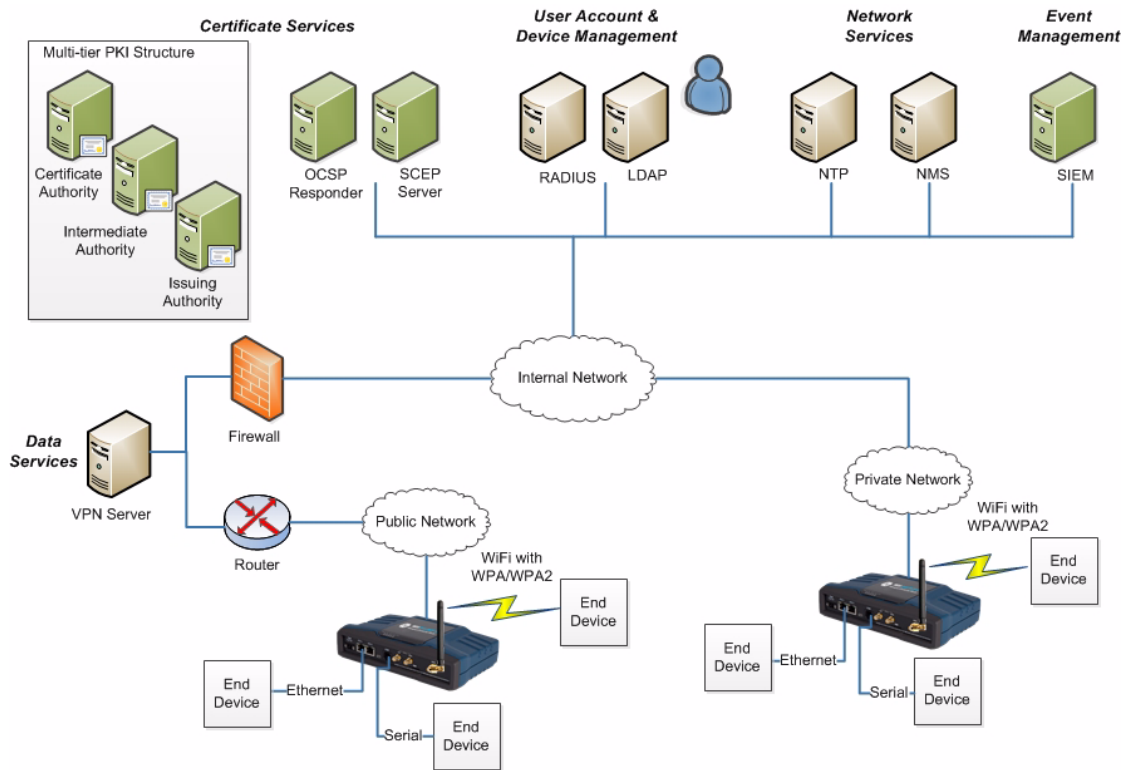


Figure 2. Typical MCR Application

2.4 Connectors and Indicators

Figure 3 shows the unit's front panel connectors and indicators. These items are referenced in the text that follows. The unit's LED Indicator Panel is described in Table 4 on Page 9.

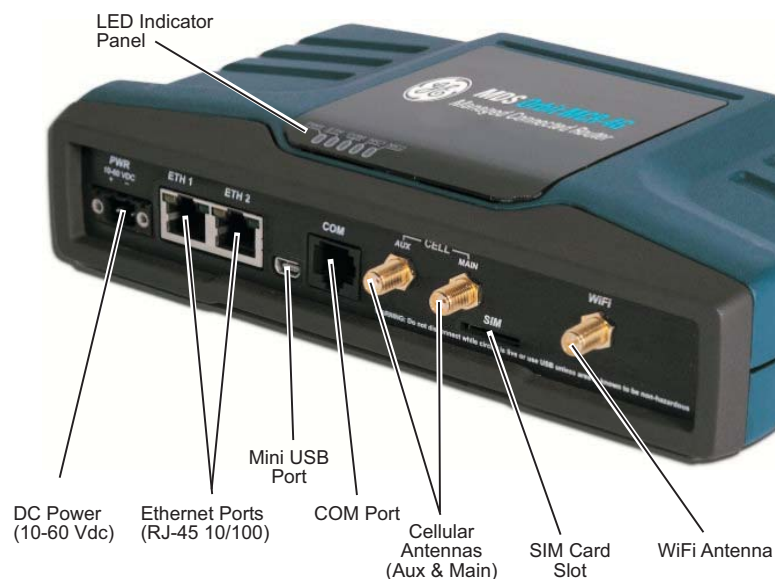


Figure 3. Connectors and Indicators
(2E1S configuration shown)

PWR—Two-conductor DC input connection. The unit includes a 6-foot (1.83 meter) power cable suitable for indoor or outdoor use when properly connected. The DC power connector ([Figure 4](#)) is keyed, and can only be inserted one way.

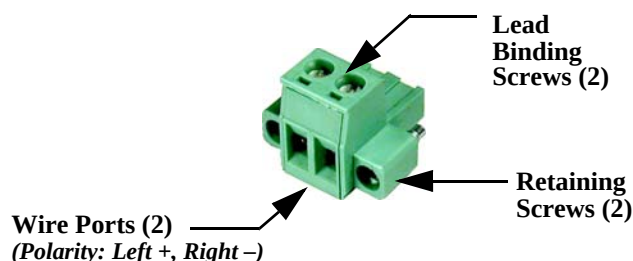


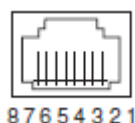
Figure 4. DC Power Connector (P/N 73-1194A39)

NOTE: The unit is designed for use in negative ground DC power systems only.

Input voltage to the unit must be well filtered, and within the range of 10-60 Vdc. The maximum rated power consumption of the device is 15 watts, but actual power may be much less, depending on configuration. The power supply must be capable of supplying the expected maximum power for the installation. For expected power requirements in common configurations, [see “Technical Specifications” on Page 86](#).

ETH1 / ETH2— Ethernet connection port. These ports support both device management and payload data transport. Depending on product version, the unit may have one or two Ethernet ports. This is a standard RJ-45 jack, and features MDIX auto-sensing capability, allowing straight-through or crossover cables to be used.

Connecting to the unit via SSH supports device management and provides the same user interface available using the unit’s COM1 serial port. Various options are available for passing Ethernet data, allowing system administrators to optimize the configuration for maximum efficiency, based on the system’s operating characteristics.



(As viewed from the outside of the unit)

Table 1. ETH1/2 Pin Details

Pin	Function
1	Transmit Data (TX) High
2	Transmit Data (TX) Low
3	Receive Data (RX) High
4	Unused
5	Unused
6	Receive Data (RX) Low
7	Unused
8	Unused

USB Port—This port allows for connection of a laptop or PC. The port provides a local console for management of the device. A standard host-to-mini device USB 2.0 cable may be used.

COM Port—This connector serves as the serial interface port for both console management and payload data. By default, the port is enabled for local console control. The COM port serves as the primary interface for connecting the unit to an external DTE serial device supporting RS-232 or RS-485. If necessary, an adapter may be used to convert the unit's RJ-45 serial jack to a DB-9F type (GE MDS 73-2434A12).

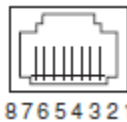
NOTE: Not all PCs include a serial port. If one is not available, the unit's USB port may be used to access the device management interface. Alternatively, a PC's USB port may be used with a USB-to-Serial adapter and appropriate driver software. These devices are available from several manufacturers.

The COM port supports a serial data rate of 1200-115200 bps (115200 default, asynchronous only). The unit is hardwired as a DCE device. Supported data formats for the COM port are:

- 8N1** - 8 char bits, no parity, 1 stop bit (*Default setting*)
- 8N2** - 8 char bits, no parity, 2 stop bits
- 8O1** - 8 char bits, odd parity, 1 stop bit
- 8O2** - 8 char bits, odd parity, 2 stop bits
- 8E1** - 8 char bits, even parity, 1 stop bit
- 8E2** - 8 char bits, even parity, 2 stop bits
- 7N1** - 7 char bits, no parity, 1 stop bit
- 7N2** - 7 char bits, no parity, 2 stop bits
- 7O1** - 7 char bits, odd parity, 1 stop bit
- 7O2** - 7 char bits, odd parity, 2 stop bits
- 7E1** - 7 char bits, even parity, 1 stop bit
- 7E2** - 7 char bits, even parity, 2 stop bits.

The tables below provide pin descriptions for the COM1 data port in RS-232 mode and RS-485 modes, respectively.

NOTE: The COM2 port, if present, is restricted to RS-232 mode; it cannot be used for RS-485.



(As viewed from the outside of the unit)

Table 2. COM1/2 Port Pin Details (RS-232)

Pin Number	Input/Output	Pin Description
1	Reserved	
2	OUT	DCD (Data Carrier Detect)
3	Reserved	
4	Ground	Connects to ground (negative supply potential) on chassis

Table 2. COM1/2 Port Pin Details (RS-232) (Continued)

Pin Number	Input/Output	Pin Description
5	OUT	RXD (Received Data)—Supplies received data to the connected device
6	IN	TXD (Transmitted Data)—Accepts TX data from the connected device
7	OUT	CTS (Clear to Send)
8	IN	RTS (Ready to Send)

Table 3. COM1 Port Pin Details (RS-485)

Pin Number	Input/Output	Pin Description
1	Reserved	
2	OUT	DCD (Data Carrier Detect)
3	Reserved	
4	Ground	Connects to ground (negative supply potential) on chassis
5	OUT	TXD+ (Transmitted Data +)—Non-inverting driver output. Supplies received payload data to the connected device.
6	IN	RXD+ (Received Data +)— Non-inverting receiver input. Accepts payload data from the connected device.
7	OUT	TXD-/TXB (Transmitted Data -)—Inverting driver output
8	IN	RXD-/RXB (Received Data -)— Inverting receiver input

COM1 Port notes and wiring arrangements (RS-485):

The COM1 port supports 4-wire and 2-wire RS-485 mode.

- RXD+ / RXB and RXD- / RXA are data sent *into* the unit
- RXD+ / RXB is positive with respect to RXD- / RXA when the line input is a "0"
- TXD+ / TXB and TXD- / TXA are data sent *out* by the unit
- TXD+ / TXB is positive with respect to the TXD- / TXA when the line output is a "0"

Cell Antennas (AUX and MAIN)—These SMA coaxial connectors are for attachment of cellular antennas. The MAIN connection is for basic cellular transmission/reception, and the AUX connector is for attachment of a receive-only antenna which provides MIMO receive operation (diversity) with standard 4G modules, improving signal quality in many installations. In general, both antennas should always be used for cellular operation. The GE MDS part number for this antenna type is 97-2485A04.



Figure 5. Directly-Connected Cellular Antenna (Typical Style)
(GE MDS Part No. 97-2485A04)

WiFi Antenna—Antenna connection for 2.4 GHz WiFi service. The connector appears similar to the cellular connectors discussed above, but is a *Reverse-SMA* type. It contains a pin that matches with an SMA-F connector. The GE MDS part number for this antenna is 97-4278A48.

SIM Port—This port accepts a mini SIM card (2FF type) for 4G cell operation. The unit's cellular interface will not function without a valid SIM card installed. The customer is responsible for obtaining a provisioned SIM card for the appropriate service plan from their cellular provider. Information on determining the cell module's IMSI/IMEI (typically required for provisioning) is provided on [Page 35](#) of this manual.



CAUTION: *Do not* insert the SIM card when the unit is powered on.

Card Insertion: The SIM card only inserts one way; do not force it. It should be inserted with the printed label facing up, and the cut-off corner on the left side (see [Figure 6](#)). This side is inserted first. A small instrument, such as a flathead screwdriver, may be helpful to *gently* push the SIM all the way in until it locks.

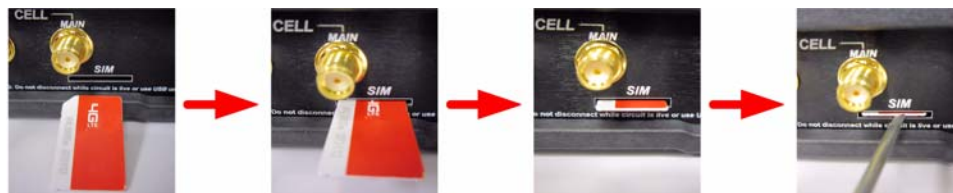


Figure 6. Steps for Inserting the SIM Card

LED Status Indicators—The LEDs on the unit provide visual indications of the status of the device as shown in Figure 7 and explained in Table 4 which follows.



Figure 7. LED Status Indicators

Table 4. Description of LED Status Indicators

LED Name	LED State	Description
PWR (DC Power)	Off	No power to unit
	Solid Green	Unit is powered, no problems detected
	Fast Blink/Red (1x/sec.)	Alarm indication
ETH (Ethernet)	Off	No Ethernet link to network
	Solid Green	Ethernet link present
	Blinking Green	Ethernet traffic in/out
COM (Serial Comm. Port)	Off	No serial connection, or idle
	Blinking Green	Serial traffic in/out
NIC1 (Cell)	Off	No cellular connection
	Solid Green	Cell Connection
NIC2 (WiFi)	Off	Interface disabled
<i>Access Point Mode</i>	Solid Green	Operating as AP and at least one client connection
	Solid Red	Operating as an AP and no client connection
<i>Station Mode</i>	Off	No connection
	Solid Green	Wi-Fi connection established.

NOTE: In addition to the LEDs above, the Ethernet connector has two embedded LEDs. A yellow indicates a link at 100 Mbps operation. A flashing green indicates Ethernet data traffic.

2.4.1 Grounding Considerations

To minimize the chance of damage to the unit and its connected equipment, a safety ground (NEC Class 2 compliant) is recommended, which bonds the chassis, antenna system(s), power supply, and connected data equipment to a *single-point* ground, keeping all ground leads as short as possible.

Normally, the unit is adequately grounded if mounted with the flat brackets to a well-grounded metal surface. If the unit is not mounted to a grounded surface, it is recommended that a safety ground wire be attached to the screw provided on the bottom corner of the enclosure, in the recessed flat area. Alternatively, a safety ground wire may be attached to one of the mounting bracket screws.

The use of a lightning protector is recommended where the antenna cable enters the building; Bond the protector to the tower ground, if possible. All grounds and cabling must comply with applicable codes and regulations. One source for lightning protection products may be found online at <http://www.protectiongroup.com/PolyPhaser>.

2.4.2 Mounting Options

The unit may be mounted with flat mounting brackets *or* an optional 35 mm DIN rail attachment. [Figure 8](#) shows the mounting dimensions for a unit equipped with flat mounting brackets.

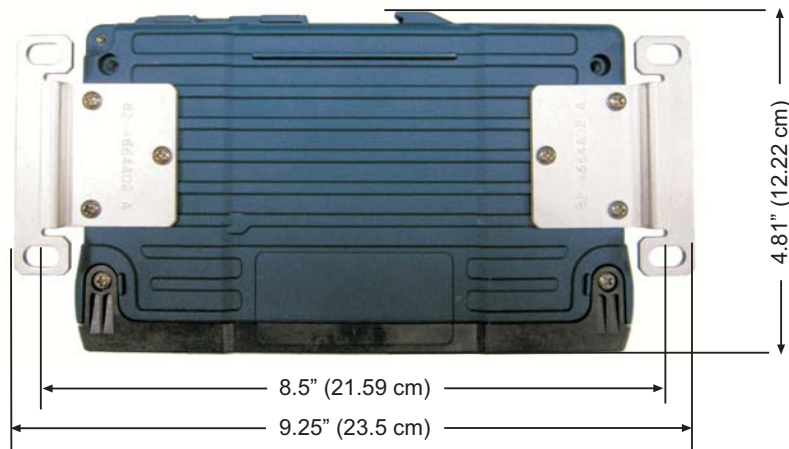


Figure 8. Flat Mounting Bracket Dimensions

NOTE: To prevent moisture from entering the unit, do not mount the case with the cable connectors pointing up. Also, dress all cables to prevent moisture from running along the cables and into the unit.

2.4.3 Optional DIN Rail Mounting

If ordered with the DIN rail mounting option, the unit is supplied with a DIN rail clip attached to the case. The integrated bracket on the unit's case allows for quick installation and removal from a DIN mounting rail as shown in [Figure 9](#).



Figure 9. DIN Rail Attachment and Removal
(Pull down tab to release from rail)

2.4.4 Antenna Planning & Installation

Consideration must be taken to select appropriate antennas for optimal RF performance. This section reviews the key factors involved in selecting and installing antennas for the MCR-4G. Only approved antennas may be used on the unit's RF output connectors, as listed in [Table 5](#). The use of non-approved antennas may result in a violation of FCC rules, and subject the user to FCC enforcement action.

Table 5. Approved Antenna Types

Antenna Application	GE MDS Part Number
WiFi (direct connect), RP SMA, 2.4-2.5 GHz Antenna, 3.2dBi Gain	97-4278A34
WiFi (external mount), Omni Ant. N M Term., 2.4-2.5 GHz, 2 dBi Gain	97-4278A48
Cell (direct connect), 960/2170/2700MHz	97-2485A04
Cell (external mount, ground plane), 960/2170/2700MHz, requires ground	97-2485A05
WiFi (Magnetic Mount) 5 ft./1.52 m Cable, RP SMA Plug	97-4278A78

Antenna Type and Orientation

It is important to use antennas designed to operate in the applicable cellular coverage bands with a Return Loss of 10 dB or better. Placement of the antennas also plays a key role in the coverage of the system. While the antennas can be placed directly on the face of the unit in some short range installations, the best performance is obtained when mounting antennas remotely using low loss coaxial cable. Antennas mounted in close proximity to each other can couple signals between them and desensitize the RF module.

When placing the indoor SMA style “paddle” antennas on the face of the unit, position them with a 90 degree angle of separation to improve the isolation. A “V” or an “L” configuration is a common approach to use *with the Main channel typically mounted for vertical polarization*. The multipath nature of Cellular systems means that polarization for indoor use is not normally a critical factor. Isolation between the antennas is more important.

Note that with any installation, there needs to be a minimum 20 cm spacing between the Wi-Fi antenna and any other radio antenna to avoid co-location difficulties.

Indoor use case:

1. This scenario employs direct mounting of an LTE paddle antenna (GE MDS PN: 97-2485A04) on the Main and Aux Cell channels, and cabled mounting of the Wi-Fi antenna (GE MDS PN: 97-4278A34) using a magnetic mount (GE MDS PN: 97-4278A78). This configuration offers easy mobility for evaluation purposes or indoor applications with good cellular signal coverage (see [Figure 10](#)).



Figure 10. Direct Mounting of Cell Antenna; Cabled WiFi Antenna
Minimum 8-inch (20.32 cm) separation between cell and WiFi antennas

2. This arrangement employs cabled mounting of the LTE paddle antennas (GE MDS 97-2485A04) on the Main and AUX Cell channels, and cabled mounting of the Wi-Fi antenna (GE MDS 97-4278A34) using a magnetic mount (GE MDS 97-4278A78). The Wi-Fi antenna may also be directly attached to the unit if desired. This configuration works well for indoor installations in equipment closets, or for more permanent applications.

Outdoor use case:

External enclosures—If the system is going to be installed in a weathertight enclosure and mounted outside in the elements, cabled use of external LTE antennas (GE MDS PN: 97-2485A05) on the Main and AUX Cell ports, with cabled use of the External Wi-Fi antenna (GE MDS PN: 97-4278A48) is a good solution. This configuration requires a suitable metallic ground plane for the Cellular antennas (8" diameter disc minimum for the 97-2485A05 series) or a suitable counterpoise for frequencies as low as 698 MHz. Metal enclosures work well for ground plane requirements when ground contact inside the box is not impeded by painted surfaces.

Do *not* use internally mounted antennas inside of metal enclosures.

Other antenna configurations can be easily customized for applications not listed here. Consult your factory representative for installation matters.

2.4.5 Accessories and Spares

Table 6 lists common accessories and spare items for use with the MCR-4G. GE MDS also offers an *Accessories Selection Guide* listing an array of additional items that may be used with the product. Contact your factory representative or visit www.gemds.com to obtain a copy of the guide.

Table 6. Accessories & Ancillary Items

Item	Description	Part Number
DC Power Plug, 2-pin, polarized	Mates with power connector on the unit's case. Screw terminals are provided for wires, threaded locking screws to prevent accidental disconnect.	73-1194A53
Setup Guide (for installation instructions)	Describes the installation and setup of the unit. It is a companion to this Technical Manual. PDF copy available free at www.gemds.com .	05-6702A01
Flat Mounting Bracket Kit	Brackets that attach to the bottom of the unit. Used for mounting to a flat mounting surface.	03-4123A14
COM Port Adapter	Converts the unit's RJ-45 serial jack to a DB-9F type.	73-2434A12



3.0 DEVICE MANAGEMENT

This section describes the steps for connecting a PC, logging in, and setting unit parameters. The focus here is on the local serial console interface, but other methods of connection are available and offer similar capabilities. The key differences are with initial access and appearance of data.

The MCR offers several interfaces to allow device configuration and monitoring of status and performance. These include local serial console, USB, NETCONF, HTTPS, and Secure Shell (SSH) for local and remote access via the WAN and LAN networks. The serial console, USB, and SSH services offer a command line interface (CLI). There are three user accounts/roles for management access: **admin**, **tech**, and **oper**. User accounts can be centrally managed with a RADIUS server. RADIUS accounts can be mapped to one of the three user accounts/roles (see [“RADIUS” on Page 71](#)).

NOTE: The Orbit MCR device is designed for high security environments. As such, management of the device does not support Telnet, but instead implements the more secure SSH protocol.

Web-Based Device Manager

A web-based user interface is also available for this product. The web interface provides an intuitive, graphical facility, well-suited for many simple routine configuration and control tasks. An introduction and sample screens for the web interface are provided in [“APPENDIX G – Device Manager” on Page 129](#).

3.1 Connecting to a PC

3.1.1 Differences Between Serial & SSH

Serial and SSH both present identical management capabilities, but the method of access is different for each. Serial involves an RS-232 serial connection from a PC to the unit’s management COM port. SSH uses an Ethernet PC connection to the unit’s ETH port. Maximum recommended cable length for a serial connection is 50 feet (15 meters). SSH can be connected to the unit from any network point that has connectivity with the PC, including remotely over the Internet, or using other networks.

The focus of these instructions is on *Serial* access, but SSH may also be used by following these additional points, which replace Steps 1-3 below:

- Connect to the unit with a PC that is on the same IP network as the MCR. Launch an SSH client program, and connect to the unit using its programmed IP address.
- The default IP address for the unit is 192.168.1.1. If you do not know the current IP address of the unit, follow the serial configuration instructions below, where you can determine the address and continue configuration, or check with your network administrator.

3.1.2 Establishing Communication—Serial Interface

Follow these steps to configure the unit for its first use with serial console interface:

1. Connect a PC to the unit’s COM port as shown in [Figure 11](#). (Maximum recommended cable length: 50 ft./15 m)

NOTE: Not all PCs include a serial port. If one is not available, a USB port may be used, along with a USB-to-Serial adapter (with appropriate driver software). Adapters are available from many manufacturers, including GE MDS. The MCR Orbit’s USB port can be used to access the device management console by using a Mini-USB cable between the device and a PC. The PC needs to register the device driver.

NOTE: If the COM port has been configured for terminal server operation, pressing +++ switches it to console (management) mode. Serial console mode is required for the following steps.

Launch a terminal communications program, such as HyperTerminal with the following communication parameters: **115200 bps (default speed), 8 bits, no parity, one stop bit (8N1), and flow control disabled**. Incorrect parameter settings are a frequent cause of connection difficulties; Double check to be sure they are correct.

If necessary, an adapter may be used to convert the unit's RJ-45 serial jack to a DB-9F type (GE MDS part no. 73-2434A12). If no serial port exist on the PC, a USB-to-serial adapter cable may be used to connect to the MCR unit, or a Mini-USB cable may be connected between the MCR's USB device port and the PC.

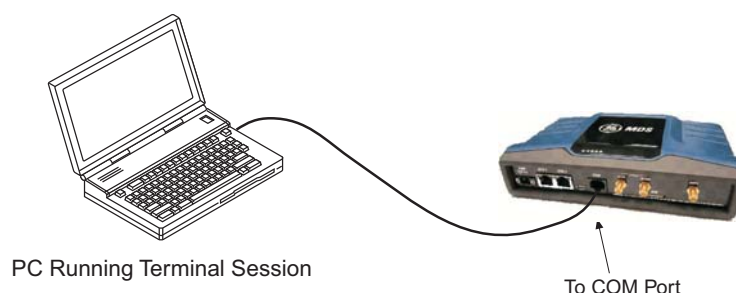


Figure 11. PC Connection for Programming/Management

2. Press the **ENTER** key to receive the **Login:** prompt. This indicates that the unit is ready to receive commands.
3. At the **Login:** prompt, enter **admin** (lower case) and press **ENTER**.
4. If no password has been previously set, enter the default password (**admin**) and press **ENTER**; Otherwise, enter the saved password at the **Password:** prompt. (Before placing the unit in final service, it is recommended that the default password be changed to ensure that only authorized users have access.)
5. After successful login, the command prompt appears where you may configure and manage a number of unit settings.

3.1.3 Setting Basic Parameters—First Steps

There are three tasks that should be performed after initial startup and connection to a PC, as follows:

1. Create One-Time Programmable passwords for device recovery in the event a password is lost.
2. Change the login passwords.
3. Evaluate the default factory configuration and set it to the user's required security level.

Tab Completion Feature

Tab-completion is a powerful feature that presents CLI users with assistance while typing. Depending on the text that was already entered, tab-completion will display different possible completions. When the tab key is pressed and no text has been entered, the CLI shows all possible commands that can be typed.

3.1.4 One-Time “Recovery” Passwords



The MDS Orbit platform employs extensive security measures to prevent unauthorized access. As such, there are no hidden manufacturer passwords or other “backdoors” found in less secure products. If a password is lost, there is no way to access the unit, except by using a one-time password (OTP) for recovery. This must be established by the user beforehand. Without a one-time password, the unit will not be accessible, and the hardware will need to be replaced. ***Not even the factory will be able to assist you if a password is lost, so creating a one-time password is strongly encouraged.***

One-Time Passwords: How They Work

One-time recovery passwords put control directly and exclusively in the user’s hands. They are similar to spare keys for a lock. If you make a spare key, and put it away safely, you can take it out to quickly gain entry when your primary key is lost. If you don’t make a spare, you are always at risk of locking yourself out.

A one-time recovery password is different from the one used to log into the unit on a routine basis. It is *only* for use when the primary password is lost or forgotten. When a one-time password is used to log in, that password is *automatically revoked* from the list of passwords created. (You may create up to five one-time passwords at one time, and more can be created if some get used). A password cannot be used again for log-in to the unit (hence the name “one-time” password).

Creating a One-Time Password

To create a one-time recovery password, proceed as follows:

1. Upon successful log-in, enter the following command:

request system recovery one-time-passwords create function <selected function>

A one-time password is automatically generated and displayed on the screen. Copy this password and save it in the desired location on your PC. **There is no way to ever view it again from the command line console, so be sure it is properly saved.**

2. To create additional one-time passwords (up to a total of five), repeat the step above.

Logging in With a One-Time Password

Logging in with a one-time password can only be performed from the local serial or USB console. You cannot use a one-time password when connecting to the unit remotely. To use the one-time password for log-in, proceed as follows:

1. At the username prompt, enter the word **recovery**.
2. At the **password** prompt, paste in the one-time-password saved earlier on your PC. Using a one-time-password forces the unit to perform the “function” which was previously defined when the password was created:
 - **factory-reset**—The unit resets its entire configuration to factory defaults
 - **login**—The unit allows logging in with “admin” privileges

Special case: If someone has disabled console access on the COM port, the login prompt will still be present on that console, but only one-time-passwords will be accepted. This is done to provide a way to recover the unit in the case where the COM port has been disabled and the unit cannot be accessed via TCP (for example; SSH).

Deleting a One-Time Password

As noted earlier, a one-time password is automatically revoked when it is used for log-in. A revoked password may be replaced, but it must first be removed from the list so a new one can be generated. Any of the five stored passwords may be removed on demand. As long as there is a free slot, an additional password can be created, up to the maximum number of five. Logs are generated when the user creates, deletes or logs in with a one-time-password. To remove an existing password from the list, proceed as follows:

Enter the command **request system recovery one-time-passwords delete identifier X**, where X is a number from the currently available one-time passwords. This identifier is not reused. If all five passwords have been created, then ID 1 can be deleted, and the next created password will be at ID 6.

The current list of passwords may be viewed by issuing the command **show system recovery one-time-passwords**. The following is an example output from that command. On the unit shown, only two passwords have been stored. Password 1 or 2 can be deleted from this list.

IDENTIFIER	FUNCTION	STATUS	DATE CREATED	DATE	USER
				REVOKED	
1	login	usable	2012-06-19T00:27:24+00:00		
2	login	usable	2012-06-19T00:27:25+00:00		

3.2 Pre-Configured Settings

The MCR is highly configurable to meet field requirements, but comes pre-configured as follows:

- The COM and USB ports are enabled for local console operation
- The Ethernet ports are bridged with the WiFi AP
- WiFi AP SSID is set based on the unit's serial number, and takes the form of: **GEMDS_<SERNUM>**. The unit's serial number is printed on the chassis sticker.
- WiFi is enabled with passphrase: **GEMDS_ORBIT**
- A DHCP server is enabled for WiFi clients and the Ethernet LAN ports
- Cellular service is enabled with firewall/router rules in place.
- The following default *configured firewall rules* are also in effect:

```
# Firewall
set services firewall enabled true
set services firewall address-set LOCAL-NETS addresses [ 192.168.1.0/24 ]
set services firewall filter IN_TRUSTED rule 10 match protocol all
set services firewall filter IN_TRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp
set services firewall filter IN_UNTRUSTED rule 1 actions action accept
set services firewall filter IN_UNTRUSTED rule 2 match protocol udp
set services firewall filter IN_UNTRUSTED rule 2 match src-port services [ dns ]
set services firewall filter IN_UNTRUSTED rule 10 match protocol all
set services firewall filter IN_UNTRUSTED rule 10 actions action drop
set services firewall filter OUT_TRUSTED rule 10 match protocol all
set services firewall filter OUT_TRUSTED rule 10 actions action accept
set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set LOCAL-NETS
set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true
set services firewall filter OUT_UNTRUSTED rule 10 match protocol all
set services firewall filter OUT_UNTRUSTED rule 10 actions action drop
set services firewall nat source rule-set MASQ rule 1 source-nat interface
```

The commands below show how the default settings are made. The unit must be in Configuration Mode to make these settings. Each command string begins with the word **set**:

1. **set interfaces interface Wi-Fi physical-interface Wi-Fi**
2. **set interfaces interface Wi-Fi wifi-config mode access-point ap-config ap GEMDS_1 broadcast-ssid true privacy-mode wpa2-personal psk-config psk GEMDS_ORBIT**
3. **set interfaces interface Cell physical-interface Cell**

4. **set interfaces interface Cell ipv4 dhcp**
5. **set interfaces interface Cell filter input IN_UNTRUSTED**
6. **set interfaces interface Cell filter output OUT_UNTRUSTED**
7. **set interfaces interface Cell nat source MASQ**
8. **set services serial console serial-ports [COM1 USB1]**
9. **set interfaces interface ETH1 physical-interface ETH1**
10. **set interfaces interface ETH2 physical-interface ETH2**
11. **set interfaces interface Bridge virtual-type bridge**
12. **set interfaces interface Bridge filter input IN_TRUSTED**
13. **set interfaces interface Bridge filter output OUT_TRUSTED**
14. **set interfaces interface Bridge ipv4 address 192.168.1.1 prefix-length 24**
15. **set interfaces interface Bridge bridge-settings members port ETH1**
16. **set interfaces interface Bridge bridge-settings members port ETH2**
17. **set interfaces interface Bridge bridge-settings members wifi-ap GEMDS_1**
18. **set services dhcp v4subnet 192.168.1.0/24 range-start 192.168.1.2 range-end 192.168.1.10 broadcast-address 192.168.1.255 router 192.168.1.1**
19. **set services dhcp enabled true**

3.3 YANG Interface

The unit employs a data modeling language called YANG to model the configuration and status of the device. YANG is used in conjunction with the NETCONF protocol to provide a device-specific data model that can be administered by any NETCONF-capable NMS. The YANG data model is released with each version of the device so NMS administrators can accurately administer the device per release.

Together, YANG and NETCONF present a structured user interface for the unit. The device data defined by the YANG data model is either Operational Data or Configuration Data. Configuration Data may be changed, but Operational Data can only be viewed.

Configuration Data

Configuration Data is any piece of data that can be changed by an administrator and the changes are persistent even if the device reboots. The IP address of the LAN port is an example of Configuration Data.

Operational Data

Operational Data is any piece of data that is volatile and will not be saved if the device is rebooted. Operational data is typically *read-only*, such as statistics information showing status or a value representing the operation of the device. Ethernet statistics are an example of operational data.

Default Values

While configuring the unit, some of the configuration data may not need to be explicitly set, but instead the data assumes the default value defined in the data model. For example, when a File Server configuration is added and the server type is specified as TFTP, then the remote TFTP port will default to **69** if the user does not explicitly specify the port. Data nodes that do not have a default value will require entry of a value for that node during configuration. The command line interface (CLI) prompts for entry of a node value if the node is mandatory and does not have a default value.

When viewing the configuration, the nodes that have default values and have not been explicitly set by the user are *not* displayed. Users can selectively view these defaulted values by using **details** option on the CLI. The **show** command can be used to view configuration data. Notice that the information displayed is different, depending on which mode the CLI is in; *Operational* or *Configuration*.

Remote Procedure Call (Request)

This is an action that a user requests. Rebooting of the device, for example, is considered a request.

Privilege

A user who logs on to the device will belong to a role-based group. Each group is limited in capability to view operational data or to change configuration data. Groups with lesser privileges will not be presented with the option to view or change data on the CLI, which can be done by higher-privileged groups.

Changing Configuration Data and committing changes

Changing configuration data requires two steps. The first step is to use a user-interface to add, remove, or alter a piece of configuration data. The second step is to use the user-interface to *commit* the change. Multiple changes can be made prior to committing them. This two-step process allows users to make multiple changes to the configuration and apply them in a bulk commit. Additionally, the device can validate the bulk commit and reject it if there is an error.

3.3.1 CLI Login Prompt

The CLI is available via the serial console or an SSH session. Use the default serial console settings shown in the section titled “[Serial Console](#)” on Page 26 to connect a Computer to the unit via a serial cable. Once the network settings are configured, users can also connect to the device via SSH over the network.

The CLI prompts for a login to the device before any other actions can be made. The defaults for both username and password are **admin**. These credentials should be changed before placing the unit in full service.

```
(none) login: admin
Password: (valid password, default is admin)
Welcome to the CLI
admin connected from 127.0.0.1 using console on (none)
admin@(none) 04:24:12>
```

Using the CLI

This section describes how to use the CLI by using an example: changing the name of the unit.

Step 1: Login to the device using the serial console and use the default username **admin** and the default password **admin**.

```
(none) login: admin
Password:
Welcome to the CLI
admin connected from 127.0.0.1 using console on (none)
admin@(none) 04:24:12>
```

Step 2: Instruct the device to enter configuration mode by typing **configure** and pressing the enter key:

```
admin@(none) 04:51:06> configure
Entering configuration mode private
[ok][2012-06-20 04:51:07]
[edit]
admin@(none) 04:51:07%
```

Step 3: Change the device name by typing in the following, followed by enter: **set system name Device539**

```
admin@(none) 05:31:14% set system name Device539
[ok][2012-06-20 05:32:45]
[edit]
admin@(none) 05:32:45%
```

Step 4: Verify the change looks correct by reading the data back using the following, followed by the enter key: **show system name**

```
admin@(none) 05:32:53% show system name
name Device539;
[ok][2012-06-20 05:35:28]
[edit]
admin@(none) 05:35:28%
```

Step 5: Commit the change by typing in the following, followed by the enter key: **commit**

```
admin@(none) 05:36:20% commit
Commit complete.
[ok][2012-06-20 05:36:21]
[edit]
admin@Device539 05:36:21%
```

Step 6: Exit the configuration mode by typing the following, followed by the enter key: **exit**

```
admin@Device539 05:40:15% exit
[ok][2012-06-20 05:40:17]
admin@Device539 05:40:17>
```

Step 7: Exit the login session by typing the following, followed by the enter key: **exit**

```
admin@Device539 05:40:32> exit
Device539 login:
```

CLI Quick Reference Table

Table 7 provides a summary listing of commonly-needed tasks and the appropriate commands to enter. The table can be used as a quick reference before consulting the more detailed information which follows in this section. Each CLI command is preceded by the symbol > for operational command, or % for a configuration command.

Table 7. CLI Quick Reference Table

<i>If you wish to...</i>	<i>Enter this CLI command:</i>
Create a one-time password	> request system recovery one-time-password create function <user function>
View all network interface status and statistics	> show interfaces
Create a bridge	% set interfaces interface <i>myBridge</i> virtual-type bridge
Add the ETH1 interface to a bridge	% set interfaces interface <i>myBridge</i> bridge-settings members port ETH1
Remove the ETH1 interface from a bridge	% delete interfaces interface <i>myBridge</i> bridge-settings members port ETH1
Set WiFi AP SSID	% set interfaces interface <i>Wi-Fi</i> wifi-config mode access-point ap-config ap <i>myssid</i>
Enable WiFi WPA2-Personal security	% set interfaces interface <i>Wi-Fi</i> wifi-config mode access-point ap-config ap <i>myssid</i> privacy-mode <i>wpa2-personal</i> psk-config psk <i>mypassphrase</i> encryption <i>ccmp</i>
Enable WiFi SSID Broadcasting	% set interfaces interface <i>Wi-Fi</i> wifi-config ap-config ap <i>myssid</i> broadcast-ssid true
View WiFi settings	> show configuration interfaces interface <i>Wi-Fi</i> wifi-config details
Monitor WiFi statistics	> show interfaces interface <i>Wi-Fi</i> statistics repeat 5
View the cell module status	> show interfaces interface <i>Cell</i>
View the cell APN	> show configuration interfaces interface <i>Cell</i> cell-config apn
View the routing table	> show routing
View the event log	> show table logging event-log
Set the admin user's password	> request system authentication change-password user <i>admin</i> password <i>admin1234</i>
Set the device name	% set system name "Mydevice"
Set the baud rate on COM1	% set services serial ports <i>COM1</i> baud-rate <i>b19200</i>
Download a firmware package from TFTP server at 192.168.1.10	> request system firmware reprogram-inactive-image filename <i>ivc-bkrc-1_0_0.mpk</i> manual-file-server { tftp { address 192.168.1.10 } }
Monitor firmware download status	> show system firmware reprogramming-status
Export configuration file to a TFTP server at 192.168.1.10	> request system configuration-files export filename <i>myConfig.txt</i> manual-file-server { tftp { address 192.168.1.10 } }
Reboot device to firmware image #2	> request system power restart-to-image location 2

Specific Examples

Example #1

In Figure 12, the MCR-4G is functioning as a WiFi Access Point to provide connectivity between a set of laptops and a handheld device. The MCR-4G is also acting as a DHCP server for the laptops and handheld device.

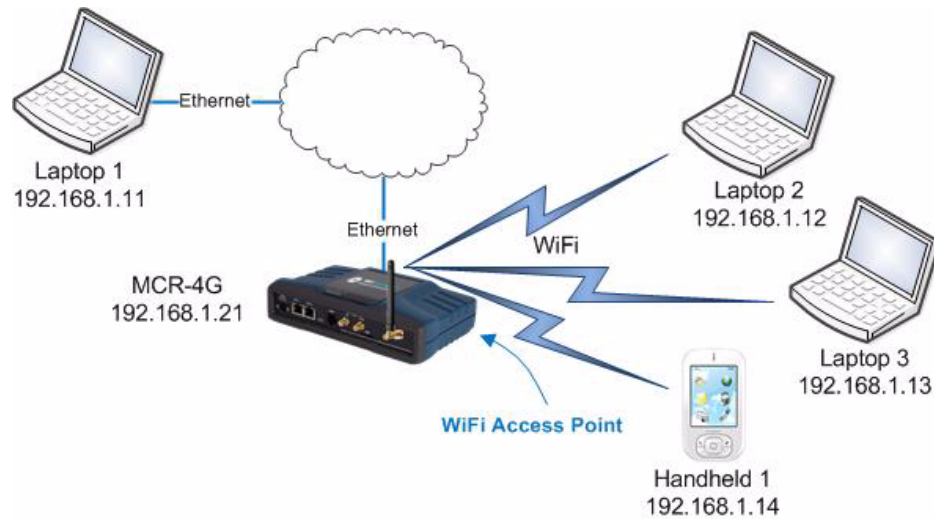


Figure 12. Example 1: Unit Providing Laptop and Handheld Device Connectivity

The following commands will configure the MCR-4G for this scenario.

1. `% set interfaces interface Wi-Fi physical-interface Wi-Fi`
2. `% set interfaces interface Wi-Fi wifi-config mode access-point ap-config ap myssid enabled true`
3. `% set interfaces interface myBridge virtual-type bridge`
4. `% set interfaces interface myBridge bridge-settings members port ETH1`
5. `% set interfaces interface myBridge bridge-settings members wifi-ap myssid`
6. `% set interfaces interface myBridge ipv4 address 192.168.1.21 prefix-length 24`
7. `% set services dhcp enabled true v4subnet 192.168.1.0/24 domain-name gemds range-start 192.168.1.10 range-end 192.168.1.19 router 192.168.1.1 broadcast-address 192.168.1.255`

Example #2

In Figure 13, there are two MCR-4G devices, one acting as a WiFi Access Point, the other as a WiFi Station. Together, the MCR-4G devices are providing a wireless bridge between the laptop and the SCADA device.

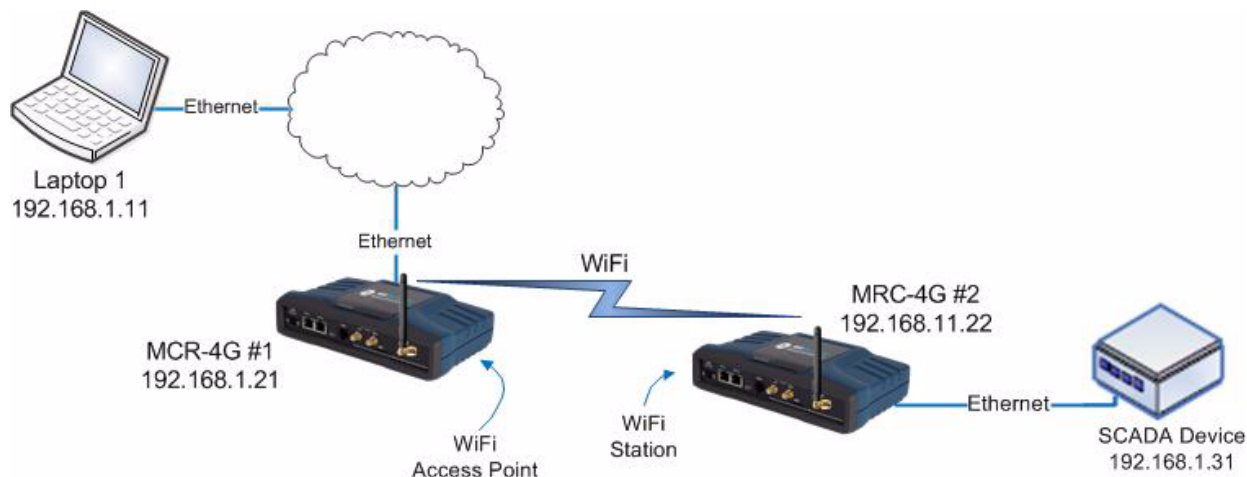


Figure 13. Example 2: Units Providing Wireless Bridge Between Laptop & SCADA Device

The following commands will configure the MCR-4G #1 for this scenario.

1. `% set interfaces interface Wi-Fi physical-interface Wi-Fi`
2. `% set interfaces interface Wi-Fi wifi-config mode access-point ap-config ap myssid`
3. `% set interfaces interface myBridge bridge-settings members port ETH1`
4. `% set interfaces interface myBridge bridge-settings members wifi-ap myssid`
5. `% set interfaces interface myBridge ipv4 address 192.168.1.21 prefix-length 24`
6. `% set services dhcp enabled true v4subnet 192.168.1.0/24 domain-name gemds range-start 192.168.1.10 range-end 192.168.1.19 router 192.168.1.1 broadcast-address 192.168.1.255`

The following commands will configure the MCR-4G #2 for this scenario.

1. `% set interfaces interface Wi-Fi physical-interface Wi-Fi`
2. `% set interfaces interface Wi-Fi wifi-config mode station station-config ap myssid enabled true`
3. `% set interfaces interface myBridge virtual-type bridge`
4. `% set interfaces interface myBridge bridge-settings members port ETH1`
5. `% set interfaces interface myBridge bridge-settings members wifi-station interface Wi-Fi`
6. `% set interfaces interface myBridge ipv4 address 192.168.1.22 prefix-length 24`

Example #3

Figure 14 shows the MCR-4G #2 device acting as a terminal server to provide connectivity to the serial-based SCADA device via UDP.

NOTE: The configuration for MCR-4G #1 in Figure 14 is identical to the configuration shown in the previous example (Example #2).

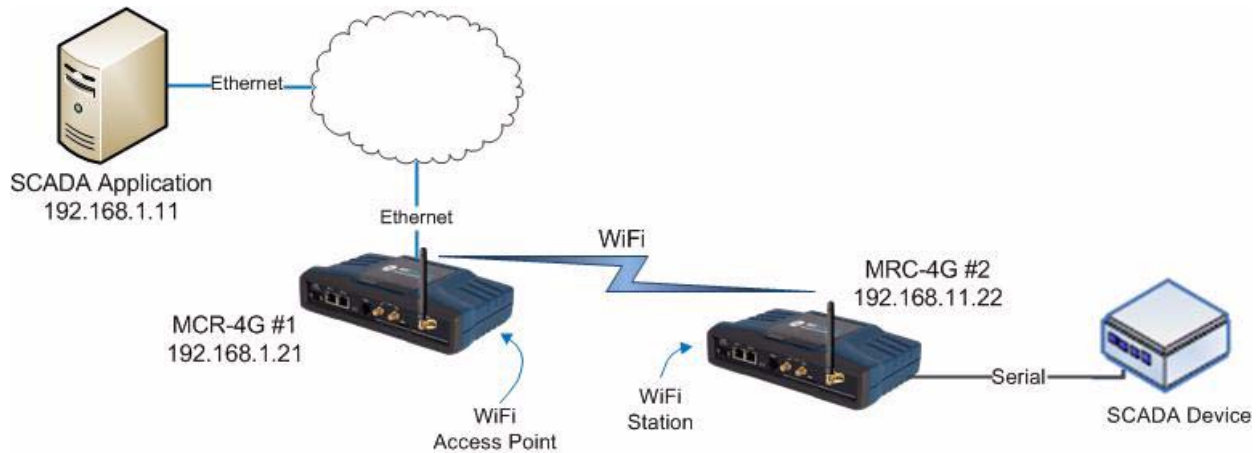


Figure 14. Example 3: Unit Providing Connectivity to Serial-Based SCADA Device via UDP

The following commands will configure the MCR-4G #2 for this scenario.

1. `% set interfaces interface Wi-Fi physical-interface Wi-Fi`
2. `% set interfaces interface Wi-Fi wifi-config mode station station-config ap myssid enabled true`
3. `% set interfaces interface myBridge virtual-type bridge`
4. `% set interfaces interface myBridge bridge-settings members port ETH1`
5. `% set interfaces interface myBridge bridge-settings wifi-station members interface Wi-Fi`
6. `% set interfaces interface myBridge ipv4 address 192.168.1.22 prefix-length 24`
7. `% set services serial terminal-server server COM1 mode udp port 30000 remote address 192.168.1.11 port 30001`

Example #4

In Figure 15, the MCR-4G provides internet access for a laptop that is accessing a public web page.

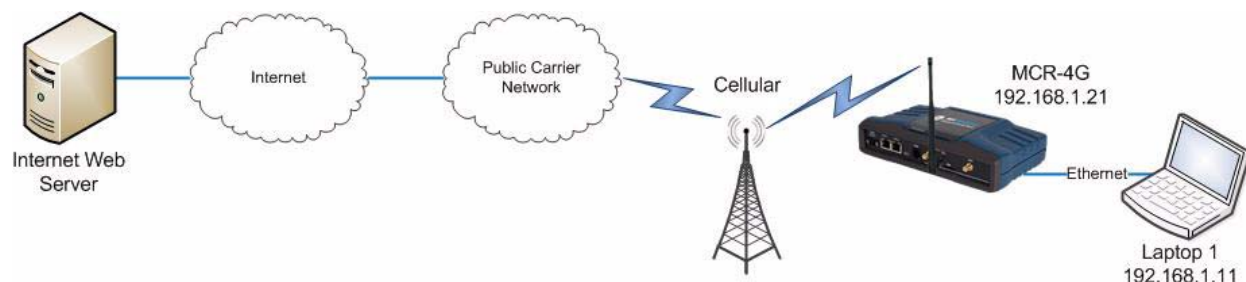


Figure 15. Example 4: Unit Providing Internet Access for Laptop

SIM Type: In this scenario, the MCR-4G has a SIM card installed that simply provides Internet access.

The following commands will configure the MCR-4G for this scenario.

1. `% set interfaces interface myBridge virtual-type bridge`
2. `% set interfaces interface myBridge bridge-settings members port ETH1`
3. `% set interfaces interface myBridge ipv4 address 192.168.1.21 prefix-length 24`
4. `% set interfaces interface Cell physical-interface Cell enabled true`
5. `% set services firewall enabled true`
6. `% set services firewall filter IN_UNTRUSTED`
7. `% set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp`
8. `% set services firewall filter IN_UNTRUSTED rule 1 actions action accept`
9. `% set services firewall filter IN_UNTRUSTED rule 10 match protocol all`
10. `% set services firewall filter IN_UNTRUSTED rule 10 actions action drop`
11. `% set interfaces interface Cell filter input IN_UNTRUSTED`
12. `% set services firewall filter OUT_UNTRUSTED rule 10 match protocol all`
13. `% set services firewall filter OUT_UNTRUSTED rule 10 actions action accept`
14. `% set interfaces interface Cell filter output OUT_UNTRUSTED`
15. `% set services firewall nat source rule-set MASQ`
16. `% set services firewall nat source rule-set MASQ rule 1 source-nat interface`
17. `% set services interfaces interface Cell nat source MASQ`

3.4 Operational Topic Areas

The remaining headings in this section describe key operational features of the MCR unit, and list configurational options for them. Each major heading begins at the top of a new page. For this reason, large areas of white space exist at the end of some sections. This is done to provide a clear delineation between major sections.

Serial Console

A serial cable may be used to connect to a COM port on the unit to access the CLI. The default serial console settings are 115200 bps with 8N1 format. A mini-USB-to-USB cable may also be used to connect to a Computer in case no serial port exists. If a mini-USB connection is used, the computer must contain the appropriate device driver. A driver for serial operation can be found on GE MDS website.

Configuring

This sequence shows how to add console access to the COM1 and COM2 serial ports and set the COM2 baud rate to 19200 bps:

```
admin@(none) 00:04:43% set services serial console serial-ports [ COM1 COM2 ]
[ok][2012-06-19 00:04:57]

[edit]
admin@(none) 00:04:59% set services serial ports COM2 baud-rate b19200
[ok][2012-06-19 00:05:28]

[edit]
admin@(none) 00:05:28% commit
Commit complete.
[ok][2012-06-19 00:07:51]

[edit]
admin@(none) 00:07:51%
```

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
admin@(none) 00:10:38> show configuration services serial | details

ports COM1 {
    line-mode      rs232;
    baud-rate      b115200;
    byte-format    bf8n1;
    hw-flow-control false;
    vmin           255;
    vtime          1;
    capability      rs485-2-wire,rs485-4-wire;
}

ports COM2 {
    line-mode      rs232;
    baud-rate      b19200;
    byte-format    bf8n1;
    hw-flow-control false;
    vmin           255;
    vtime          1;
    capability      "";
}

console {
    serial-ports [ COM1 COM2 ];
}
[ok][2012-06-19 00:12:00]
admin@(none) 00:12:00>
```

Network

Understanding

The unit has multiple network interfaces including LAN, Cellular, and WiFi. Each of these has numerous networking features and each feature is described in a separate section on the following pages:

- Static or dynamic IP addressing (DHCP) for each interface
- Bridging
- Firewall
- Routing
- VPN

Configuring

See each individual section for details about configuring the LAN, Cell, WiFi interfaces, and related networking features.

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics of all the network interfaces. The result of this command will vary from one configuration to another, so the following is intended merely to serve as an example:

```
admin@(none) 11:36:52> show interfaces
interfaces interface Bridge
oper-status      up
if-index         1
phys-address     00:06:3d:06:ea:99
lower-layer-if   [ ETH1 ETH2 ]
statistics discontinuity-time 2013-09-09T16:16:13-04:00
statistics in-octets 397914757
statistics in-unicast-pkts 1755097
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 734348
statistics out-unicast-pkts 14144
statistics out-discards 0
statistics out-errors 0
system-device    br0
                PREFIX
IP               LENGTH
-----
192.168.1.102   23

IP               PHYS ADDRESS      STATE
-----
192.168.1.1     04:fe:7f:e3:7b:c2  stale
192.168.1.91    80:c1:6e:fb:99:33  stale
192.168.1.171   68:05:ca:05:de:2a  stale
192.168.1.98    80:c1:6e:f0:3b:7a  reachable
192.168.1.172   00:1e:67:18:b3:34  stale
FF02::1         33:33:00:00:00:01  noarp
FF02::1:FF00:1  33:33:ff:00:00:01  noarp
FF02::1:FFBF:1917 33:33:ff:bf:19:17  noarp
```

```

bridgeStatus stp port ETH1
  number      1
  priority    0
  state       forwarding
  path-cost   100
  designated-root 7035.04fe7fe36980
  designated-cost 100
  designated-bridge 8000.0002fd5dd280
  designated-port 32788
bridgeStatus stp port ETH2
  number      2
  priority    0
  state       disabled
  path-cost   100
  designated-root 8000.00063d06ea99
  designated-cost 0
  designated-bridge 8000.00063d06ea99
  designated-port 32770
bridgeStatus stp port GEMDS_ORBIT
interfaces interface Cell
  oper-status    not-present
  if-index       2
  lower-layer-if [ ]
  statistics discontinuity-time 2013-09-09T16:16:13-04:00
  statistics in-octets 0
  statistics in-unicast-pkts 0
  statistics in-multicast-pkts 0
  statistics in-discards 0
  statistics in-errors 0
  statistics out-octets 0
  statistics out-unicast-pkts 0
  statistics out-discards 0
  statistics out-errors 0
  system-device eth5
  cell-status imsi ""
  cell-status imei ""
  cell-status iccid ""
  cell-status mdn ""
  cell-status apn ""
  cell-status app-sw-version ""
  cell-status modem-sw-version ""
  cell-status sim-state unknown
  cell-status modem-state unknown
  cell-status roaming-state unknown
  cell-status service-state none
  cell-status rssi 0
interfaces interface ETH1
  oper-status    up
  if-index       3
  phys-address   00:06:3d:06:ea:99
  lower-layer-if [ ]
  speed          10000000
  statistics discontinuity-time 2013-09-09T16:16:13-04:00
  statistics in-octets 461542638
  statistics in-unicast-pkts 2649078
  statistics in-multicast-pkts 0
  statistics in-discards 13
  statistics in-errors 0
  statistics out-octets 991884
  statistics out-unicast-pkts 18019

```

```

statistics out-discards 0
statistics out-errors 0
eth-phy-status "10 Mb, Half Duplex"
system-device eth0
interfaces interface ETH2
oper-status lower-layer-down
if-index 4
phys-address 00:06:3d:06:ea:99
lower-layer-if [ ]
speed 10000000
statistics discontinuity-time 2013-09-09T16:16:13-04:00
statistics in-octets 0
statistics in-unicast-pkts 0
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 0
statistics out-unicast-pkts 0
statistics out-discards 0
statistics out-errors 0
eth-phy-status "Not Connected"
system-device eth1
interfaces interface Wi-Fi
oper-status not-present
if-index 5
lower-layer-if [ ]
statistics discontinuity-time 2013-09-09T16:16:14-04:00
statistics in-octets 0
statistics in-unicast-pkts 0
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 0
statistics out-unicast-pkts 0
statistics out-discards 0
statistics out-errors 0
system-device wlan0
wifi-status serial-number ""
wifi-status mode ""
wifi-status tx-power 0
wifi-status channel 0
wifi-status ap-status ap GEMDS_ORBIT
[ok][2013-09-12 11:37:02]
admin@(none) 11:37:02>

```

LAN

Understanding

The unit has external Local Area Network (LAN) ports that can be used to connect to a local LAN. It supports both IPv4 and IPv6 addresses and may be assigned multiple IP addresses. The LAN port can be assigned static IP addresses or a dynamically allocated address can be assigned using DHCP.

NOTE: The LAN port should be assigned IP addresses only if it is a routed interface (that is, *not* in a bridge). Refer to the section on Bridging later in the document.

Configuring

The following sequence shows how to configure the ETH1 port with a static IPv4 address:

```
admin@(none) 06:03:53> configure
Entering configuration mode private
[ok][2012-06-20 06:03:54]

admin@(none) 06:04:45% set interfaces interface ETH1 ipv4 address 192.168.1.11
prefix-length 24
[ok][2012-06-20 06:05:01]

[edit]
admin@(none) 06:05:01% commit
Commit complete.
[ok][2012-06-20 06:05:03]

[edit]
admin@(none) 06:05:03%
```

The following sequence shows how to configure the ETH1 port to obtain a dynamic IPv4 address using DHCP:

```
admin@(none) 06:03:53> configure
Entering configuration mode private
[ok][2012-06-20 06:03:54]

admin@(none) 06:04:45% set interfaces interface ETH1 ipv4 dhcp
[ok][2012-06-20 06:05:01]

[edit]
admin@(none) 06:05:01% commit
Commit complete.
[ok][2012-06-20 06:05:03]

[edit]
admin@(none) 06:05:03%
```

Monitoring

Ensure the CLI is in Operational mode. Follow the example below to view the state and statistics of the ETH1 port:

```
admin@(none) 11:41:58> show interfaces interface ETH1
interfaces interface ETH1
  oper-status      up
  if-index         3
  phys-address     00:06:3d:06:ea:99
  lower-layer-if [ ]
  speed            10000000
  statistics discontinuity-time 2013-09-09T16:16:13-04:00
  statistics in-octets 3435997213
  statistics in-unicast-pkts 37738358
  statistics in-multicast-pkts 0
  statistics in-discards 13
  statistics in-errors 0
  statistics out-octets 3537454
  statistics out-unicast-pkts 73998
  statistics out-discards 0
  statistics out-errors 0
  eth-phy-status "10 Mb, Half Duplex"
  system-device   eth0
                PREFIX
IP                LENGTH
-----
192.168.1.11     24

IP                PHYS ADDRESS                STATE
-----
192.168.1.100    04:fe:7f:e3:7b:c2    reachable
192.168.1.171    68:05:ca:05:de:2a    stale
192.168.1.104    00:06:3d:06:bd:12    stale
192.168.1.98     80:c1:6e:f0:3b:7a    reachable
192.168.1.172    00:1e:67:18:b3:34    stale
FF02::1:3        33:33:00:01:00:03    noarp
FF02::1:FF00:1   33:33:ff:00:00:01    noarp
[ok][2013-09-24 11:42:15]
```

VLAN Operation

Understanding

Virtual Local Area Networks (VLANs) are generic interface types in the MCR-4G, and can be assigned unique IP addresses. They are treated the same as any other interface type, but they offer a way to link traffic between interface ports. As such, a VLAN device can be thought of as a “bridging device.”

Setup

To setup a VLAN, you must first create one or more VLAN interfaces. Four sample commands are shown below for doing this; one with an ID of **99** and another with an ID of **300**:

```
% set interfaces interface mgmt_vlan virtual-type vlan
% set interfaces interface mgmt_vlan vlan-config vlan-id 99
% set interfaces interface video_vlan virtual-type vlan
% set interfaces interface video_vlan vlan-config vlan-id 300
```

Operational Modes

Interfaces can have three separate VLAN modes: **none** (default), **trunk**, or **access**. These modes are used to set interface behavior, and examples of their use are provided below.

Trunk: To add ETH1 as a trunk (tagged) port in both defined VLANs above, the command is:

```
% set interfaces interface ETH1 vlan-mode trunk vlans [ video_vlan mgmt_vlan ]
```

Access: To set ETH2 as an access port for **video_vlan** the command is:

```
% set interfaces interface ETH2 vlan-mode access vlan video_vlan
```

Native VLANs

A VLAN device may also be specified as a “native” VLAN, and this is set by the command:

```
set interfaces interface my_native_vlan virtual-type vlan vlan-config vlan-id 600 native-vlan true
```

A native VLAN is conceptually the same as a standard VLAN except that the packets will never be tagged. The purpose of a native VLAN is to segregate untagged packets on a VLAN trunk port that normally only contains tagged traffic. If a VLAN trunk port receives an untagged packet, and the trunk is a member of the native VLAN, that packet will be treated as if it came from the native VLAN. If the trunk port is not a member of the native VLAN and an untagged packet arrives on that port, the packet will be dropped.

As VLAN's are implemented as bridges, and it is not valid for a bridge to be a member of another bridge, it follows that a VLAN interface cannot be configured as a member of a bridge. VLANs can be configured with IP addresses just as any other interface in the system can.

Cell

Understanding

The unit incorporates a 4G LTE module capable of operation on Verizon Wireless LTE/CDMA network (LTE 700 Mhz Band 13) in the United States. The unit supports routing of TCP/UDP/IP data from the Cellular WAN network interface to any of the other network interfaces (including WiFi or LAN) using the IPsec VPN or network address and port translation (NAPT) feature and to the COM1 (or COM2) serial port using the terminal server service. The configuration of these use cases is specified in respective sections on VPN, Firewall and NAT, and Terminal Service.

The cellular modem inside the unit supports main (primary) and secondary antenna (for receive diversity). The primary antenna must be installed for cell modem to register with the cellular network. It is strongly recommended that secondary antenna be installed for achieving a robust cellular link. There should be no physical obstructions around the antennas. The main and diversity antennas must have a minimum amount of 27 dB isolation from each other to ensure optimal LTE mode operation of the module.

Cell Configuration Hierarchy

```
interface Cell {
    cell config {
        apn <apn-name>
        keep-alive {
            address <host name or address>
            interval <host name or address>
            recovery-on-timeout <true|false>
        }
        service-recovery {
            general-recovery-interval <time in seconds>
            lte-recovery <true|false>
            lte-recovery-interval <time in seconds>
        }
    }
}
```

Access Point Name (APN)

After MCR has registered on the cellular network, it sets up the IP data connection with a specific Packet Data Network identified by the Access Point Name (APN). APN is a string identifier.

The MCR comes preconfigured with APN of “vzwinternet”. Hence, it attempts to set up a data connection toward internet PDN that provides internet connectivity. For this data connection to succeed, a SIM card that has been provisioned for internet access needs to be obtained from the service provider and installed in MCR.

If a private network (PN) account has been arranged with the service provider, a SIM card will be issued from that account. When the modem is powered up with such a SIM, the default APN on the modem is automatically updated by the service provider to the one that identifies the user’s private network. This procedure is called OTA APN update. This procedure may not always succeed, and hence, requires the user to manually update the APN on the MCR. The following example shows how to update APN manually via CLI:

```
admin@(none) 15:28:44> config
Entering configuration mode private
[ok][2013-01-18 15:28:46]

[edit]
admin@(none) 15:28:46% set interfaces interface Cell cell-config apn GEDEROC.GW6.VZWENTP
[ok][2013-01-18 15:29:36]

[edit]
admin@(none) 15:29:36% commit
Commit complete.
[ok][2013-01-18 15:29:46]
```

LTE Recovery

The cellular modem used inside the unit may occasionally remain in a 3G (EVDO-REV A) service state and not transition to 4G LTE. The firmware incorporates a recovery mechanism to recover from this condition. If the cellular modem has been in 3G coverage for more than 15 minutes, the firmware resets the modem to bring it back into LTE service state. LTE recovery is enabled by default. This mechanism should be disabled if the unit is deployed in areas that either lack or have poor LTE coverage. Otherwise, the cellular modem will unnecessarily reset every 15 minutes.

Keep Alive

This feature allows the cellular modem to maintain a connection in situations where no traffic is passed over cellular link for long periods of time, which would otherwise cause disruption. The keep alive mechanism sends an ICMP echo message to the configured address/host at the configured interval. This feature should be used only if an application is passing data very infrequently over a cellular connection (*i.e.*, if data is passed at a rate of less than once per hour).

The commands for setting 3G/4G operation are as follows:

4G Operation – Default programming.

```
% set interfaces interface Cell cell-config service-recovery lte-recovery true
% commit
```

3G Operation – Turn off the LTE Recovery Mode to allow continual 3G mode operation without periodic disconnection for 4G service search.

```
% set interfaces interface Cell cell-config service-recovery lte-recovery false
% commit
```

NOTE: The Verizon network can disconnect the cellular connection if any packets get routed from LAN to Cellular interface without undergoing masquerading (Source Network Address Translation (NAT) before exiting the cellular interface. Therefore, always configure masquerading on the cellular interface. Refer to the “Firewall and NAT” section ([Page 45](#)) in this manual for more information on NAT configuration.

Monitoring

Ensure the CLI is in Operational mode. Follow the example below to view the cellular interface state and statistics:

```
admin@(none) 08:33:32> show interfacesshow interfaces interface Cell
interfaces interface Cell
oper-status up
if-index 2
phys-address 00:15:ff:75:93:50
lower-layer-if [ ]
statistics discontinuity-time 2013-03-18T09:07:53+00:00
statistics in-octets 3847
statistics in-unicast-pkts 26
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 55555
statistics out-unicast-pkts 220
statistics out-discards 0
statistics out-errors 0
system-device eth5
cell-status imsi 311480023788535
cell-status imei 990000624071751
cell-status iccid 89148000000234127059
cell-status mdn 5853534418
cell-status apn GEDEROC.GW6.VZWENTP
cell-status sw-version "1.41 SVN 0 [2011-08-23 18:47:59]"
cell-status sim-state "SIM INIT COMPLETED"
cell-status modem-state connected
cell-status roaming-state home
cell-status service-state lte
cell-status rssi -61
```

Determining the Cell Module's IMSI/IMEI

When provisioning the cell module for network service, the cellular provider typically requires the International Mobile Subscriber Identity code (IMSI) or International Mobile Station Equipment Identity code (IMEI) to be provided. These codes can be determined by entering the following command:

```
> show interfacesshow interfaces interface Cell cell-status
```

(Where *Cell* is the configured name for the cellular device. **Cell** is the factory default name, but it may have been changed by a previous user.)

When the above command is entered, a number of items are returned as shown in the example below. The first two items (highlighted blue) show the IMSI and IMEI codes. These are unique for each unit.

```
cell-status imsi 311480023631413
cell-status imei 990000947608727
cell-status iccid 89148000000232694605
cell-status mdn 5857948168
cell-status apn VZWINTERNET
cell-status app-sw-version 0.0.5
cell-status modem-sw-version "4.08.02 SVN 0 [2012-12-21 10:52:58]"
cell-status sim-state Ready
cell-status modem-state connected
cell-status roaming-state home
cell-status service-state lte
cell-status rssi -62
```

WiFi

Understanding

The internal WiFi module has FCC modular approval and may only be used with one of the GE MDS approved antennas (see 802.11 WiFi Module Specifications below). The WiFi antenna is connected to the reverse-SMA connector on the unit's front panel. *Only* these antennas may be used. The WiFi module can be configured to operate as an 802.11b/g/n Access Point or Station. The operational mode and frequency can be configured through the user interface.

The specifications for the 2.4 GHz WiFi module (including permissible antennas) are covered in [“Technical Specifications”](#) on Page 86.

The unit supports the following WiFi security modes:

1. **None** (should be used only to test connectivity)
2. **WPA2 + CCMP/AES Encryption** – This mode should be used if all client devices support WPA2/CCMP.
3. **Encryption + TKIP Encryption** – This mode should be used if there is mix of both legacy client devices that only support WPA/TKIP and newer devices that support WPA2/CCMP.

Also, WPA and WPA2 can be configured further in following modes:

- **Personal** – This uses pre-shared keys (passphrases) configured on the MCR and client devices.
- **Enterprise** – This supports EAP-TLS based authentication of client devices (configured with certificates/keys) via RADIUS.

The default SSID is based on the unit's serial number, and takes the form of: **GEMDS_<SERNUM>** (the serial number is printed on the chassis sticker). The default password for WiFi operation is **GEMDS_ORBIT**.

AP Mode

Basic configuration with defaults

The following will configure a basic access point with **somessid** and set up a basic AP to verify connectivity:

```
admin@(none) 17:06:10% set interfaces interface Wi-Fi physical-interface Wi-Fi
admin@(none) 17:06:12% set interfaces interface Wi-Fi wifi-config mode access-point ap-config
operation-mode 80211g ap somessid

admin@(none) 17:06:13% show interfaces interface Wi-Fi wifi-config | details
mode          access-point;
tx-power 15;
ap-config {
    ap somessid {
        broadcast-ssid      true;
        station-max          7;
        station-timeout      300;
        beacon-interval      100;
        privacy-mode         none;
        vlan-mode            none;
    }
    channel                6;
    operation-mode          80211g;
    dtim-period             2;
    rts-threshold           2347;
    fragm-threshold         2346;
}
[ok][2013-09-24 17:06:21]

admin@(none) 17:06:37% commit
Commit complete.
[ok][2013-09-24 17:06:39]
```

Privacy Mode Configuration

The default privacy mode is *wpa2-personal*. (The privacy mode in the previous example was set to *none*.) The following configures the unit to use WPA2-Personal security with the default of CCMP/AES encryption and disables the broadcasting of the SSID.

```
admin@none) 17:08:10% set interfaces interface Wi-Fi wifi-config ap-config ap somessid
broadcast-ssid false privacy-mode wpa2-personal psk-config psk somepassphrase encryption ccmp
```

```
admin@none) 17:08:24% show interfaces interface Wi-Fi wifi-config | details
```

```
mode      access-point;
tx-power 15;
ap-config {
  ap somessid {
    broadcast-ssid      false;
    station-max         7;
    station-timeout     300;
    beacon-interval     100;
    privacy-mode        wpa2-personal;
    psk-config {
      encryption        ccmp;
      key-mgmt          wpa-psk;
      psk               somepassphrase;
    }
    vlan-mode          none;
  }
  channel              6;
  operation-mode       80211g;
  dtim-period          2;
  rts-threshold        2347;
  fragm-threshold      2346;
}
[ok][2013-09-24 17:08:26]
```

```
admin@none) 17:08:30% commit
Commit complete.
[ok][2013-09-24 17:08:33]
```

This example takes the previous configuration and changes the security to WPA2-Personal with CCMP/AES + TKIP encryption.

```
admin@none) 17:09:10% set interfaces interface Wi-Fi wifi-config ap-config ap somessid
broadcast-ssid false privacy-mode wpa2-personal psk-config psk somepassphrase encryption
ccmp-tkip
```

```
admin@none) 17:09:12% show interfaces interface Wi-Fi wifi-config | details
```

```
mode      access-point;
tx-power 15;
ap-config {
  ap somessid {
    broadcast-ssid      false;
    station-max         7;
    station-timeout     300;
    beacon-interval     100;
    privacy-mode        wpa2-personal;
    psk-config {
      encryption        ccmp-tkip;
      key-mgmt          wpa-psk;
      psk               somepassphrase;
    }
    vlan-mode          none;
  }
}
```

```

channel        6;
operation-mode  80211g;
dtim-period    2;
rts-threshold  2347;
fragm-threshold 2346;
}
[ok][2013-09-24 17:09:16]

```

```

admin@(none) 17:09:30% commit
Commit complete.
[ok][2013-09-24 17:09:31]

```

Other configuration

The following configures the device to broadcast its SSID, support 802.11b/g/n modes, and operate on channel 3.

```

admin@(none) 17:09:14% set interfaces interface Wi-Fi wifi-config ap-config operation-mode 80211n
channel 3 ap somessid broadcast-ssid true privacy-mode wpa2-personal psk-config psk
somepassphrase encryption ccmp-tkip

```

```

admin@(none) 17:09:24% show interfaces interface Wi-Fi wifi-config | details
mode      access-point;
tx-power  15;
ap-config {
  ap somessid {
    broadcast-ssid      true;
    station-max         7;
    station-timeout     300;
    beacon-interval     100;
    privacy-mode        wpa2-personal;
    psk-config {
      encryption        ccmp-tkip;
      key-mgmt          wpa-psk;
      psk               somepassphrase;
    }
    vlan-mode           none;
  }
  channel        3;
  operation-mode  80211n;
  dtim-period    2;
  rts-threshold  2347;
  fragm-threshold 2346;
}
[ok][2013-09-24 17:09:26]

```

```

admin@(none) 17:09:37% commit
Commit complete.
[ok][2013-09-24 17:09:44]

```

Station Mode

This sets the unit to act as a WiFi station to connect to an AP with **somessid** and WPA2 Personal security.

```
admin@(none) 17:28:10% set interfaces interface Wi-Fi wifi-config mode station station-config ap  
somessid enabled true privacy-mode wpa2-personal psk-config psk somepassphrase encryption ccmp
```

```
admin@(none) 17:28:23% show interfaces interface Wi-Fi | details
```

```
enabled          true;
wifi-config {
  mode          station;
  tx-power      15;
  station-config {
    ap somessid {
      enabled          true;
      privacy-mode      wpa2-personal;
      psk-config {
        encryption      ccmp;
        key-mgmt         wpa-psk;
        psk              somepassphrase;
      }
    }
  }
}
physical-interface Wi-Fi;
[ok][2013-09-25 09:37:31]
```

```
admin@(none) 17:28:35% commit
Commit complete.
[ok][2013-09-24 17:28:39]
```

Monitoring

Ensure the CLI is in Operational mode.

Access Point Mode

The following shows status and statistics of the WiFi interface with two stations connected.

```
admin@(none) 09:45:40> show interfaces interface Wi-Fi wifi-status
wifi-status serial-number N722M33NU000628
wifi-status mode "Access Point"
wifi-status tx-power 15
wifi-status channel 4
wifi-status ap-status ap somessid
[ok][2013-09-25 09:46:29]
```

```
admin@(none) 09:48:59> show interfaces interface Wi-Fi statistics
statistics discontinuity-time 2013-09-24T13:12:25-04:00
statistics in-octets 3747
statistics in-unicast-pkts 26
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 55511
statistics out-unicast-pkts 215
statistics out-discards 0
statistics out-errors 0
[ok][2013-09-25 09:49:10]
```

Station Mode

The following shows status when connected to a configured AP.

```
admin@(admin) 10:04:42> show interfaces interface Wi-Fi wifi-status
wifi-status serial-number N722M33NU000628
wifi-status mode Station
wifi-status tx-power 15
wifi-status channel 4
wifi-status station-status ssid somessid
wifi-status station-status bssid 00:19:70:2c:40:3f
wifi-status station-status rssi -58
wifi-status station-status authenticated true
wifi-status station-status authorized true
wifi-status station-status inactive 29270
wifi-status station-status rxbytes 27119
wifi-status station-status rxpackets 564
wifi-status station-status txbitrate 54
wifi-status station-status txbytes 897
wifi-status station-status txpackets 9
wifi-status station-status txfailed 0
wifi-status station-status txretries 0
[ok][2013-09-25 10:05:00]
```

```
admin@(admin) 10:05:53> show interfaces interface Wi-Fi statistics
statistics discontinuity-time 2013-09-24T13:12:25-04:00
statistics in-octets 288
statistics in-unicast-pkts 2
statistics in-multicast-pkts 0
statistics in-discards 0
statistics in-errors 0
statistics out-octets 752
statistics out-unicast-pkts 7
statistics out-discards 0
statistics out-errors 0
[ok][2013-09-25 10:06:42]
```

Bridging

Understanding

The unit supports transparent bridging of LAN and WiFi networks. The bridge forwards traffic between LAN and WiFi networks at the layer-2 of OSI model. This allows LAN and WiFi clients to be in the same IP sub-network.

The bridge learns the clients' locations by analyzing the source address of incoming frames from all attached networks (LAN and WiFi network). For example, if a bridge sees a frame arrive on LAN port from Host A, the bridge concludes that Host A can be reached through the segment connected to LAN port. Through this process, the bridge builds a forwarding table (the learning process). When a frame is received on one of the bridge's interfaces, the bridge looks up the frame's destination address in its forwarding table. If the table contains an association between the destination address and any of the bridge's ports aside from the one on which the frame was received, the frame is forwarded out the indicated port. If no association is found, the frame is flooded to all ports except the inbound port. Broadcasts and multicast also are flooded in this way.

Typically, for LAN/WiFi-to-Cellular Router use case (a.k.a LAN/WiFi HotSpot), the LAN and WiFi interface (acting as an Access Point) are bridged. However, for security and bandwidth considerations, a user might want to remove LAN and WiFi networks from the bridge (*i.e.*, configuring LAN and WiFi networks as separate IP networks). In this network setup, broadcast/multicasts data packets coming into WiFi are not directed out the LAN connection and vice versa.

The bridged network is addressable via bridge interface (a virtual interface). The interfaces that are in the bridge are called bridged interfaces. The interfaces that are not in the bridge are called routed interfaces. Bridging is performed between bridged interfaces. Routing is performed between routed interfaces. The bridge interface is a routed interface.

NOTE: The Cellular modem by its nature can never be added to the bridge and is, therefore, a routed interface. Advanced details of networking concepts such as routing and bridging are outside the scope of this manual but are available through various training materials freely available on the Internet.

Theory of Operation

Refer to [Figure 16](#) for this discussion. In a typical application, the MCR-4G provides cellular connectivity to locally connected devices that are located on the user's local/internal/private LAN or WiFi network. The MCR-4G acts as an Access Point on the Wi-Fi interface, providing connectivity to Wi-Fi clients. The Wi-Fi traffic is combined with the local Ethernet port traffic through a Layer 2 bridge. The serial interface is matched to a terminal server that encapsulates serial data over a TCP or UDP connection.

The MCR-4G provides Network Address Translation (NAT) (both Masquerading and Port Forwarding) as well as Firewalling between the cellular data interface (WAN side) and the local network (LAN/WiFi). The MCR-4G can also act as a VPN client to provide a secure tunnel for LAN data to the user's local network (LAN/WiFi). This configuration obviates the need for NAT, as the back-office network behind the VPN Concentrator (VPNC) can address the local LAN or WiFi network directly via the secure tunnel.

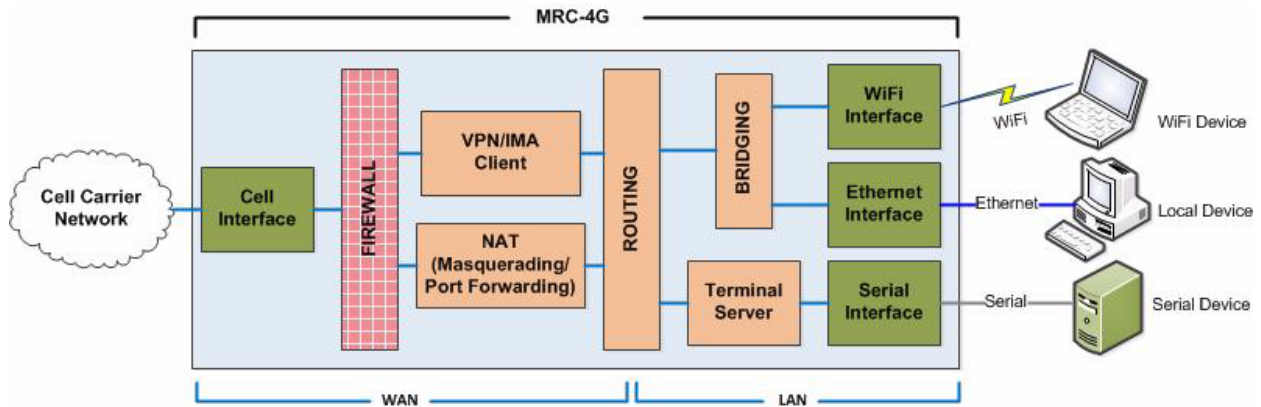


Figure 16. Bridging Functions Diagram

Configuring

Creating a bridge interface and assigning it an IP address:

```
admin@(none) 00:02:09% set interfaces interface myBridge virtual-type bridge
admin@(none) 00:02:20% set interfaces interface myBridge bridge-settings ageing-time 500
admin@(none) 00:22:26% set interfaces interface myBridge ipv4 address 192.168.1.10 prefix-length 24
```

Adding LAN (ETH1) interface to the bridge:

```
admin@(none) 00:06:20% set interfaces interface myBridge bridge-settings members port ETH1
```

Adding WiFi interface to the bridge (Access Point):

```
admin@(none) 00:06:20% set interfaces interface myBridge bridge-settings members wifi-ap myssid
```

OR:

Adding WiFi interface to the bridge (Station):

```
admin@(none) 00:23:00% set interfaces interface myBridge bridge-settings members wifi-station
interface Wi-Fi
```

Removing LAN (ETH1) interface from the bridge:

```
admin@(none) 00:06:36% delete interfaces interface myBridge bridge-settings members port ETH1
```

Removing WiFi interface from the bridge:

```
admin@(none) 00:06:20% delete interfaces interface myBridge bridge-settings members wifi-ap
somessid
```

OR:

```
admin@(none) 00:06:20% delete interfaces interface myBridge bridge-settings members wifi-station
interface Wi-Fi
```

Removing the bridge interface:

```
admin@(none) 00:23:00% delete interfaces interface myBridge
```

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics of a bridge. In this example, bridge (Bridge) is bridging the LAN (ETH1).

```
admin@(none) 10:14:19> show interfaces interface Bridge
interfaces interface Bridge oper-status    up
  if-index      1
  phys-address   00:06:3d:06:ea:99
  lower-layer-if [ ETH1 ]
  statistics discontinuity-time 2013-09-24T13:12:24-04:00
  statistics in-octets 105280647
  statistics in-unicast-pkts 486200
  statistics in-multicast-pkts 0
  statistics in-discards 0
  statistics in-errors 0
  statistics out-octets 899432
  statistics out-unicast-pkts 8728
  statistics out-discards 0
  statistics out-errors 0
  system-device br0
```

```

          PREFIX
IP        LENGTH
-----
192.168.1.102  23
```

IP	PHYS ADDRESS	STATE
192.168.1.100	04:fe:7f:e3:7b:c2	reachable
192.168.1.171	68:05:ca:05:de:2a	stale
192.168.1.104	00:06:3d:06:bd:12	stale
192.168.1.98	80:c1:6e:f0:3b:7a	reachable
192.168.1.172	00:1e:67:18:b3:34	stale
FF02::1:FFC4:D0A1	33:33:ff:c4:d0:a1	noarp
FF02::1	33:33:00:00:00:01	noarp
FF02::1:FF00:1	33:33:ff:00:00:01	noarp

```
bridgeStatus stp port ETH1
  number      1
  priority     0
  state        forwarding
  path-cost    100
  designated-root 7035.04fe7fe36980
  designated-cost 100
  designated-bridge 8000.0002fd5dd280
  designated-port 32789
bridgeStatus stp port somessid
  number      2
  priority     0
  state        listening
  path-cost    100
  designated-root 7035.04fe7fe36980
  designated-cost 200
  designated-bridge 8000.00063d06ea99
  designated-port 32770
[ok][2013-09-25 10:14:30]
admin@(none) 10:14:30>
```

Routing

Understanding

The unit can be configured to route IP packets between routed interfaces.

Configuring a default static route:

```
admin@(none) 00:50:52% set routing static-routes ipv4 route 1 dest-prefix 0.0.0.0/0 next-hop 192.168.1.10
```

Configuring a static host route:

```
% set routing static-routes ipv4 route 2 dest-prefix 10.2.3.1/32 next-hop 192.168.1.9
```

```
admin@(none) 00:04:57% show routing static-routes
ipv4 {
```

```
    route 1 {
        dest-prefix 0.0.0.0/0;
        next-hop    192.168.1.10;
```

```
    route 2 {
        dest-prefix 10.2.3.1/32;
        next-hop    192.168.1.9;
```

```
[ok][2012-06-19 00:05:01]
```

```
[edit]
```

```
admin@(none) 00:05:01% commit
```

```
Commit complete.
```

```
[ok][2012-06-19 00:05:09]
```

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state of the routing table:

```
admin@(none) 09:04:19> show routing
```

DEST PREFIX	NEXT HOP	OUTGOING INTERFACE	SOURCE
10.10.10.0/23	-	ETH1	kernel
172.168.1.0/24	-	ETH2	kernel
192.110.11.0/24	-	Wi-Fi	kernel
192.168.0.0/24	-	Bridge	kernel
216.171.112.36/32	10.10.10.101	ETH1	static
fe80::/64	-		kernel
fe80::/64	-	Bridge	kernel
fe80::/64	-	ETH1	kernel
fe80::/64	-	Wi-Fi	kernel

```
[ok][2013-09-13 09:04:28]
```

Firewall and NAT

Understanding

The MCR incorporates a firewall service that provides the following functionality:

1. Packet filtering to permit or deny incoming or outgoing traffic on an interface.
2. Network Address Translation (NAT)
 - Source NAT - Masquerading
 - Destination NAT – Port Forwarding

Packet Flow

This section provides a simplified view of packet flow for various categories of traffic flows going in and out of the MCR unit. [Figure 17](#) shows the flow of packets terminating at MCR. For example, device management traffic using SSH or NETCONF protocol terminating at local device management process within the MCR unit.



Figure 17. Packets Terminating at MCR

[Figure 18](#) shows flow of packets originating from the MCR unit. For example, DNS queries and/or VPN connection setup traffic originating from local VPN service within the MCR unit.



Figure 18. Packets Originating from MCR

[Figure 19](#) shows the flow of packets being forwarded (routed) through the MCR unit. For example, IP packets arriving inside IPsec VPN tunnel, being routed from cellular WAN to the local Ethernet interface.



Figure 19. Packets Being Forwarded Through MCR

Figure 20 shows the flow of packets being port-forwarded (DNAT'ed) through the MCR unit. For example, TCP traffic arriving at the cellular interface and getting port forwarded to a private host connected to the local Ethernet interface.

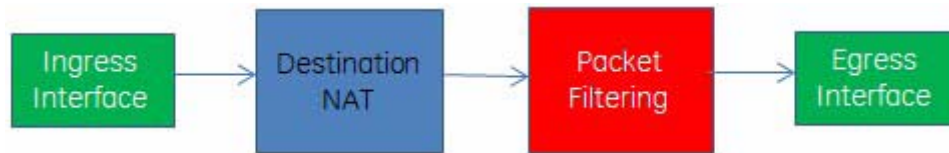


Figure 20. Packets Being Port-Forwarded Through MCR

Figure 21 shows the flow of packets being masqueraded (source NATed) through the MCR unit. For example, TCP traffic from a private host arriving at Local Ethernet interface, being masqueraded to the cellular interface's IP address before being sent out the cellular interface.

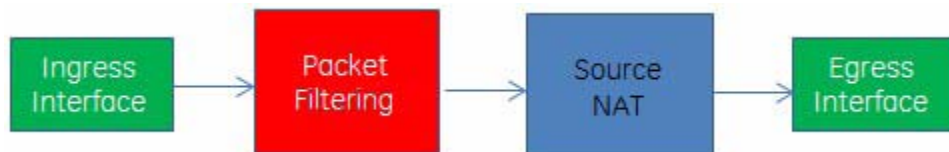


Figure 21. Packets Being Masqueraded Through MCR

Packet Filtering

Understanding

Packet filtering allows configuring and applying a packet filter (also called Access Control List, or ACL) to incoming or outgoing traffic on an interface. A filter is a set of one or more rules. Each rule consists of two parts:

- Matching criteria that a packet must satisfy for the rule to be applied. Matching criteria consists of various parameters like protocol, source/destination addresses and ports etc
- Actions that specify what to do with the packet when the matching criteria is met, for example, to drop or accept the packet.

The filter can then be applied to an interface in the incoming or outgoing direction. Note that typically, different filters are applied in the incoming and outgoing direction on an interface. For example, a filter applied to the cellular (WAN) interface of the MCR is typically very restrictive, permitting only a small set of traffic to enter the MCR, where as outgoing filter might permit all outgoing traffic etc.



NOTE: If the firewall service is enabled and no filter is applied to an interface, then both incoming and outgoing traffic is dropped on that interface.

Configuring

Configuration Hierarchy

NOTE: The configuration parameters shown here are a subset of the available configuration parameters. Refer to the appendix for a complete listing.

```

firewall {
  enabled <true|false>;
  filter <name> {
    rule <id> {
      match {
        protocol <icmp|udp|tcp|esp|all>;
        src-address {
          address <network/prefix> or address-range;
        }
        src-port {
          services [ <name1> <name2> ...] or port-range;
        }
        dst-address {
          address <network/prefix> or address-range;
        }
        dst-port {
          services [ <name1> <name2> ...] or port-range;
        }
        ipsec {
          direction <in|out>;
          tunnel-src-address <network/prefix>;
          tunnel-dst-address <network/prefix>;
        }
      }
    }
    actions {
      action <accept|drop|reject>;
      reject-type <net-unreachable|...>;
      log {
        level <debug|info|...>;
        prefix <string>;
      }
    }
  }
  interfaces {
    interface <name> {
      filter {
        input <name>;
        output <name>;
      }
    }
    .....
  }
}

```

Packet filter configuration on MCR involves following these high level steps:

1. Create a filter, decide on default policy of the filter. For example, there are usually two ways to organize a filter:
 - a. Create a “restrictive” filter i.e. the last rule in the filter (also called “default policy” of filter) is to deny traffic and rules are added to specifically permit the traffic. For example,
 - i. Rule 1 = permit protocol=tcp, dst port=22
 - ii. Rule 2 = permit protocol=icmp
 - iii. Rule 3 = deny everything
 - b. Or Create a “permissive” filter i.e. the last rule in the filter (also called “default policy” of filter) is to permit traffic and rules are added to specifically deny traffic. For example,
 - i. Rule 1 = deny protocol=tcp, dst port=80
 - ii. Rule 2 = deny protocol=icmp
 - iii. Rule 3 = permit everything
2. Apply the filter to input or output direction of the interface.

The following example describes the step-by-step configuration of an example filter that can be applied to cellular interface of the MCR. Change to CLI configuration mode:

1. Enable firewall service
admin@(none) 19:33:20% set services firewall enabled true
2. Create a “restrictive” filter named “IN_UNTRUSTED” to indicate that this filter has been designed to be applied to an untrusted cellular interface of MCR. The cellular interface can be considered untrusted as it is connected to public cellular network, which is inherently an untrusted network.
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED
3. Create rule to permit encrypted IPsec tunnel traffic i.e. traffic with protocol=ESP
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 1 match protocol esp
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 1 actions action accept
4. Create rule to permit traffic for the following UDP services: DNS, NTP and IKE (to allow IPsec connection setup).
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 2 match protocol udp
src-port services [dns ike ntp]
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 2 actions action accept
5. Create rule to permit traffic for following TCP services: SSH and NETCONF (to allow management of MCR):
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 3 match protocol tcp
dst-port services [netconf ssh]
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 3 actions action accept

NOTE: The rule stated in step 5 permits SSH or NETCONF connection addressed to the cellular interface's IP address. If it is desired that SSH or NETCONF connection only be allowed via the VPN tunnel, then ipsec match criteria described *below* should be used instead of the rule stated in step 5.

```
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 3 match ipsec direction in
tunnel-src-address 10.150.1.1/32 tunnel-dst-address 10.150.1.10/32
```

```
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 3 actions action accept
```

The above example assumes cell interface's IP address is 10.150.1.10 and VPN Gateway's IP address is 10.150.1.1.

6. Create the last rule for this "restrictive" filter to deny everything else. Note that rules are applied in ascending order using rule IDs. Any rules added after this last rule will have no effect, as they would match "any" traffic, and be dropped. In this example rule ID 10 is chosen. This facilitates the insertion of new rules prior to this last one to support future new traffic types.

```
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 10 match protocol all
admin@(none) 19:33:20% set services firewall filter IN_UNTRUSTED rule 10 actions action drop
```

7. Apply this filter to incoming direction on cellular interface "Cell".

```
admin@(none) 19:33:20% set interfaces interface Cell filter input IN_UNTRUSTED
```

8. Create a "permissive" filter that permits all traffic. Later on, if needed, this filter can be enhanced to deny certain traffic from getting out of the cellular interface.

```
admin@(none) 19:33:20% set services firewall filter OUT_UNTRUSTED rule 10 match protocol all
admin@(none) 19:33:20% set services firewall filter OUT_UNTRUSTED rule 10 actions action accept
```

9. Apply this filter to outgoing direction on cellular interface "Cell".

```
admin@(none) 19:33:20% set interfaces interface Cell filter output OUT_UNTRUSTED
```

10. Commit configuration and exit configuration mode.

```
admin@(none) 19:33:20% commit
Commit complete.
[ok][2013-09-24 19:33:20]
admin@(none) 19:33:21% exit
admin@(none) 19:33:21>
```

Monitoring

At this time there are no commands to monitor traffic statistics for packets being dropped or permitted by the firewall. This feature may be added to future revisions of firmware.

Network Address Translation (NAT)

Understanding

Network address translation allows one to map private IP addresses to public IP addresses and vice versa. There are two basic kinds of network address translation:

- Source NAT
- Destination NAT

Source NAT

Source NAT performs translation of source IP address of the traffic egressing an interface. This is typically used to provide many-to-one translation (also called masquerading) of a private network behind MCR to allow hosts on that private network to access a host (say HOST-B) on the public network. (See [Figure 22](#).) All traffic originating from hosts in the private network will appear to have originated from a single IP address (the IP address of the public interface of the MCR, typically, cellular interface) from HOST-B's point of view. To allow return IP traffic for UDP/TCP connections, to be delivered to right private host, the MCR also performs source port translation. Therefore, masquerading consists of Network Address and Port Translation (NAPT).

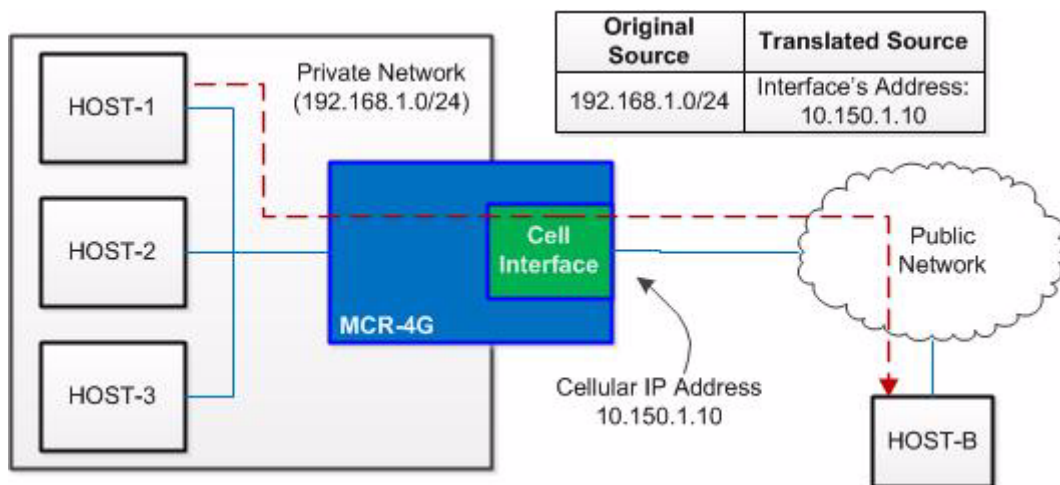


Figure 22. Source NAT Translation of IP Address

Configuring

Configuration Hierarchy

```

services {
  firewall
  nat {
    source {
      rule-set <name> {
        rule <id> {
          match {
            src-address {
              not <boolean>;
              add-interface-address <true|false>;
              address <network/prefix>;
              address-range <to/from>;
              address-set <name> {
                add-interface-address <true|false>
                not <boolean>
              }
            }
            dst-address {
              not <boolean>;
              add-interface-address <true|false>;
              address <network/prefix>;
              address-range <to/from>;
              address-set <name> {
                add-interface-address <true|false>
                not <boolean>
              }
            }
          }
          source-nat {
            interface;
            address <IP>;
          }
        }
      }
    }
  }
}

interfaces {
  interface <name> {
    nat {
      source <name>;
    }
  }
}

```

Source NAT configuration on MCR involves following high level steps:

1. Create a source NAT rule-set.
2. Add rule to perform source NAT on the public interface.
3. Apply the source NAT rule-set to the public interface.

Following example describes the step-by-step configuration of an example source NAT rule-set to perform masquerading on cellular interface of MCR. Change to CLI configuration mode:

1. Enable firewall service, if it is not already enabled.

```
admin@(none) 19:33:20% set services firewall enabled true
```

2. Create source NAT rule-set named MASQ.

```
admin@(none) 19:33:20% set services firewall nat source rule-set MASQ
```

3. Create rule for masquerading

```
admin@(none) 19:33:20% set services firewall nat source rule-set MASQ rule 1 source-nat interface
```

4. Apply this source NAT rule-set to the cellular interface.

```
admin@(none) 19:33:20% set interfaces Cell nat source MASQ
```

5. Commit configuration and exit configuration mode.

```
admin@(none) 19:33:20% commit
Commit complete.
```

```
[ok][2013-09-24 17:06:39]
```

```
admin@(none) 19:33:20% exit
```

```
admin@(none) 19:33:20>
```

Monitoring

At this time there are no commands to monitor traffic statistics for packets being masqueraded by the firewall. This feature may be added in future revisions of firmware.

Destination NAT

Destination NAT performs translation of destination IP address (and, optionally, destination port) of the traffic ingressing an interface. This is typically used to allow a host on the public network (HOST-B) to access a service running on a host in the private network (HOST-1). This is also called port forwarding.

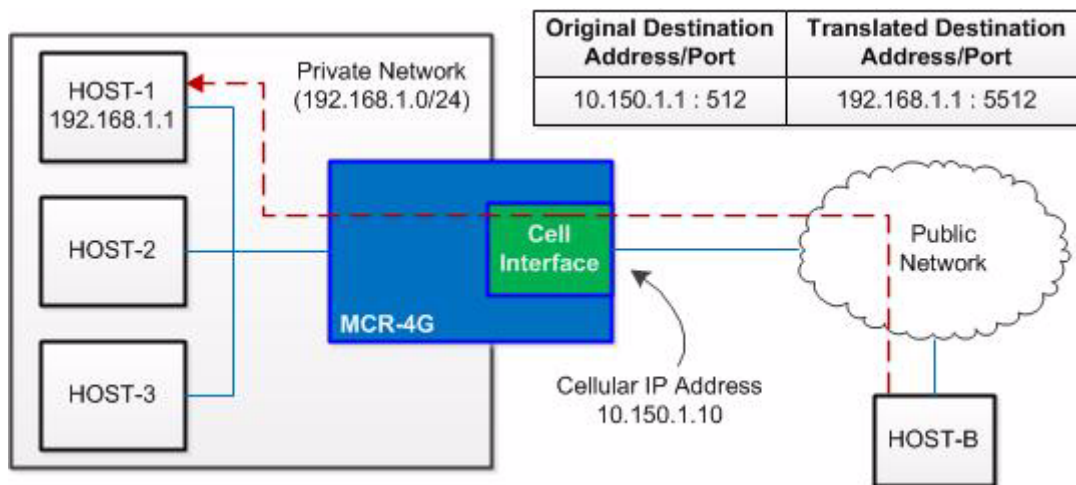


Figure 23. Destination NAT Translation of IP Address

Configuring

Configuration Hierarchy

```

services {
  firewall
  nat {
    destination {
      rule-set <name> {
        rule <id> {
          match {
            src-address {
              not <boolean>;
              add-interface-address <true|false>;
              address <network/prefix>;
              address-range <to/from>;
              address-set <name> {
                add-interface-address <true|false>
                not <boolean>
              }
            }
            dst-address {
              not <boolean>;
              add-interface-address <true|false>;
              address <network/prefix>;
              address-range <to/from>;
              address-set <name> {
                add-interface-address <true|false>
                not <boolean>
              }
            }
            destination-nat {
              address <ip-address>;
              port <unit16>;
            }
          }
        }
      }
    }
  }
}

interfaces {
  interface <name> {
    nat {
      destination <name>;
    }
  }
}

```

Destination NAT configuration on MCR involves following high level steps:

1. Create a destination NAT rule-set.
2. Add one or more rules to perform destination NAT for specific incoming traffic on the public interface.
3. Apply the destination NAT rule-set to the public interface.

Following example describes the step-by-step configuration of an example destination NAT rule-set to perform port forwarding for incoming Modbus protocol (TCP port 512) traffic on the cellular interface to the private HOST-1 (assume that modbus traffic is running on port 5512 on HOST-1). Change to CLI configuration mode:

1. Enable firewall service, if it is not already enabled.
admin@(none) 19:33:20% set services firewall enabled true
2. Create source NAT rule-set named IO_SERVICES.
admin@(none) 19:33:20% set services firewall nat destination rule-set IO_SERVICES

3. Create rule for port forwarding Modbus TCP traffic coming into cellular interface on port 512 to port 5512 on private HOST-1.

```
admin@(none) 19:33:20% set services firewall nat destination rule-set IO_SERVICES rule 1 match protocol tcp dst-address address 10.150.1.1/32
```

Value for 'services firewall nat destination rule-set IO_SERVICES rule 1 destination-nat-address'(<IP address>):
192.168.1.1

```
admin@(none) 19:33:20% set services firewall nat destination rule-set IO_SERVICES rule 1 match dst-port 512
```

```
admin@(none) 19:33:20% set services firewall nat destination rule-set IO_SERVICES rule 1 destination-nat port 5512
```

4. Apply this destination NAT rule-set to the cellular interface.

```
admin@(none) 19:33:20% set interfaces Cell nat destination IO_SERVICES
```

5. Commit configuration and exit configuration mode.

```
admin@(none) 19:33:20% commit
```

Commit complete.

```
[ok][2013-09-24 19:33:20]
```

```
admin@(none) 19:33:21% exit
```

```
admin@(none) 19:33:21>
```

Monitoring

At this time there are no commands to monitor traffic statistics for packets being masqueraded by the firewall. This feature may be added in future revisions of firmware.

VPN

Understanding

The MCR supports standards-based IPsec Virtual Private Network (VPN) technology to securely connect remote private network (LAN or WiFi) with the customer's backoffice/data center private network see [Figure 24](#)). This allows IP traffic from/to devices connected to either LAN, WiFi or Serial port of the MCR to securely flow to/from back-office applications via a secure tunnel through a public cellular network. The tunneled application traffic is authenticated and encrypted to protect from eavesdropping, tampering and replay attacks.

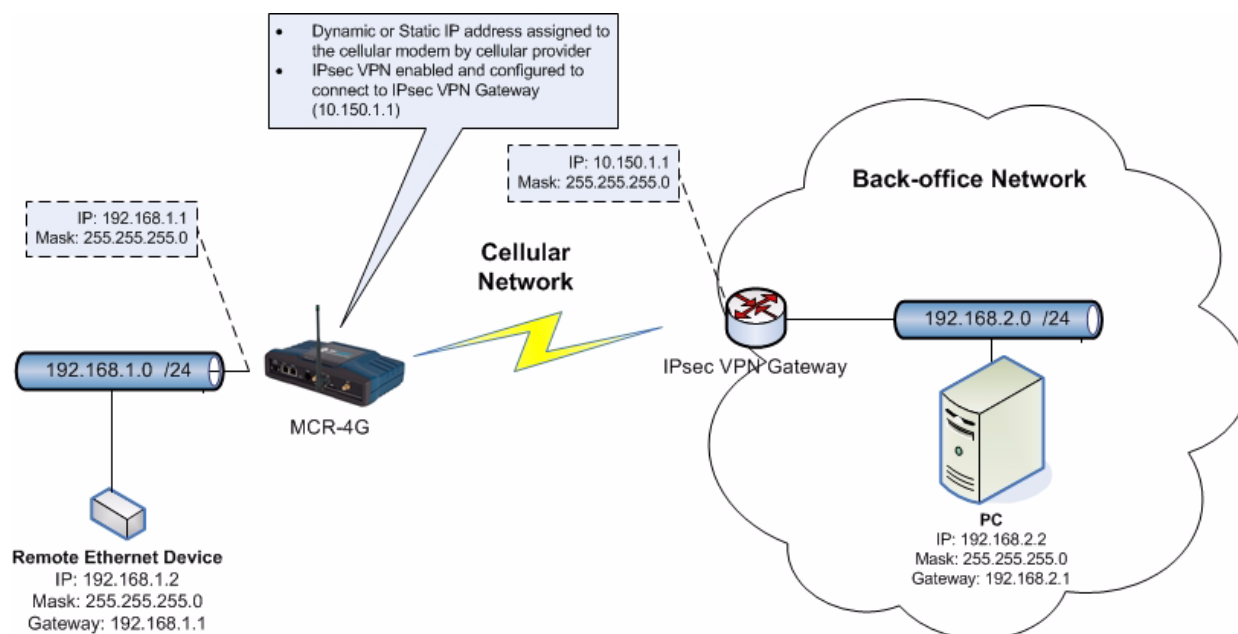


Figure 24. VPN Setup Example

[Figure 24](#) shows an example network, where a remote Ethernet device is connected to MCR via Ethernet on 192.168.1.0/24 network. The MCR establishes a VPN connection with IPsec VPN gateway, thereby securely connecting remote private network (192.168.1.0/24) with back-office private network (192.168.2.0/24). This allows PC (192.168.2.2) to communicate with remote Ethernet device (192.168.1.2) using any TCP/UDP/IP based protocol and vice versa.

IPsec, Internet Protocol Security, is a set of protocols defined by the IETF, Internet Engineering Task Force, to provide IP security at the network layer.

An IPsec based VPN is made up by two parts:

- Internet Key Exchange protocol (IKE)
- IPsec protocols (ESP, AH)

The first part, IKE, is the initial negotiation phase, where the MCR and VPN gateway agree on which methods will be used to provide security for the underlying IP traffic. There are two IKE protocol versions: IKE-v1 and IKE-v2. These are not compatible with each other. The IKE-v2 is more efficient and therefore should be preferred for new deployments. The MCR supports IKE-v1 and IKE-v2.

The other part is the actual IP data being transferred, using the encryption and authentication methods agreed upon in the IKE negotiation. This is accomplished by using IPsec protocols like Encapsulating Security Payload (ESP) or Authentication Header (AH). The MCR only supports ESP protocol as it provides both encryption and authentication of the data. The AH protocol provides only data authentication.

The process of IPsec VPN connection establishment consists of following phases:

- IKE Phase-1 (IKE security negotiation)
 - Negotiate how IKE should be protected
- IKE Phase-2 (IPsec Security Association)
 - Negotiate how IPsec should be protected
 - Derive fresh keying material from the key exchange in phase-1, to provide session keys to be used in the encryption
 - and authentication of the VPN data flow
- Exchange data over the IPsec tunnel

Both the IKE and the IPsec connections have limited lifetimes. These lifetimes prevent a connection from being used too long, which is desirable from a cryptanalysis perspective.

The IPsec lifetime is generally shorter than the IKE lifetime. This allows for the IPsec connection to be re-keyed simply by performing another phase-2 negotiation.

Configuration

VPN Configuration Hierarchy

NOTE: The configuration parameters shown here are a subset of all available configuration parameters. Refer to the appendix section for all available parameters.

```

services {
  vpn {
    enabled <true|false>;
    ike {
      policy <name> {
        auth-method <eap-tls|eap-ttls|pre-shared-key|pub-key>;
        pki {
          cert-type <rsa|ecdsa>;
          cert-id <certificate-id>;
          key-id <private-key-id>;
          ca-cert-id <ca-certificate-id>;
        }
        ciphersuite <name> {
          encryption-algo <aes-256-cbc|...>;
          mac-algo <sha256-hmac|...>;
          dh-group <dh-14|...>;
        }
      }
      peer <name> {
        ike-policy <reference-to-ike-policy>;
        peer-identity {
          address <ip-address>;
          default <ip-address>;
          dn <name>;
          fqdn <string>;
          user-fqdn <string>;
        }
        peer-endpoint {address|any|fqdn};
        peer-identity-no-idr <true|false>;
        local-identity {address|default|dn|fqdn|user-fqdn};
        local-endpoint {address|any|sqdn};
        role <initiator|responder>;
        dpd-interval <interval (secs)>
        dpd-enabled <true|false>;
      }
    }
  }
  ipsec {
    policy <name> {
      life-time <sec>;
      ciphersuite <name> {
        encryption-algo <aes-256-cbc|...>;
        mac-algo <sha256-hmac|...>;
        dh-group <dh-14|...>;
      }
    }
  }
}

```

```

        connection <name> {
            ike-peer                <reference-to-ike-peer>;
            ipsec-policy             <reference-to-ipsec-policy>;
            local-ip-subnet          <ip address/len>;
            remote-ip-subnet         <ip address/len>;
            failure-retry-interval   1;
            is-out-of-band-ima       <true|false>;
            local-source-ip-address <ip address>;
            periodic-retry-interval <mins>;
        }
    }
}

```

Firewall Filters for the Cellular Interface

When setting up IPsec VPN over a Cellular interface, the following firewall filters are recommended to be configured and applied to the cellular interface. The **IN_UNTRUSTED** and **OUT_UNTRUSTED** filters should be applied to incoming and outgoing traffic respectively.

```

filter IN_UNTRUSTED {
    rule 1 {
        match {
            protocol udp;
            src-port {
                services [ dns ike ntp ];
            }
        }
        actions {
            action accept;
        }
    }
    rule 2 {
        match {
            protocol esp;
        }
        actions {
            action accept;
        }
    }
    rule 3 {
        match {
            protocol icmp;
        }
        actions {
            action accept;
        }
    }
    rule 4 {
        match {
            ipsec {
                direction      in;
                tunnel-src-address <VPN SERVER IP ADDRESS>/32;
                tunnel-dst-address <CELL INTERFACE IP ADDRESS>/32;
            }
        }
        actions {
            action accept;
        }
    }
    rule 10 {
        match {
            protocol all;
        }
        actions {
            action drop;
        }
    }
}

filter OUT_UNTRUSTED {
    rule 1 {
        match {
            src-address {
                address <CELL INTERFACE IP ADDRESS>/32;
            }
        }
        actions {
            action accept;
        }
    }
}

```

```
rule 2 {
  match {
    ipsec {
      direction      out;
      tunnel-src-address <CELL INTERFACE IP ADDRESS>/32;
      tunnel-dst-address <VPN SERVER IP ADDRESS>/32;
    }
  }
  actions {
    action accept;
  }
}
rule 10 {
  match {
    protocol all;
  }
  actions {
    action drop;
  }
}
}
```

VPN configuration involves the following high level steps:

1. Configure an IKE policy specifying an authentication method, cipher suites to be included in the proposal during IKE phase-1 and the credentials to be used for authentication e.g. certificates or preshared-keys.
2. Configure an IKE peer specifying peer endpoint address, IKE policy to used for IKE phase-1 negotiation. The “role” specifies whether MCR initiates connection (initiator) or it waits for the connection from the peer (responder). This should usually be set to “initiator”.
3. Configure an IPsec policy specifying ESP cipher suites to be included in the proposal during IKE phase-2.
4. Configure an IPsec connection specifying IKE peer, IPsec policy, local and remote private IP subnets.

NOTE: The above configuration parameters should match with the corresponding parameters set in the peer. Otherwise, the IPsec VPN connection will not succeed. Typical configuration mistakes include incorrect security credentials (psk or certificates/keys), mismatched cipher suite configuration, and mismatched local and remote subnet configuration.

The following example describes the step-by-step VPN configuration for the example network shown in figure above. We’ll assume that certificates are being used as security credentials and have already been loaded in the MCR either manually or via SCEP.

1. Ensure that cellular interface has been configured.
2. Ensure that device has been configured with certificates/keys.
3. Ensure that device has been configured to obtain time via NTP.

NOTE: The VPN connection will fail unless the time is synchronized on the device because certificate validation will fail.

4. Enable VPN service

```
admin@(none) 20:38:44% set services vpn enabled true
```

5. Create IKE policy with auth-method “public-key encryption”.

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 auth-method pub-key
```

6. Configure Public Key Infrastructure (PKI) security credentials

- Certificate type as “rsa” if RSA public key encryption based certificates are being used.
- Client certificate ID – This is the ID that was assigned to the client certificate obtained via SCEP or loaded manually.
- Client private key ID – This is the ID that was assigned to the client private key generated during SCEP procedure or loaded manually.
- Certificate Authority (CA) certificate ID – This is the ID that was assigned to the CA certificate obtained via SCEP or loaded manually.

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 pki cert-type rsa
```

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 pki cert-id ID-1
```

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 pki key-id ID-1
```

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 pki ca-cert-id GEPKI
```

1. Configure the following ciphersuite to be included as proposal for IKE phase-1 negotiation:

- Encryption Algorithm = AES 256 Bit in CBC mode
- Message Authentication Algorithm = HMAC using SHA256 digest
- Diffie-Hellman Group = DH-14 (group 14 modp2048)

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 ciphersuite  
AES256_CBC-SHA256-DH14 encryption-algo aes-256-cbc
```

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 ciphersuite  
AES256_CBC-SHA256-DH14 mac-algo sha256-hmac
```

```
admin@(none) 19:33:29% set services vpn ike policy IKE-POLICY-1 ciphersuite  
AES256_CBC-SHA256-DH14 dh-group dh-14
```

NOTE: More than one ciphersuite can be included in the proposal.

1. Create IKE peer with address 10.150.1.1 and dead peer detection enabled and interval set to 5 mins.

The dead peer detection (DPD) is enabled by default. When enabled, it sends **R_U_THERE/INFORMATIONAL** messages to the peer if there no other data sent within DPD interval. This allows MCR to detect dead VPN peers and clear a VPN connection. The DPD interval should be set to no less than 300 seconds (5 minutes) to reduce the periodic traffic in the network.

The peer-identity-no-idr parameter, when set to true, prevents the unit from sending the responder’s ID (IDr) in its **IKE_AUTH** request which might prevent the peer from finding matching a configuration.

```
admin@(none) 19:33:29% set services vpn ike peer VPN-GW role initiator
```

```
admin@(none) 19:33:29% set services vpn ike peer VPN-GW ike-policy IKE-POLICY-1
```

```
admin@(none) 19:33:29% set services vpn ike peer VPN-GW peer-endpoint address 10.150.1.1
```

```
admin@(none) 19:33:29% set services vpn ike peer VPN-GW peer-identity-no-idr true
```

```
admin@(none) 19:33:29% set services vpn ike peer VPN-GW dpd-interval 300
```

2. Create an IPsec policy and configure the following ciphersuite to be included as proposal for IKE phase-2 negotiation:

- Encryption Algorithm = AES 256 Bit in CBC mode
 - Message Authentication Algorithm = HMAC using SHA256 digest
 - Diffie-Hellman Group = DH-14 (group 14 modp2048)
- ```
admin@(none) 19:33:29% set services vpn ipsec policy IPSEC-POLICY-1 ciphersuite
AES256_CBC-SHA256-DH14 encryption-algo aes-256-cbc

admin@(none) 19:33:29% set services vpn ipsec policy IPSEC-POLICY-1 ciphersuite
AES256_CBC-SHA256-DH14 mac-algo sha256-hmac

admin@(none) 19:33:29% set services vpn ipsec policy IPSEC-POLICY-1 ciphersuite
AES256_CBC-SHA256-DH14 dh-group dh-14
```

---

**NOTE:** More than one ciphersuite can be included in the proposal.

---

3. Create IPsec connection

```
admin@(none) 19:33:29% set services vpn ipsec connection VPN-GWY-CONN-1 ike-peer VPN-GWY
admin@(none) 19:33:29% set services vpn ipsec connection VPN-GWY-CONN-1 ipsec-policy
IPSEC-POLICY-1

admin@(none) 19:33:29% set services vpn ipsec connection VPN-GWY-CONN-1 local-ip-subnet
192.168.1.0/24

admin@(none) 19:33:29% set services vpn ipsec connection VPN-GWY-CONN-1 remote-ip-subnet
192.168.2.0/24

admin@(none) 19:33:29% set services vpn ipsec connection VPN-GWY-CONN-1 failure-retry-interval 1
```

The following table describes the VPN connection attempt retries and time interval between them. After giving up as listed below, the unit waits for “failure-retry-interval” and repeats the connection attempt sequence.

| Attempt#                                                      | Relative Timeout<br>Between Attempts (secs) | Absolute Timeout<br>From First Attempt (secs) |
|---------------------------------------------------------------|---------------------------------------------|-----------------------------------------------|
| 1                                                             | 0                                           | 0                                             |
| 2 (1 <sup>st</sup> retry)                                     | 4                                           | 4                                             |
| 3 (2 <sup>nd</sup> retry)                                     | 7                                           | 11                                            |
| 4 (3 <sup>rd</sup> retry)                                     | 13                                          | 24                                            |
| 5 (4 <sup>th</sup> retry)                                     | 23                                          | 47                                            |
| 6 (5 <sup>th</sup> retry)                                     | 42                                          | 89                                            |
| Give up                                                       | 76                                          | 165                                           |
| Wait for “failure-retry-interval”, then repeat above sequence |                                             |                                               |

During initial configuration set failure-retry-interval to lowest value of 1 min, to have MCR attempt connection more quickly. This allows debugging of any connection-related issue by watching logs on peer side etc. Be sure to change this value to 5 mins or higher to prevent excessive attempts and traffic.

Commit configuration and exit configuration mode.

```
admin@(none) 20:38:44% commit
Commit complete.

admin@(none) 20:38:44% exit
[ok][2013-01-18 20:40:45]

admin@(none) 20:38:44>
```

## Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the VPN connection state (connecting, connected or disconnected). The failure-reason displays the reason for last connection failure.

```
admin@(none) 20:40:45> show services vpn
services vpn ipsec ipsec-status connection VPN-GWY-CONN-1
state connecting
failure-reason none
last-timestamp 2013-01-18T20:24:15+00:00
ima-evaluation none
ima-recommendation none
```

```
admin@(none) 20:40:45> show services vpn
services vpn ipsec ipsec-status connection VPN-GWY-CONN-1
state connected
failure-reason none
last-timestamp 2013-01-18T20:24:15+00:00
ima-evaluation none
ima-recommendation none
```

With a connection made, ping the back-office PC to make sure the traffic is passing between device and PC.

```
admin@(none) 20:41:32> ping 192.168.2.1
PING 192.168.1.2 (192.168.2.1) 56(84) bytes of data.
64 bytes from 192.168.2.1: icmp_req=1 ttl=63 time=389 ms
64 bytes from 192.168.2.1: icmp_req=2 ttl=63 time=161 ms
[ok][2013-01-18 20:49:42]
```

## VPN Troubleshooting

The following are common reasons for VPN connection failure:

1. Invalid certificate or keys loaded on the device
2. Time not synchronized on the device. Note that after cell connection is established, device can take few minutes to sync time from NTP server. VPN connection will not succeed until time is synchronized.
3. Mismatch in ciphersuites configured for IKE policy on device and peer VPN gateway.
4. Mismatch in ciphersuites configured for IPsec policy on device and peer VPN gateway.
5. Mismatch in remote and local IP subnets configured for IPsec connection on device and peer VPN gateway. Note the following:
  - a. For device
    - i. remote ip subnet = back-office subnet
    - ii. local ip subnet = local LAN or WIFI subnet on device
  - b. For VPN gateway
    - i. remote ip subnet = device's local LAN or WIFI subnet
    - ii. local ip subnet = back-office subnet on device

## DNS

### Understanding

Domain Name System (DNS) servers can be configured on the unit to facilitate the resolution of domain names to IP addresses.

---

**NOTE:** Manual configuration of DNS overrides any DNS settings obtained via DHCP.

---

### Configuring

The following example shows how to configure a DNS server with IP address 192.168.1.2 on the MCR. Note that the “search” option can take a list of arguments and in this example, there are two arguments; **mds** and **gemds**.

```
admin@(none) 00:31:02% set system dns server 192.168.1.2 search [mds gemds] options attempts 3 timeout 3
```

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics.

The *ping* utility can be used on the CLI when it is in operational mode to verify that DNS is working properly. If ping can resolve a name on the connected network to an IP address then DNS settings are working properly. The example below shows the resolution of the name “example.com” to the IP address “192.0.43.10” on a unit that is connected to the Internet.

Use the control sequence “CTRL-C” to stop the ping utility.

```
admin@(none) 00:20:33> ping example.com
PING example.com (192.0.43.10) 56(84) bytes of data.
64 bytes from 43-10.any.icann.org (192.0.43.10): icmp_req=1 ttl=237 time=30.8 ms
64 bytes from 43-10.any.icann.org (192.0.43.10): icmp_req=2 ttl=237 time=44.7 m
[ok][2012-06-19 00:24:08]
admin@(none) 00:24:08>
```

## DHCP Service

### Understanding

The unit can be configured to act as a DHCP server. When enabled, this service will respond to DHCP requests from any interface.

### Configuring

The following shows an example of configuring DHCP service on the unit. The unit will administer IPv4 addresses from the 192.168.x.x network when requests are received from DHCP clients.

---

**NOTE:** At least one of the unit's interfaces (ETH1, ETH2, WiFi or Bridge if the interface is bridged) must be configured with an IP address from this subnet.

---

```
admin@(none) 04:18:26% set services dhcp v4subnet 192.168.0.0/16 domain-name gemds range-start
192.168.1.100 range-end 192.168.1.150 router 192.168.1.1 broadcast-address 192.168.255.255
ntp-servers [time.mds]
```

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the DHCP leases.

```
admin@(none) 04:18:26> show services dhcp

services dhcp leases 192.168.1.100
starts 2013-01-22T12:55:13+00:00
ends 2013-01-23T00:55:13+00:00
binding-state free
client-mac 70:f1:a1:fc:1d:da
hostname ""
[ok][2013-01-23 04:18:27]
```

## Terminal Service

### Understanding

The unit allows the setup of the COM ports as a terminal server that passes data to/from the serial port to network interfaces. The serial port must be configured to do this, in addition to the baud rate and data format. The data from the serial port is treated as a seamless stream; meaning it is not protocol aware and will send data from the serial port to the remote endpoint as soon as the data is received. A terminal-server can consist of a TCP server, a TCP client, or a UDP endpoint, and a MODBUS-TCP server.

When a terminal server on the unit is configured as TCP server, then the unit listens on a TCP port for client connections. When a terminal server on the unit is configured as TCP client, then the unit will attempt to connect to the remote IP address. Once a TCP connection is established, then serial traffic from the COM port can pass to and from the TCP port as long as the TCP connection remains established.

When a terminal server on the unit is configured as a UDP endpoint, then traffic from the COM port is sent to the remote host at the specified port in UDP packets. Likewise, traffic sent to the UDP port of the unit is forwarded out the COM port. Since UDP is stateless, some packets may not reach their intended destination or may arrive out of order. The protocol contained in the UDP messages must handle these scenarios.

When a terminal server on the unit is configured as a MODBUS/TCP server, then the unit listens on a TCP port for a client connection. Once a TCP connection is established, the unit will convert the incoming MODBUS/TCP frame into either a MODBUS/RTU or MODBUS/ASCII frame for transmitting on the serial port. Serial data received is converted from either MODBUS/RTU or MODBUS/ASCII to MODBUS/TCP for transmission back to the MODBUS/TCP client.

---

**NOTE:** Once a terminal-server is enabled on a COM port, the port stays in data mode and the CLI will not be available on that port. To break out of data mode, the escape sequence +++ can be entered on the PC's keyboard. The baud rate and format must match on the PC and on the unit for the escape sequence to be detected. Once the sequence is detected, the login prompt is presented as long as the port is enabled for console access.

---

### Configuring

The following shows how to enable a UDP terminal server on COM1

```
admin@(none) 01:34:45% set services serial terminal-server server COM1 mode udp port 10000
remote address 192.168.1.12 port 10000
[ok][2012-06-19 01:35:36]

[edit]
admin@(none) 01:35:36% commit
```

The following shows how to enable a TCP terminal server on COM1

```
admin@(none) 01:22:09% set services serial terminal-server server COM1 mode tcp-server port
30011 idle-timeout 30
[ok][2012-06-19 01:22:36]
[edit]
admin@(none) 01:22:36% commit
```

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
admin@(none) 22:03:06> show services serial
```

| SERIAL<br>PORT | IP TX<br>PACKETS | IP TX<br>BYTES | IP RX<br>PACKETS | IP RX<br>BYTES | SERIAL<br>TX<br>PACKETS | SERIAL<br>TX<br>BYTES | SERIAL<br>RX<br>PACKETS | SERIAL<br>RX<br>BYTES |
|----------------|------------------|----------------|------------------|----------------|-------------------------|-----------------------|-------------------------|-----------------------|
| COM2           | 0                | 0              | 0                | 0              | 0                       | 0                     | 0                       | 0                     |

```
[ok][2013-01-24 22:03:13]
```

## Iperf Service

### Understanding

Iperf service allows one to receive TCP traffic from remote host running iperf. Currently, iperf service is hardcoded to act only as a TCP server listening on port 5001.

### Configuring

The following shows how to enable iperf service:

```
admin@(none) 22:04:32% set services iperf enabled true
admin@(none) 22:04:32% commit
Commit complete.
[ok][2013-09-24 22:04:33]
```

---

**NOTE:** If firewall is enabled, then it must be configured to permit incoming TCP traffic on port **5001**.

---

### Monitoring

Ensure the CLI is in operational mode. Follow the example to view the state of iperf service:

```
admin@(none) 22:07:37> show services
```

| NAME         | STATUS   |
|--------------|----------|
| -----        |          |
| DHCP Server  | running  |
| Firewall     | running  |
| IPerf Server | running  |
| Serial       | running  |
| SNMP Server  | running  |
| SSH Server   | disabled |
| VPN          | running  |
| Web Server   | running  |

## Date, Time and NTP

### Understanding

The date and time can be set on the MCR using a manually configured value or automatically via Network Time Protocol (NTP). The NTP settings take precedence over the manual settings. If NTP is enabled, then the user will not be able to set the date and time manually.

### Configuring

To manually set the date and time, use the request `set-current-datetime`:

```
admin@none 18:18:58> request system clock set set-current-datetime current-datetime
2013-10-01T8:33:45
```

To use an NTP server, an NTP server must be configured on MCR:

```
admin@none 00:20:33% set system ntp use-ntp true ntp-server time.nist.gov
admin@none 00:20:33% commit
Commit complete.
[ok][2012-06-19 00:20:36]
```

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
admin@none 00:20:34> show system clock
system clock current-datetime 2012-06-19T00:20:34+00:00
system clock boot-datetime 2012-06-19T00:18:01+00:00
[ok][2012-06-19 00:20:34]
```

## Geographical-location

The geographical-location of the unit can be configured as shown below:

```
admin@none 00:50:46% set system geographical-location altitude 1.0 latitude 43.117807
longitude -77.611896
[ok][2012-06-19 00:56:00]
```

```
[edit]
admin@none 00:56:00% commit
Commit complete.
[ok][2012-06-19 00:56:05]
```

```
[edit]
admin@none
```

## User Management and Access Controls

### Understanding

There are three user accounts/roles (administrator, technician, and operator) for management access.

Users in the *admin* group have the highest privilege and can read everything in the tree that is readable, write everything that is writable, and can execute any of the requests.

Users in the *tech* group have less access than admin. Generally, the tech group cannot configure any security-related configuration.

Users in the *oper* group can only view status and configuration. They do not have access to modify the device configuration.

By default, the password for each account is the same as the username. The passwords should be changed by users prior to deploying the device. When local user management is being used, passwords are stored in non-volatile memory using PKCS#5 based encryption.

The user authentication can be done using locally stored passwords or via RADIUS.

### Configuring

The password for each user account can be changed using a request:

```
admin@(none) 01:04:19> request system authentication change-password user admin password
new_password
```

---

**NOTE:** If the admin password is forgotten, the only way to reset the login password is by using the login One-Time-Password. This will reset the user passwords AND reset the entire unit's configuration to defaults. Refer to section **3.1.4 One-Time “Recovery” Passwords** on [Page 16](#).

---

User authentication order can be specified to give preference to which method is used first when authenticating user access. In the following example, the list of RADIUS servers will be contacted first before the local authentication rules are used.

---

**NOTE:** If the local-users option is specified *before* RADIUS, then only the local-users option will be utilized; the RADIUS servers will never be contacted.

---

```
admin@(none) 01:05:07% set system authentication user-authentication-order [radius local-users]
```

```
admin@(none) 01:05:07% commit
```

```
Commit complete.
```

```
[ok][2013-09-24 01:05:10]
```

## Monitoring

Ensure the CLI is in operational mode. Follow the example below to see the history of login attempts by reviewing the event log:

```
admin@(none) 01:21:48> show logging event-log event-type console_login
```

```
logging event-log 62625
```

```
time-stamp 2011-12-21T01:18:08.985996+00:00
```

```
priority notice
```

```
event-type console_login
```

```
status success
```

```
message "user_name oper, "
```

```
logging event-log 62627
```

```
time-stamp 2011-12-21T01:23:00.288046+00:00
```

```
priority notice
```

```
event-type console_login
```

```
status failure
```

```
message "msg noauth, user_name admin, "
```

```
[ok][2011-12-21 01:23:03]
```

```
admin@(none) 01:23:03>
```

## Login-Lockout

### Understanding

The unit has protections against repeated login attempts. The max-login-attempts configuration determines the number of failed logins that can occur in succession before the unit disables the ability to login for a specified amount of time. The amount of time is determined by failed-login-lockout-time, which represents the time in seconds.

### Configuring

```
admin@none 01:51:26% set system max-login-attempts 30
[ok][2012-06-19 01:56:38]

[edit]
admin@none 01:56:38% set system failed-login-lockout-time 300
[ok][2012-06-19 01:56:56]

[edit]
admin@none 01:56:56% commit
Commit complete.
[ok][2012-06-19 01:56:58]
```

## RADIUS

### Understanding

User accounts can be centrally managed with a RADIUS server. RADIUS accounts can be mapped to one of the three user roles.

If the RADIUS server is not accessible, users may use the local username/password to “fall back” to local authentication if the unit is configured to do so. Many RADIUS servers do not respond to a failed login attempt. To the unit, this appears the same as if the server is not there. The consequence of this behavior is that after three failed login attempts, the authentication will take place against the local user/password database if local fallback is enabled. Refer to the section on “Local User Management” for configuring the authentication order.

If more than one RADIUS server is configured, then the unit will attempt each RADIUS server in the order that they appear in the configuration until a successful response is received. A RADIUS server must be configured to provide the user’s authentication group in its authentication reply via a GE MDS vendor attribute. This can be configured in freeradius (an open source RADIUS server) by using the following dictionary file:

```
VENDOR GEMDS 4130
BEGIN-VENDOR GEMDS
ATTRIBUTE GEMDS-UserAuth-Group 1 integer
VALUE GEMDS-UserAuth-Group Operator 0
VALUE GEMDS-UserAuth-Group Technician 1
VALUE GEMDS-UserAuth-Group Administrator 2
END-VENDOR GEMDS
```

And configuring users as follows:

```
admin Cleartext-Password := "admin"
 GEMDS-UserAuth-Group := Administrator

tech Cleartext-Password := "tech"
 GEMDS-UserAuth-Group := Technician

oper Cleartext-Password := "oper"
 GEMDS-UserAuth-Group := Operator
```

### Configuring

The following shows how to configure a RADIUS server:

```
admin@none 02:23:42% set system mds-radius servers server1 address 192.168.1.2
shared-secret abcd1234 user-authentication-type radius-CHAP
admin@none 00:06:15% show system mds-radius
servers server1 {
 address 192.168.1.2;
 authentication-port 1812;
 shared-secret abcd1234;
 user-authentication-type radius-CHAP;
}
[ok][2012-06-19 00:06:22]

[edit]
admin@none 00:06:22% commit
Commit Complete.
[ok][2012-06-19 00:06:25]
```

## File Servers

### Understanding

External file servers can be preconfigured so that the configuration can easily be referenced in other services without the need to re-enter the information. File Server Configurations can be used for reprogramming, downloading certificates, configuration script import and export, and sending support bundles for debugging.

### Configuring

The following shows how to add a file server configuration named “GE File Server 1”:

```
admin@(none) 05:11:42% set file-servers GE_file_server_1 tftp address 192.168.1.2
admin@(none) 05:11:42% commit
Commit complete.
[ok][2012-06-19 05:11:43]

admin@(none) 05:11:45> show configuration file-servers
file-servers GE_file_server_1 {
 tftp {
 address 192.168.1.2;
 }
}
[ok][2012-06-19 05:11:46]
```

### Monitoring

Ensure the CLI is in operational mode. The file transfer status is available as operational data. Refer to the sections on “Firmware Management” and “Certificate Management” for more information.

## Certificate Management

### Understanding

The unit uses x509 public certificates and private keys for the following services:

- Secure Reprogramming
- Syslog over TLS
- IPsec VPN/IMA (when using pub-key, EAP-TLS or EAP-TTLS based authentication)
- WiFi (when doing EAP-TLS authentication in station mode)

Certificates can be loaded into the device using one of two methods: manual or SCEP. Note that certificates for secure reprogramming can only be loaded using the manual method.

The unit can load certificates that are in DER, PEM, or Encrypted PEM format. The unit can load private keys that are in DER, PEM, or Encrypted PEM.

### Configuring

From either operational or configuration mode, requests can be made on the device related to certificate management. Using the Tab character after entering 'request pki' shows a list of the available requests.

```
admin@(none) 05:04:37> request pki
Possible completions:
cancel-scep-operation - Cancel the last SCEP operation initiated.
delete-cacert - Delete identified CA certificate
delete-clientcert - Delete identified Client certificate
delete-firmware-cert - Delete identified certificate
delete-priv-key - Delete identified Private Key
generate-priv-key -
get-ca-cert - Request the certmgr to retrieve a CA cert from store.
get-client-cert - Request the certmgr to retrieve a client cert from
 store.
get-firmware-cert - Install a certificate to be used for firmware
 validation
get-priv-key - Retrieve private key file from network or local file
 system.
show-cert-info - Dump identified certificate as text to display
```

### Manual Download of Security Material

The 'get' series of requests allow security material to be downloaded from the network. The specifics of the communication can either be defined in the request or a server can be preconfigured separately (see "File Servers" on [Page 72](#)) and used in the request.

To manually load certificates from a file server, the following requests must be used:

- **get-ca-cert** – To load CA certificates
- **get-client-cert** – To load device/client certificates
- **get-firmware-cert** – To load firmware verification certificates
- **get-priv-key** – To load device/client private key

When loading certificates manually, the file server from which the certificate will be retrieved must be provided. The file server configuration can be entered every time or, to reduce typing, the file server configuration can be selected from one of the preconfigured file servers (see "File Servers" section on [Page 72](#)):

The following example shows loading of CA certificates using a file server defined prior to using the Certificate Manager request:

```
admin@(none) 01:19:31> request pki get-ca-cert file { preconfigured-file-server {
configuration_name GE_file_server_1 } filename cacert.der } cacert-identity ex_cacert
is-valid true
[ok][2012-06-19 01:20:03]
admin@(none) 01:20:03> show pki

CACERT
IDENTITY

ex_cacert
```

Here is an example of defining the file server manually in-line with the request call:

```
admin@(none) 00:35:27> request pki get-priv-key manual-file-server { tftp { address
192.168.1.2 } } filename der2048-priv-key.der key-identity ex_key_1
is-valid true
[ok][2012-06-19 00:36:27]
admin@(none) 00:36:27> show pki

KEY KEY
IDENTITY LENGTH KEY DATE TIME

ex_key_1 2048 2012-06-19T04:36:26Z
```

When defining a file server manually you may, as in this example, accept the defaults provided (in this example, block-size, port and timeout). After entering the address, a space and ‘}’ must be entered to complete the parameters for the chosen mode. Always try the Tab-Enter to have the CLI show the next needed parameters.

## SCEP and CA Configuration

The process of interacting with a SCEP server involves getting the currently published certificate(s) from the CA and then making a request for a client certificate with information and key material.

Before any attempt to interact with the SCEP server, the SCEP server itself, the CA associated with the SCEP server must be identified and the certificate information must be defined:

- **pki certificate-servers**
- **pki ca-servers**
- **pki cert-info**

The certificate server is defined under certificate-server. In the operation shown below, we define the SCEP server.

```
admin@(none) 23:46:28> config
Entering configuration mode private
[ok][2012-06-22 23:46:35]

[edit]
admin@(none) 23:48:14% set pki certificate-servers certificate-server ex_scep_serv
server-type scep scep-server-setting uri 192.168.1.5:12345/certserv/mscep/mscep.dll
poll-interval 5 retry-count 120 digest-algo sha256 encrypt-algo aes128_cbc
[ok][2012-06-22 23:49:52]

[edit]
admin@(none) 23:49:52% commit
Commit complete.
[ok][2012-06-22 23:49:56]

[edit]
admin@(none) 23:49:56%%
```

This defines the server that is running the SCEP protocol on an accessible network. The unit will append an 'http://' to the URL so it *must not* be entered as part of the uri parameter in the configuration. Note also, the above is just an example. Your IP address, specific port (if different from the default), and path to .dll or .cgi or other SCEP server mechanism must be obtained from your System Administration or Security personnel.

The configuration of the Certificate Authority that will be accessed at the above server is setup in a second command under ca-servers.

```
admin@(none) 03:05:56% set pki ca-servers ca-server ex_ca_serv ca-fingerprint
c1f2b0930c2c8e96164c3ed2d7e970a16860df8537403632dc18d7bf9bb7d546
[ok][2012-06-20 03:08:07]
[edit]
admin@(none) 03:08:07% commit
Commit complete.
[ok][2012-06-20 03:08:30]

[edit]
admin@(none) 03:08:30%
```

The fingerprint of the CA server is another data item you will obtain from your System Administrator or Security personnel. The ca server name is the name that will be referenced in the SCEP operations described below. In general, it is simply for your reference and does not have to be a specific name. In fact, it can be the same name as the ca-server if this helps to remember it.

Also, client certificate information that goes in the “Subject” portion of an X.509 certificate must be configured. Some fields may be fixed/required by the specific SCEP server.

```
admin@(none) 05:08:11% config
Entering configuration mode private
[ok][2012-06-23 04:08:19]

[edit]
admin@(none) 04:08:19% set pki cert-info certificate-info ex_ca_serv
Possible completions:
 common-name-x509 -
 country-x509 -
 locale-x509 -
 org-unit-x509 -
 organization-x509 -
 pkcs9-email-x509 -
 state-x509 -
```

The list above was displayed by entering Space-Tab after entering a name for the new set of certificate info.

The parameters that must be entered for your client certificate information must again be obtained from your System Administration or Security personnel. The common name will always be required. Other parameters may be required.

Here is an example:

```
admin@(none) 06:37:30> config
Entering configuration mode private
[ok][2012-06-23 06:37:32]

[edit]
admin@(none) 06:37:32% set pki cert-info certificate-info ex_ca_serv organization-x509 "GE
MDS LLC" org-unit-x509 Engineering common-name-x509 00102200000102030411223344556670
[ok][2012-06-23 06:38:34]

[edit]
admin@(none) 06:38:34% commit
Commit complete.
[ok][2012-06-23 06:38:38]
```

## Generating a Private Key

To have the device generate a private key, the following request must be used:

- **> request pki generate-priv-key**

The following example shows how to generate a private key with identifier **ex\_key**:

```
admin@(none) 21:54:47> request pki generate-priv-key key-size 2048 key-identity ex_key
```

## SCEP Certificate Requests

To load certificates via SCEP, the following requests must be used:

- **> request pki get-ca-cert scep** – To obtain CA certificate chain
- **> request pki get-client-cert scep** – To obtain device/client certificate

The first step is to acquire the CA published public certificate(s):

```
admin@(none) 00:27:14> request pki get-ca-cert scep { cert-server-name ex_scep_serv
ca-server-name ex_ca_serv } cacert-identity ex_cacert
is-valid true
[ok][2012-06-23 00:27:47]
admin@(none) 00:27:47> show pki
```

| KEY<br>IDENTITY | KEY<br>LENGTH | KEY DATE TIME        |
|-----------------|---------------|----------------------|
| ex_key          | 2048          | 2012-06-20T10:46:59Z |

```

CACERT
IDENTITY

ex_cacert
ex_cacert_ENC
ex_cacert_SGN

```

Additional CA server files sent as part of the request and needed later are saved with the base name you selected for the CA server and an added extension. Some of the names that may be added are:

- **\_ENC** , SCEP encryption certificate
- **\_SGN** , SCEP digital signature certificate

The second step is to request a client cert from the CA server via the SCEP server.

```
admin@(none) 06:28:39> request pki get-client-cert scep { cert-server-name ex_scep_serv
ca-server-name ex_ca_server cert-info-name ex_ca_server cert-key-name ex_key ca-challenge
51F67BBA1BCF20F1 cacert-identity-name ex_cacert } clientcert-identity ex_client
is-valid true
[ok][2012-06-20 06:32:04]
```

```
admin@(none) 06:32:04> show pki
```

```

KEY KEY
IDENTITY LENGTH KEY DATE TIME

ex_key 2048 2012-06-20T10:46:59Z

CACERT
IDENTITY

ex_cacert
ex_cacert_ENC
ex_cacert_SGN

CERT
IDENTITY

ex_client
```

The parameter that must be entered for your ca-challenge must be obtained from your System Administrator or Security personnel.

### Certificate Renewal with SCEP

At some point, the dates on your certificate will need to be renewed due to time or security policy. A client certificate can be renewed using the existing certificate with the same key as originally used when it was generated. An alternative is to provide a new key and identify for the certificate that is to be renewed and rekeyed.

The same request is used to renew as for the original request with a slight change in parameters provided. For this request, the cert-key-name is always the key that will be used in the certificate that you identify with the cert-identification-name. The 'self' cert and optional 'self' key are respectively the existing certificate that will be renewed and the key that was originally used when it was created.

In the case we are going to use the same key in a renewed cert. Here is a renewal request formed accordingly:

```

admin@(none) 02:03:49% request pki get-client-cert scep { cert-server-name ex_scep_serv
cert-info-name ex_ca_server ca-server-name ex_ca_server cacert-identity-name ex_cacert
cert-key-name ex_key cert-self-cert-name ex_client cert-self-key-name ex_key } client-
cert-identity ex_c_cert
is-valid true
[ok][2012-06-24 02:05:19]

[edit]
admin@(none) 02:05:19% exit
admin@(none) 02:13:51> show pki

KEY KEY
IDENTITY LENGTH KEY DATE TIME

ex_key 2048 2012-06-20T10:46:59Z

CACERT IDENTITY

ex_cacert
ex_cacert_ENC
ex_cacert_SGN

CERT
IDENTITY

ex_c_cert
ex_client
admin@(none) 02:05:19%
```

Here is an example of how to renew a cert with a new key named ex\_key\_1:

```
admin@(none) 05:16:58> request pki get-client-cert scep { cert-server-name ex_scep_serv
cert-info-name ex_ca_server ca-server-name ex_ca_server cacert-identity-name ex_cacert
cert-key-name ex_key_1 cert-self-cert-name ex_client cert-self-key-name ex_key } client-
cert-identity tst4
is-valid true
[ok][2012-06-24 05:17:32]
admin@(none) 05:17:32> show pki
```

| KEY<br>IDENTITY | KEY<br>LENGTH | KEY DATE TIME        |
|-----------------|---------------|----------------------|
| ex_key          | 2048          | 2012-06-20T10:46:59Z |
| ex_key_1        | 2048          | 2012-06-19T10:57:10Z |

```

CACERT IDENTITY

ex_cacert
ex_cacert_ENC
ex_cacert_SGN

CERT
IDENTITY

ex_c_cert
ex_client
tst4

[ok][2012-06-24 05:17:38]
admin@(none) 05:17:38>
```

## Deleting security material

Obsolete security material in all categories can be deleted from the device with the ‘delete’ series of requests:

- delete-cacert
- delete-clientcert
- delete-firmware-cert
- delete-priv-key

Here is an example of deleting the private key we have moved beyond when we re-keyed the client certificate in the last step:

```
admin@(none) 06:07:41% request pki delete-priv-key key-identity ex_key
is-valid true
[ok][2012-06-24 06:07:55]
admin@(none) 06:07:55%
```

## Firmware Certificate

The following example shows how to retrieve a certificate that can be used to verify a signed firmware package:

```
admin@(none) 06:07:41% request pki get-firmware-cert preconfigured-file-server {
configuration_name GE-FileServer-1 } filename certs/cert1.pem identity cert1
```

## Monitoring

Certificate information can be viewed for the following items:

- **ca-cert-info**
- **client-cert-info**
- **firmware-cert-info**
- **priv-key-info**

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
admin@(none) 01:03:45> show pki

 KEY
KEY IDENTITY LENGTH KEY DATE TIME

test_priv_key 1024 2012-06-19T00:05:23Z

CACERT IDENTITY

test_ca_cert
test_ca_cert_INT
test_ca_cert_ISS

CERT IDENTITY

test_client_cert

FWCERT
IDENTITY CERT HASH

GE_Cert1 7bd5c7aa56f469614f5ee13daa0a0800b60d97fbccfcb85c9fc2af87656043d8

[ok][2012-06-19 01:03:49]
admin@(none) 01:03:49>
```

## Event Logging

### Understanding

An event is a notification that something meaningful occurred on the unit. Events contain information about the occurrence that may be useful for administrators. The event can be stored locally and/or transported to a remote server. Administrators can adjust which events are reported by the unit. The structure of the information about the event is described below (CEE).

Logs are stored in the Event Log, which can be viewed with the command:

```
admin@(none) 00:15:32> show table logging event-log
```

### NETCONF-notifications

The events generated by the unit are converted to NETCONF notifications. NETCONF clients can subscribe to the unit to receive those notifications.

### Syslog

The events generated by the unit can be sent to remote syslog servers. The connection to the syslog server can be made secure using syslog over TLS. To set up a syslog server, use the command:

```
admin@(none) 00:16:20> % set logging syslog server my_server ip 192.168.1.200
```

When logging to a syslog server, the following attributes can also be set:

- priority
- syslog-facility

### Event Rules

All events can be configured to be logged to any combination of the following locations based on the event type:

- Local: Store event in the local event log.
- Netconf-notification: generate a NETCONF notification
- Syslog: Forward events to a remote syslog server.

Configure the event rules `% set logging event-rules <parameter> <functions/outputs>`

## Firmware Management

### Understanding

The unit can have two firmware packages programmed into the device. The package that the device booted into is referred to as the *Active Firmware*. The other image is referred to as the *Inactive Firmware*.

To reprogram the device, the Active Firmware streams the new firmware package from the network and writes the package into the Inactive Firmware location in memory. To use the new firmware package, the user must reboot the device to the Inactive Firmware. Doing so will make the Inactive Firmware the Active Firmware and vice-versa.

Firmware packages released by the factory are digitally signed using a private key. The unit will not accept firmware packages that are unsigned nor will it accept firmware packages that fail to verify while using the public certificates loaded into the device. Therefore it is necessary to have the GE MDS public certificate loaded into the device to reprogram the firmware.

Users may add their own signatures to the firmware package using the GE MDS code signing tool.

---

**NOTE:** Any additional signatures added to a firmware package will require the corresponding public certificates to be loaded into the unit for firmware reprogramming to complete successfully. Similarly, any additional firmware-validation public certificates loaded into the unit require a firmware package to be signed with the corresponding private keys.

---

The request *reprogram-inactive-image* initiates the reprogramming sequence on the unit. The request will return immediately and the reprogramming sequence will continue in the background on the device. The reprogramming sequence can take several minutes. The status of the reprogramming sequence can be polled to know when reprogramming has completed.

```
admin@none) 06:24:44> request system firmware reprogram-inactive-image
preconfigured-file-server { configuration_name GE-FileServer-1 } filename
files/firmware.mpk
[ok][2012-06-21 06:25:26]
admin@none) 06:25:26>
```

## Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics of the currently installed firmware packages:

```
admin@(none) 03:55:43> show system firmware versions
system firmware versions 1
version 1.0.1
active true
```

```
CERTIFICATE
SIGNING
INDEX CERTIFICATE SHA256

1 3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990

system firmware versions 2
version 1.0.0
active false
```

```
CERTIFICATE
SIGNING
INDEX CERTIFICATE SHA256

1 3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990
```

## Requesting an update

```
admin@(none) 03:55:43>request system firmware reprogram-inactive-image filename iwc-bkrc-1_0_0.mpk
manual-file-server { tftp { address 192.168.1.10 } }
```

## Retrieving Status on a Reprogramming Session

```
admin@(none) 03:55:43>show system firmware reprogramming-status
system firmware reprogramming-status state active
system firmware reprogramming-status detailed-message "Transferring file"
system firmware reprogramming-status size 36005116
system firmware reprogramming-status bytes-transferred 7455744
system firmware reprogramming-status percent-complete 20

admin@(none) 03:55:43>show system firmware reprogramming-status
system firmware reprogramming-status state complete
system firmware reprogramming-status detailed-message "Reprogrammed successfully"
system firmware reprogramming-status size 36005116
system firmware reprogramming-status bytes-transferred 35984896
system firmware reprogramming-status percent-complete 100
```

The command below provides a simple way to monitor percent complete. (Use Ctrl-C to abort.)

```
admin@(none) 03:55:43>show system firmware reprogramming-status percent-complete | repeat 1
system firmware reprogramming-status percent-complete 25
system firmware reprogramming-status percent-complete 27
system firmware reprogramming-status percent-complete 28
```

## Support Bundle

### Understanding

The MCR incorporates a facility to generate a support package bundle that includes internal debugs, logs, etc. This can help factory personnel troubleshoot user issues.

### Configuring

The following example shows how to have MCR generate and transfer a support package bundle (named `debug-2013-01-24.tgz`) to a FTP server running on host (address `192.168.1.2`) that is accessible from the MCR (e.g. a locally connected host or remote host accessible via cellular interface):

```
admin@(none) 22:14:57> request system support generate-support-package filename
debug-2013-01-24.tgz manual-file-server { ftp { address 192.168.1.2 username xyz password xyz } }
```

The MCR supports TFTP, FTP, and SFTP transfer protocols.

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state of the support bundle transfer:

```
admin@(none) 22:17:18> show system support
system support support-transfer-status state active
system support support-transfer-status detailed-message "Transferring"
system support support-transfer-status size 0
system support support-transfer-status bytes-transferred 0
system support support-transfer-status percent-complete 0
[ok][2013-01-24 22:17:21]
```

## Configuration Scripts

---

**NOTE:** The web-based device manager interface should not be active when importing a configuration script.

---

### Understanding

An exported configuration script will contain all of the settable parameters of the unit for which the current user has read-access; e.g. configuration scripts exported by the tech user will not contain values which only the admin user has permissions to view. Configuration scripts can be saved and used to restore known-good configurations.

### Configuring

The following example shows how to have MCR generate and transfer a configuration script (named `configscript-2013-09-24.txt`) to a SFTP server running on host (address `192.168.1.10`) that is accessible from the MCR (e.g. a locally connected host or remote host accessible via cellular interface):

```
admin@(none) 22:14:57> request system configuration-files export manual-file-server { sftp { address
192.168.1.10 username myusername password mypassword } } filename configscript-2013-09-24.txt
```

The configuration script can then be imported to the unit using TFTP, for example, using the commands below:

```
admin@(none) 22:18:32> request system configuration-files import manual-file-server { tftp { address
192.168.1.10 } } filename configscript-2013-09-24.txt
```

The MCR supports TFTP, FTP, and SFTP transfer protocols for configuration script export and import.

### Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state of the configuration script file transfer:

```
admin@(none) 22:17:18> show system configuration-file transfer-status
system support configuration-files transfer-status state active
system support configuration-files transfer-status detailed-message "Transferring"
system support configuration-files transfer-status size 30004
system support configuration-files transfer-status bytes-transferred 29404
system support configuration-files transfer-status percent-complete 97
[ok][2013-09-24 22:17:21]
```

## 4.0 TECHNICAL REFERENCE

### 4.1 Troubleshooting

All units must meet the basic requirements listed below for proper operation. Check these items first when troubleshooting a system problem:

- Adequate and stable primary power
- Secure connections (antennas, data and power)
- A clear transmission path between associated units
- An efficient, properly installed antenna system
- Proper configuration of unit settings
- Correct interface between the unit and other equipment

#### 4.1.1 LED Status Indicators

The LEDs on the unit are visual indications of the status of the device. These indicators can provide useful information when troubleshooting. Refer to [Table 8](#) for LED indications.



Figure 25. LED Status Indicators

Table 8. Description of LED Status Indicators

| LED Name                          | LED State                | Description                                        |
|-----------------------------------|--------------------------|----------------------------------------------------|
| <b>PWR</b><br>(DC Power)          | Off                      | No power to unit                                   |
|                                   | Solid Green              | Unit is powered, no problems detected              |
|                                   | Fast Blink/Red (1x/sec.) | Alarm indication                                   |
| <b>ETH</b><br>(Ethernet)          | Off                      | No Ethernet link to network                        |
|                                   | Solid Green              | Ethernet link present                              |
|                                   | Blinking Green           | Ethernet traffic in/out                            |
| <b>COM</b><br>(Serial Comm. Port) | Off                      | No serial connection, or idle                      |
|                                   | Blinking Green           | Serial traffic in/out                              |
| <b>NIC1</b><br>(Cell)             | Off                      | No cellular connection                             |
|                                   | Solid Green              | Cell Connection                                    |
| <b>NIC2</b><br>(WiFi)             | Off                      | Interface disabled                                 |
| <i>Access Point Mode</i>          | Solid Green              | Operating as AP and at least one client connection |
|                                   | Solid Red                | Operating as an AP and no client connection        |
| <i>Station Mode</i>               | Off                      | No connection                                      |
|                                   | Solid Green              | Wi-Fi connection established.                      |

**NOTE:** In addition to the LEDs above, the Ethernet connector has two embedded LEDs. A yellow indicates a link at 100 Mbps operation. A flashing green indicates Ethernet data traffic.

## 4.2 Technical Specifications

### 4.2.1 General

**Input Power:** 10 to 60 Vdc, 15 Watts maximum, depending on configuration. Below are power consumption figures for common configurations:

- Typical High Throughput Wi-Fi power consumption  $\leq 4.1$  Watts
- Minimum Wi-Fi power consumption  $\leq 3.4$  Watts

**Ethernet Port(s):** RJ-45 10/100 Mbps Auto-MDIX

**Serial Port(s):** RJ-45, supporting RS-232/RS-485

**LAN Protocols:** 802.3 (Ethernet) 802.1D (Spanning Tree) TCP/IP, DHCP, ICMP, IGMP, FTP, TFTP, SFTP, UDP, SNMP, VPN, VLAN

**Networking:** DHCP, Port Forwarding, NAT, VLAN, SNMP

**Configuration:** Serial console, SSH, HTTP/HTTPS, Configuration files

**Security:** Encryption, Password access, Radius, Firewall, SCEP, VPN

### 4.2.2 Physical

**Size:** 6.5" long (16.51 cm), 4.625" wide (11.75 cm), 1.5" High (3.81 cm)

**Housing:** Die-cast Aluminum

**Weight:** 2 lbs (without mounting hardware)

### 4.2.3 Environmental

**Operating Temperature Range:** -40°C to +70°C

### 4.2.4 Agency/Regulatory Approvals

**FCC:**

- WiFi – M4Y-ZCN722MV1,
- Cell – PKRNVWE362

**IC - Industry:**

- WiFi – 3195A-ZCN722MV1
- Cell -3229B-E362

Specifications subject to change without notice or obligation.

### 4.2.5 2.4 GHz WiFi Specifications

- Protocol: IEEE 802.11b/g/n OFDM 6 to 54Mbps, CCK 1 to 11Mbps
- Frequency Range: 2400 to 2500 MHz
- Maximum Transmit Power: 18 dBm (Default is 15 dBm)
- Permissible Antennas:
  - GE MDS 97-4278A36
  - GE MDS 97-4278A34
  - GE MDS 97-4278A35
- FCC: Part 15C
- FCC ID: VRA-SG9011028
- WiFi Antenna Connector: Female Reverse SMA

## 4.3 Glossary of Terms & Abbreviations

If you are new to wireless communications systems, some of the terms used in this guide may be unfamiliar. The following glossary explains many of these terms and will prove helpful in understanding the operation of the unit.

**Antenna System Gain:** A figure, normally expressed in dB, representing the power increase resulting from the use of a gain-type antenna. System losses (from the feedline and coaxial connectors, for example) are subtracted from this figure to calculate the total antenna system gain.

**Bit:** The smallest unit of digital data, often represented by a one or a zero. Eight bits (plus start, stop, and parity bits) usually comprise a byte.

**Bits-per-second:** See *BPS*.

**BPS (Bits-per-second):** A measure of the information transfer rate of digital data across a communication channel.

**Bridging:** (see *Ethernet Bridging*)

**Byte:** A string of digital data usually made up of eight data bits and start, stop and parity bits.

**CLI:** Command Line Interface. A method of user control where commands are entered as character strings to set configuration and operating parameters.

**CTS:** Clear to Send

**Decibel (dB):** A measure computed from the ratio between two signal levels. Frequently used to express the gain (or loss) of a system.

**Data Circuit-terminating Equipment:** See *DCE*.

**Data Communications Equipment:** See *DCE*.

**Data Terminal Equipment:** See *DTE*.

**dB<sub>i</sub>:** Decibels referenced to an “ideal” isotropic radiator in free space, frequently used to express antenna gain.

**dB<sub>m</sub>:** Decibels referenced to one milliwatt. An absolute unit used to measure signal power, as in transmitter power output, or received signal strength.

**DCE (Data Circuit-terminating Equipment)** (or Data Communications Equipment): In data communications terminology, this is the “modem” side of a computer-to-modem connection. The unit described in this manual is hardwired as a DCE device.

**DTE (Data Terminal Equipment):** A device that provides data in the form of digital signals at its output. DTE connects to the DCE device.

**ETH:** Ethernet

**Ethernet Bridging:** To be supplied.

**Fade Margin:** The greatest tolerable reduction in average received signal strength that will be anticipated under most conditions. It provides an allowance for reduced signal strength due to multipath, slight antenna movement or changing atmospheric losses. A fade margin of 20 to 30 dB is usually sufficient in most systems.

**FPGA:** Field Programmable Gate Array

**Frame:** A segment of data that adheres to a specific data protocol and contains definite start and end points. It provides a method of synchronizing transmissions.

**Hardware Flow Control:** A feature used to prevent data buffer overruns when the unit is handling high-speed data from an RTU or PLC. When the buffer approaches overflow, the unit drops the clear-to-send (CTS) line, which instructs the RTU or PLC to delay further transmission until CTS again returns to the high state.

**Host Computer:** The computer installed at the master unit, which controls the collection of data from one or more remote sites.

**IP:** Internet Protocol

**LAN:** Local Area Network

**LED:** Light Emitting Diode

**mA:** Milliamperes

**MAC:** Media Access Control

**Poll:** A request for data issued from the host computer (or master PLC) to a Remote unit.

**PLC (Programmable Logic Controller):** A dedicated microprocessor configured for a specific application with discrete inputs and outputs. It can serve as a host or as an RTU.

**PPM:** Parts per Million

**Programmable Logic Controller:** See *PLC*.

**Remote Terminal Unit:** See *RTU*.

**RTS:** Request-to-send

**RTU:** Remote Terminal Unit. A data collection device installed at a Remote unit site.

**RX:** Abbreviation for “Receive.”

**Signal-to-Noise Ratio:** See *SNR*.

**SCADA (Supervisory Control And Data Acquisition):** An overall term for the functions commonly provided through a multiple address radio system.

**SCEP:** Simple Certificate Enrollment Protocol. A scalable protocol for networks based on digital certificates, which can be requested by users without the need for assistance or manual intervention from a system administrator.

**SNR (Signal-to-Noise ratio):** A measure of how well the signal is being received at a radio relative to noise on the channel.

**SSH:** Secure Shell protocol for a network that allows users to open a window on a local PC and connect to a remote PC as if they were present at the remote.

**SSID (Service Set Identifier):** A name that identifies a particular 802.11 wireless LAN.

**Supervisory Control And Data Acquisition:** See *SCADA*.

**Telnet:** A terminal emulation protocol that enables an Internet user to communicate with a Remote device for management activities as if it were locally connected to a PC.

**TX:** Abbreviation for “Transmit.”

**WAN:** Wide Area Network.

## 5.0 APPENDIX A – DATA CONFIGURATION TREE

Current version matches with Firmware version 1.1.9.

The following is a hierarchical view of the data configuration tree for the unit. It is a composition of all YANG files used by the unit.

```

+--rw interfaces
| +--rw interface [name]
| | +--rw name string
| | +--rw description? string
| | +--rw enabled? boolean
| | +--ro oper-status? enumeration
| | +--ro last-change? yang:date-and-time
| | +--ro if-index? int32
| | +--rw link-up-down-trap-enable? enumeration
| | +--ro phys-address? yang:phys-address
| | +--ro higher-layer-if* interface-ref
| | +--ro lower-layer-if* interface-ref
| | +--ro speed? yang:gauge64
| | +--ro statistics
| | | +--ro discontinuity-time? yang:date-and-time
| | | +--ro in-octets? yang:counter64
| | | +--ro in-unicast-pkts? yang:counter64
| | | +--ro in-broadcast-pkts? yang:counter64
| | | +--ro in-multicast-pkts? yang:counter64
| | | +--ro in-discards? yang:counter32
| | | +--ro in-errors? yang:counter32
| | | +--ro in-unknown-protos? yang:counter32
| | | +--ro out-octets? yang:counter64
| | | +--ro out-unicast-pkts? yang:counter64
| | | +--ro out-broadcast-pkts? yang:counter64
| | | +--ro out-multicast-pkts? yang:counter64
| | | +--ro out-discards? yang:counter32
| | | +--ro out-errors? yang:counter32
| | +--rw ip:ipv4?
| | | +--rw ip:enabled? boolean
| | | +--rw ip:forwarding? boolean
| | | +--rw ip:mtu? uint16
| | | +--rw ip:address [ip]
| | | | +--rw ip:ip inet:ipv4-address-no-zone
| | | | +--rw (subnet)
| | | | | +--:(prefix-length)
| | | | | | +--rw ip:prefix-length? uint8
| | | | | +--:(netmask)
| | | | | +--rw ip:netmask? yang:dotted-quad
| | | +--rw ip:neighbor [ip]
| | | | +--rw ip:ip inet:ipv4-address-no-zone
| | | | +--rw ip:phys-address? yang:phys-address
| | | +--rw mdsif:dhcp?
| | | | +--rw mdsif:client-identifier? string
| | | | +--rw mdsif:retry-interval? uint16
| | | +--ro mdsif:current-address [ip]
| | | | +--ro mdsif:ip inet:ipv4-address-no-zone
| | | | +--ro mdsif:prefix-length? uint8
| | +--rw ip:ipv6?
| | | +--rw ip:enabled? boolean
| | | +--rw ip:forwarding? boolean
| | | +--rw ip:mtu? uint32
| | | +--rw ip:address [ip]
| | | | +--rw ip:ip inet:ipv6-address-no-zone
| | | | +--rw ip:prefix-length uint8

```

```

| | | +--rw ip:neighbor [ip]
| | | | +--rw ip:ip inet:ipv6-address-no-zone
| | | | +--rw ip:phys-address? yang:phys-address
| | | +--rw ip:dup-addr-detect-transmits? uint32
| | | +--rw ip:autoconf
| | | | +--rw ip:create-global-addresses? boolean
| | | | +--rw ip:create-temporary-addresses? boolean
| | | | +--rw ip:temporary-valid-lifetime? uint32
| | | | +--rw ip:temporary-preferred-lifetime? uint32
| | | +--ro mdsif:current-address [ip]
| | | | +--ro mdsif:ip inet:ipv6-address-no-zone
| | | | +--ro mdsif:prefix-length? uint8
| | | +--rw mdsif:eth-phy-rate? bits
| | | +--ro mdsif:eth-phy-status? enumeration
| | | +--rw mdsif:virtual-type? identityref
| | | +--rw mdsif:physical-interface? leafref
| | | +--ro mdsif:system-device? string
| | | +--ro mdsif:neighbors
| | | | +--ro mdsif:ip? inet:ip-address-no-zone
| | | | +--ro mdsif:phys-address? yang:phys-address
| | | | +--ro mdsif:state? enumeration
| | | +--rw mds_wifi:wifi-config?
| | | | +--rw mds_wifi:mode enumeration
| | | | +--rw mds_wifi:tx-power? uint32
| | | | +--rw mds_wifi:station-config?
| | | | | +--rw mds_wifi:ap [ssid]
| | | | | | +--rw mds_wifi:ssid string
| | | | | | +--rw mds_wifi:enabled? boolean
| | | | | | +--rw mds_wifi:privacy-mode? enumeration
| | | | | | +--rw mds_wifi:psk-config
| | | | | | | +--rw mds_wifi:encryption? enumeration
| | | | | | | +--rw mds_wifi:key-mgmt? enumeration
| | | | | | | +--rw mds_wifi:psk? string
| | | | | | +--rw mds_wifi:eap-config
| | | | | | | +--rw mds_wifi:encryption? enumeration
| | | | | | | +--rw mds_wifi:key-mgmt? enumeration
| | | | | | | +--rw mds_wifi:eap-method? enumeration
| | | | | | +--rw mds_wifi:psk?
| | | | | | | +--rw mds_wifi:cert-type enumeration
| | | | | | | +--rw mds_wifi:cert-id string
| | | | | | | +--rw mds_wifi:key-id string
| | | | | | | +--rw mds_wifi:ca-cert-id string
| | | | +--rw mds_wifi:ap-config?
| | | | | +--rw mds_wifi:ap [ssid]
| | | | | | +--rw mds_wifi:ssid string
| | | | | | +--rw mds_wifi:broadcast-ssid? boolean
| | | | | | +--rw mds_wifi:station-max? uint32
| | | | | | +--rw mds_wifi:station-timeout? uint32
| | | | | | +--rw mds_wifi:beacon-interval? uint32
| | | | | | +--rw mds_wifi:privacy-mode? enumeration
| | | | | | +--rw mds_wifi:psk-config
| | | | | | | +--rw mds_wifi:encryption? enumeration
| | | | | | | +--rw mds_wifi:key-mgmt? enumeration
| | | | | | | +--rw mds_wifi:psk? string
| | | | | | +--rw mds_wifi:eap-config
| | | | | | | +--rw mds_wifi:encryption? enumeration
| | | | | | | +--rw mds_wifi:key-mgmt? enumeration
| | | | | | | +--rw mds_wifi:eap-method? enumeration
| | | | | | +--rw mds_wifi:radius-server? leafref
| | | | | | +--rw mds_vlan:vlan-mode? enumeration
| | | | | | +--rw mds_vlan:vlan? if:interface-ref
| | | | | | +--rw mds_vlan:vlan? if:interface-ref
| | | +--rw mds_wifi:channel? uint32
| | | +--rw mds_wifi:operation-mode? enumeration
| | | +--rw mds_wifi:dtim-period? uint32
| | | +--rw mds_wifi:rts-threshold? uint32

```

```

| | +--rw mds_wifi:fragm-threshold? uint32
+--ro mds_wifi:wifi-status
| | +--ro mds_wifi:serial-number? display-string
| | +--ro mds_wifi:mode? display-string
| | +--ro mds_wifi:tx-power? uint8
| | +--ro mds_wifi:channel? uint8
| | +--ro mds_wifi:ap-status
| | | +--ro mds_wifi:ap [ssid]
| | | | +--ro mds_wifi:ssid ssid
| | | | +--ro mds_wifi:client [mac]
| | | | | +--ro mds_wifi:mac string
| | | | | +--ro mds_wifi:rssi? int8
| | | | | +--ro mds_wifi:authenticated? boolean
| | | | | +--ro mds_wifi:authorized? boolean
| | | | | +--ro mds_wifi:inactive? uint32
| | | | | +--ro mds_wifi:rxbytes? uint32
| | | | | +--ro mds_wifi:rxpackets? uint32
| | | | | +--ro mds_wifi:txbitrate? uint16
| | | | | +--ro mds_wifi:txbytes? uint32
| | | | | +--ro mds_wifi:txpackets? uint32
| | | | | +--ro mds_wifi:txfailed? uint32
| | | | | +--ro mds_wifi:txretries? uint32
| | +--ro mds_wifi:station-status
| | | +--ro mds_wifi:ssid? ssid
| | | +--ro mds_wifi:bssid? string
| | | +--ro mds_wifi:rssi? int8
| | | +--ro mds_wifi:authenticated? boolean
| | | +--ro mds_wifi:authorized? boolean
| | | +--ro mds_wifi:inactive? uint32
| | | +--ro mds_wifi:rxbytes? uint32
| | | +--ro mds_wifi:rxpackets? uint32
| | | +--ro mds_wifi:txbitrate? uint16
| | | +--ro mds_wifi:txbytes? uint32
| | | +--ro mds_wifi:txpackets? uint32
| | | +--ro mds_wifi:txfailed? uint32
| | | +--ro mds_wifi:txretries? uint32
+--rw mds_vlan:vlan-config
| | +--rw mds_vlan:vlan-id? vlan-id
| | +--rw mds_vlan:native-vlan? boolean
+--rw mds_vlan:vlan-mode? enumeration
+--rw mds_vlan:vlan* if:interface-ref
+--rw mds_vlan:vlan? if:interface-ref
+--rw mds_bridge:bridgeStatus
| | +--rw mds_bridge:stp
| | | +--ro mds_bridge:port [interface]
| | | | +--ro mds_bridge:interface if:interface-ref
| | | | +--ro mds_bridge:number? uint32
| | | | +--ro mds_bridge:priority? uint8
| | | | +--ro mds_bridge:state? enumeration
| | | | +--ro mds_bridge:path-cost? uint32
| | | | +--ro mds_bridge:designated-root? string
| | | | +--ro mds_bridge:designated-cost? uint32
| | | | +--ro mds_bridge:designated-bridge? string
| | | | +--ro mds_bridge:designated-port? uint32
+--rw mds_bridge:bridge-settings
| | +--rw mds_bridge:members
| | | +--rw mds_bridge:port [interface]
| | | | +--rw mds_bridge:interface if:interface-ref
| | | | +--rw mds_bridge:port-priority? uint32
| | | | +--rw mds_bridge:port-path-cost? uint32
| | | +--rw mds_bridge:wifi-ap [ssid]
| | | | +--rw mds_bridge:ssid leafref
| | | | +--rw mds_bridge:port-priority? uint32
| | | | +--rw mds_bridge:port-path-cost? uint32
| | +--rw mds_bridge:wifi-station
| | | +--rw mds_bridge:interface? if:interface-ref

```

```

| | | | +-rw mds_bridge:port-priority? uint32
| | | | +-rw mds_bridge:port-path-cost? uint32
| | | | +-rw mds_bridge:stp-mode? enumeration
| | | | +-rw mds_bridge:ageing-time? uint32
| | | | +-rw mds_bridge:max-age? uint32
| | | | +-rw mds_bridge:hello-time? uint32
| | | | +-rw mds_bridge:forward-delay? uint32
| | | | +-rw mds_bridge:bridge-priority? uint32
| +-rw mds-cell:cell-config
| | +-rw mds-cell:apn? string
| | +-rw mds-cell:keep-alive?
| | | +-rw mds-cell:address inet:host
| | | +-rw mds-cell:interval? uint8
| | | +-rw mds-cell:recovery-on-timeout? boolean
| | | +-rw mds-cell:max-num-retries? uint8
| | +-rw mds-cell:service-recovery
| | | +-rw mds-cell:general-recovery-interval? uint16
| | | +-rw mds-cell:lte-recovery? boolean
| | | +-rw mds-cell:lte-recovery-interval? uint16
| +-ro mds-cell:cell-status
| | +-ro mds-cell:imsi? display-string
| | +-ro mds-cell:imei? display-string
| | +-ro mds-cell:iccid? display-string
| | +-ro mds-cell:mdn? display-string
| | +-ro mds-cell:apn? display-string
| | +-ro mds-cell:app-sw-version? display-string
| | +-ro mds-cell:modem-sw-version? display-string
| | +-ro mds-cell:sim-state? display-string
| | +-ro mds-cell:modem-state? enumeration
| | +-ro mds-cell:roaming-state? enumeration
| | +-ro mds-cell:service-state? enumeration
| | +-ro mds-cell:rssi? int8
| +-rw fire:filter
| | +-rw fire:input? leafref
| | +-rw fire:output? leafref
| +-rw fire:nat
| | +-rw fire:source? leafref
| | +-rw fire:destination? leafref
| +-rw mdsif:physical-interface [name]
| | +-rw mdsif:name string
| | +-rw mdsif:type identityref
| | +-rw mdsif:system-name string
+--rw system
| +-rw contact? string
| +-rw name? string
| +-rw location? string
| +-ro platform
| | +-ro os-name? string
| | +-ro os-release? string
| | +-ro os-version? string
| | +-ro machine? string
| | +-ro nodename? string
| +-rw clock
| | +-ro current-datetime? yang:date-and-time
| | +-ro boot-datetime? yang:date-and-time
| | +-rw (timezone)?
| | | +--:(timezone-location)
| | | | +-rw timezone-location? ianatz:iana-timezone
| | | | +--:(timezone-utc-offset)
| | | | +-rw timezone-utc-offset? int16
| | +-rw mdssys:set
+--rw ntp
| +-rw use-ntp? boolean
| +-rw ntp-server [address]
| | +-rw association-type? enumeration
| | +-rw address inet:host

```

```

| | +--rw enabled? boolean
| | +--rw iburst? boolean
| | +--rw prefer? boolean
| +--rw dns
| | +--rw search* inet:host
| | +--rw server* inet:ip-address
| | +--rw options
| | +--rw timeout? uint8
| | +--rw attempts? uint8
| +--rw radius
| | +--rw server [address]
| | +--rw address inet:host
| | +--rw authentication-port? inet:port-number
| | +--rw shared-secret? string
| | +--rw authentication-type? identityref
| | +--rw options
| | +--rw timeout? uint8
| | +--rw attempts? uint8
| +--rw authentication
| | +--rw user-authentication-order* identityref
| | +--rw user [name]
| | +--rw name string
| | +--rw password? crypt-hash
| | +--rw ssh-key [name]
| | +--rw name string
| | +--rw algorithm? string
| | +--rw key-data? binary
| +--ro mdssys:serial-number-core? uint32
| +--ro mdssys:serial-number-platform? uint32
| +--ro mdssys:product-configuration? string
| +--ro mdssys:guid? string
| +--rw mdssys:pre-login-banner? string
| +--rw mdssys:authentication
| | +--ro mdssys:group-memberships? string
| | +--rw mdssys:max-login-attempts? uint32
| | +--rw mdssys:failed-login-lockout-time? uint32
| | +--rw mdssys:user-authentication-order* identityref
| | +--rw mdssys:password-options
| | +--rw mdssys:minimum-length? uint16
| | +--rw mdssys:minimum-lower-case-letters? uint16
| | +--rw mdssys:minimum-capital-letters? uint16
| | +--rw mdssys:minimum-numeric? uint16
| | +--rw mdssys:minimum-non-alpha-numeric? uint16
| +--rw mdssys:mds-radius
| | +--rw mdssys:servers [name]
| | +--rw mdssys:name string
| | +--rw mdssys:address inet:host
| | +--rw mdssys:authentication-port? inet:port-number
| | +--rw mdssys:shared-secret string
| | +--rw mdssys:user-authentication-type? identityref
| | +--rw mdssys:options
| | +--rw mdssys:timeout? uint8
| | +--rw mdssys:attempts? uint8
| +--rw mdssys:firmware
| | +--ro mdssys:versions [location]
| | +--ro mdssys:location uint8
| | +--ro mdssys:version? string
| | +--ro mdssys:active? boolean
| | +--ro mdssys:signatures [certificate-signing-index]
| | +--ro mdssys:certificate-signing-index uint8
| | +--ro mdssys:certificate-sha256? string
| +--ro mdssys:reprogramming-status
| | +--ro mdssys:state? enumeration
| | +--ro mdssys:detailed-message? string
| | +--ro mdssys:size? uint32
| | +--ro mdssys:bytes-transferred? uint32

```

```

| | +--ro mdssys:percent-complete? uint32
|--rw mdssys:geographical-location
| | +--rw mdssys:latitude? decimal64
| | +--rw mdssys:longitude? decimal64
| | +--rw mdssys:altitude? decimal64
| | +--ro mdssys:current-gps-location
| | | +--ro mdssys:latitude? decimal64
| | | +--ro mdssys:longitude? decimal64
| | | +--ro mdssys:altitude? decimal64
| | | +--ro mdssys:fix-quality? enumeration
| | | +--ro mdssys:satellites [prn]
| | | | +--ro mdssys:prn uint8
| | | | +--ro mdssys:snr? uint8
| | | | +--ro mdssys:azimuth? uint16
| | | | +--ro mdssys:elevation? uint8
| | | | +--ro mdssys:used? boolean
|--rw mdssys:support
| | +--ro mdssys:support-transfer-status
| | | +--ro mdssys:state? enumeration
| | | +--ro mdssys:detailed-message? string
| | | +--ro mdssys:size? uint32
| | | +--ro mdssys:bytes-transferred? uint32
| | | +--ro mdssys:percent-complete? uint32
|--rw mdssys:power
|--rw mdssys:configuration-files
| | +--ro mdssys:transfer-status
| | | +--ro mdssys:state? enumeration
| | | +--ro mdssys:detailed-message? string
| | | +--ro mdssys:size? uint32
| | | +--ro mdssys:bytes-transferred? uint32
| | | +--ro mdssys:percent-complete? uint32
|--rw mdssys:recovery
| | +--ro mdssys:snapshots
| | | +--ro mdssys:identifier string
| | | +--ro mdssys:description? string
| | | +--ro mdssys:date? string
| | | +--ro mdssys:version? string
| | | +--ro mdssys:hash? string
|--rw mdssys:one-time-passwords
| | +--ro mdssys:passwords
| | | +--ro mdssys:identifier uint64
| | | +--ro mdssys:function? otp-function-type
| | | +--ro mdssys:status? status_type
| | | +--ro mdssys:date-created? string
| | | +--ro mdssys:date-revoked? string
| | | +--ro mdssys:user? string
|--ro mdssys:uptime
| | +--ro mdssys:seconds? uint32
| | +--ro mdssys:text? string
|--ro mdssys:temperature? int32
+--rw pki
|--rw certificate-servers
| | +--rw certificate-server [cert-server-identity]
| | | +--rw cert-server-identity string
| | | +--rw server-type? cert-mgmt-type
| | | +--rw certmgr-servers:server-setting
| | | | +--rw certmgr-servers:uri? inet:uri
| | | | +--rw certmgr-servers:retry-count? uint16
| | | | +--rw certmgr-servers:poll-interval? uint16
| | | | +--rw certmgr-servers:digest-algo? cm:certmgr-digest-algo
| | | | +--rw certmgr-servers:encrypt-algo? cm:certmgr-enc-algo
|--rw cert-info
| | +--rw certificate-info [certificate-info-identity]
| | | +--rw certificate-info-identity string
| | | +--rw country-x509? string
| | | +--rw state-x509? string

```

```

| | +--rw locale-x509? string
| | +--rw organization-x509? string
| | +--rw org-unit-x509? string
| | +--rw common-name-x509 string
| | +--rw pkcs9-email-x509? string
+--rw ca-servers
| +--rw ca-server [ca-issuer-identity]
| | +--rw ca-issuer-identity string
| | +--rw ca-fingerprint? string
+--ro private-keys [key-identity]
| +--ro key-identity string
| +--ro key-length? uint16
| +--ro key-date-time? string
+--ro ca-certs [cacert-identity]
| +--ro cacert-identity string
+--ro client-certs [cert-identity]
| +--ro cert-identity string
+--ro firmware-certs
| +--ro fwcert-identity? string
| +--ro cert-hash? string
+--ro scep-status
| +--ro last-status? int32
| +--ro poll-count? int32
| +--ro last-state? string
| +--ro req-fp-md5? string
| +--ro req-fp-sha1? string
| +--ro req-fp-sha256? string
| +--ro req-fp-sha512? string
+--rw file-servers [configuration-name]
| +--rw configuration-name string
+--rw (protocol)
| +--:(tftp)
| | +--rw tftp
| | | +--rw address string
| | | +--rw block-size? uint32
| | | +--rw port? uint16
| | | +--rw timeout? uint32
| +--:(sftp)
| | +--rw sftp
| | | +--rw address string
| | | +--rw username string
| | | +--rw password string
| | | +--rw port? uint16
| | | +--rw timeout? uint32
| +--:(ftp)
| | +--rw ftp
| | | +--rw address string
| | | +--rw username? string
| | | +--rw password? string
| | | +--rw control-port? uint16
| | | +--rw data-port? uint16
| | | +--rw timeout? uint32
| +--:(http)
| | +--rw http
| | | +--rw address? string
| | | +--rw port? uint16
| | | +--rw timeout? uint32
+--rw logging
| +--rw event-rules [name]
| | +--rw name string
| | +--rw description? string
| | +--rw local? boolean
| | +--rw priority? priority-enumeration
| | +--rw syslog-facility? enumeration
| | +--rw syslog? boolean
| | +--rw snmp-notification? boolean

```

```

| | +--rw snmp-notify-name? leafref
| | +--rw netconf-notification? boolean
| | +--rw alarm? boolean
| | +--rw alarm-outputs* leafref
|--rw syslog
| +--rw server [name]
| | +--rw name string
| | +--rw ip inet:host
| | +--rw port? inet:port-number
| | +--rw version? enumeration
| | +--rw protocol? enumeration
| | +--rw tls-options
| | | +--rw tls-ca-certificate? string
| | | +--rw tls-client-certificate? string
| | | +--rw tls-client-key? string
|--rw alarm-output [name]
| +--rw name string
| +--rw signal-period? uint32
| +--rw signal-duration? uint32
|--ro event-log [id]
| +--ro id int64
| +--ro time-stamp? yang:date-and-time
| +--ro priority? priority-enumeration
| +--ro event-type? string
| +--ro status? string
| +--ro message? string
|--ro current-alarms [name]
| +--ro name string
| +--ro events* string
|--ro event-log-export-status
| +--ro state? enumeration
| +--ro detailed-message? string
| +--ro size? uint32
| +--ro bytes-transferred? uint32
| +--ro percent-complete? uint32
|--rw routing
| +--rw static-routes
| | +--rw ipv4
| | | +--rw route [id]
| | | | +--rw id uint32
| | | | +--rw description? string
| | | | +--rw outgoing-interface? if:interface-ref
| | | | +--rw dest-prefix inet:ipv4-prefix
| | | | +--rw next-hop? inet:ipv4-address
| | | +--rw ipv6
| | | | +--rw route [id]
| | | | | +--rw id uint32
| | | | | +--rw description? string
| | | | | +--rw outgoing-interface? if:interface-ref
| | | | | +--rw dest-prefix inet:ipv6-prefix
| | | | | +--rw next-hop? inet:ipv6-address
| | +--ro routes
| | | +--ro dest-prefix? inet:ip-prefix
| | | +--ro next-hop? inet:ip-address
| | | +--ro outgoing-interface? if:interface-ref
| | | +--ro source? enumeration
|--rw services
| +--ro services-status [name]
| | +--ro name string
| | +--ro status? enumeration
|--rw dhcp:dhcp
| +--ro dhcp:leases [ip]
| | +--ro dhcp:ip inet:ip-address
| | +--ro dhcp:starts? yang:date-and-time
| | +--ro dhcp:ends? yang:date-and-time
| | +--ro dhcp:binding-state? enumeration

```

```

| | +--ro dhcp:client-mac? yang:mac-address
| | +--ro dhcp:hostname? string
+--rw dhcp:enabled? boolean
+--rw dhcp:default-lease-time? uint32
+--rw dhcp:min-lease-time? uint32
+--rw dhcp:max-lease-time? uint32
+--rw dhcp:v4subnet [subnet-mask]
| | +--rw dhcp:subnet-mask inet:ipv4-prefix
| | +--rw dhcp:range-start inet:ipv4-address
| | +--rw dhcp:range-end inet:ipv4-address
| | +--rw dhcp:broadcast-address? inet:ipv4-address
| | +--rw dhcp:router? inet:ipv4-address
| | +--rw dhcp:domain-name-servers* inet:ipv4-address
| | +--rw dhcp:domain-name? inet:domain-name
| | +--rw dhcp:ntp-servers* inet:host
| | +--rw dhcp:netbios-name-servers* inet:host
+--rw dhcp:v6subnet [subnet-mask]
| | +--rw dhcp:subnet-mask inet:ipv6-prefix
| | +--rw dhcp:range-start inet:ipv6-address
| | +--rw dhcp:range-end inet:ipv6-address
+--rw iperf:iperf
| +--rw iperf:enabled? boolean
+--rw serial:serial
| +--rw serial:ports [name]
| | +--rw serial:name string
| | +--rw serial:line-mode? enumeration
| | +--rw serial:baud-rate? enumeration
| | +--rw serial:byte-format? enumeration
| | +--rw serial:hw-flow-control? boolean
| | +--rw serial:vmin? uint32
| | +--rw serial:vtime? uint16
| | +--rw serial:capability? bits
+--rw serial:console
| +--rw serial:serial-ports* leafref
+--rw serial:terminal-server
| +--rw serial:server [serial-port]
| | +--rw serial:serial-port leafref
| | +--rw serial:description? string
| | +--rw serial:enabled? boolean
| | +--rw serial:mode
| | | +--rw (tcp-or-udp)?
| | | | +--:(tcp)
| | | | | +--rw serial:tcp-server?
| | | | | | +--rw serial:port? inet:port-number
| | | | | | +--rw serial:idle-timeout? uint32
| | | | | +--rw serial:tcp-client?
| | | | | | +--rw serial:remote
| | | | | | | +--rw serial:address inet:ip-address
| | | | | | | +--rw serial:port? inet:port-number
| | | | | | +--rw serial:idle-timeout? uint32
| | | | | +--:(modbus-tcp)
| | | | | +--rw serial:modbus-tcp?
| | | | | | +--rw serial:mode enumeration
| | | | | | +--rw serial:port? inet:port-number
| | | | | | +--rw serial:idle-timeout? uint32
| | | | | +--:(udp)
| | | | | +--rw serial:udp?
| | | | | | +--rw serial:port? inet:port-number
| | | | | | +--rw serial:remote
| | | | | | | +--rw serial:address inet:ip-address
| | | | | | | +--rw serial:port? inet:port-number
+--ro serial:status
| +--ro serial:ip-tx-packets? uint32
| +--ro serial:ip-tx-bytes? uint32
| +--ro serial:ip-rx-packets? uint32
| +--ro serial:ip-rx-bytes? uint32

```

```

| +--ro serial:serial-tx-packets? uint32
| +--ro serial:serial-tx-bytes? uint32
| +--ro serial:serial-rx-packets? uint32
| +--ro serial:serial-rx-bytes? uint32
+--rw fire:firewall
| +--rw fire:enabled? boolean
| +--rw fire:address-set [name]
| | +--rw fire:name sec:word-string
| | +--rw fire:addresses* inet:ipv4-prefix
+--rw fire:filter [name]
| +--rw fire:name sec:word-string
| +--rw fire:rule [id]
| | +--rw fire:id uint32
| | +--rw fire:match
| | | +--rw fire:protocol? protocol
| | | +--rw fire:icmp-type? icmp-type
| | | +--rw fire:src-address?
| | | | +--rw fire:not?
| | | | +--rw (type)
| | | | | +--:(address)
| | | | | | +--rw fire:address? inet:ipv4-prefix
| | | | | +--:(address-range)
| | | | | | +--rw fire:address-range
| | | | | | | +--rw fire:from inet:ip-address
| | | | | | | +--rw fire:to? inet:ip-address
| | | | | +--:(address-set)
| | | | | +--rw fire:address-set? leafref
| | | | | +--rw fire:add-interface-address? boolean
+--rw fire:src-port?
| +--rw fire:not?
+--rw (type)
| +--:(services)
| | +--rw fire:services* service
+--:(port-range)
| +--rw fire:port-range [from]
| | +--rw fire:from uint16
| | +--rw fire:to? uint16
+--rw fire:dst-address?
| +--rw fire:not?
+--rw (type)
| +--:(address)
| | +--rw fire:address? inet:ipv4-prefix
+--:(address-range)
| | +--rw fire:address-range
| | | +--rw fire:from inet:ip-address
| | | +--rw fire:to? inet:ip-address
+--:(address-set)
| | +--rw fire:address-set? leafref
| | +--rw fire:add-interface-address? boolean
+--rw fire:dst-port?
| +--rw fire:not?
+--rw (type)
| +--:(services)
| | +--rw fire:services* service
+--:(port-range)
| +--rw fire:port-range [from]
| | +--rw fire:from uint16
| | +--rw fire:to? uint16
+--rw fire:ipsec?
| +--rw fire:direction enumeration
| +--rw fire:tunnel-src-address inet:ipv4-prefix
| +--rw fire:tunnel-dst-address inet:ipv4-prefix
+--rw fire:actions?
| +--rw fire:action rule-action
| +--rw fire:reject-type? icmp-reject-type
+--rw fire:log?

```

```

| +--rw fire:level? syslog-level
| +--rw fire:prefix? sec:word-string
+--rw fire:nat
| +--rw fire:source
| | +--rw fire:rule-set [name]
| | | +--rw fire:name sec:word-string
| | | +--rw fire:rule [id]
| | | | +--rw fire:id uint32
| | | | +--rw fire:match
| | | | | +--rw fire:src-address?
| | | | | | +--rw fire:not?
| | | | | | +--rw (type)
| | | | | | | +--:(address)
| | | | | | | | +--rw fire:address? inet:ipv4-prefix
| | | | | | | | +--:(address-range)
| | | | | | | | | +--rw fire:address-range
| | | | | | | | | | +--rw fire:from inet:ip-address
| | | | | | | | | | +--rw fire:to? inet:ip-address
| | | | | | | | | | +--:(address-set)
| | | | | | | | | | | +--rw fire:address-set? leafref
| | | | | | | | | | | +--rw fire:add-interface-address? boolean
| | | | +--rw fire:dst-address?
| | | | +--rw fire:not?
| | | | +--rw (type)
| | | | | +--:(address)
| | | | | | +--rw fire:address? inet:ipv4-prefix
| | | | | | +--:(address-range)
| | | | | | | +--rw fire:address-range
| | | | | | | | +--rw fire:from inet:ip-address
| | | | | | | | +--rw fire:to? inet:ip-address
| | | | | | | | +--:(address-set)
| | | | | | | | | +--rw fire:address-set? leafref
| | | | | | | | | +--rw fire:add-interface-address? boolean
| | +--rw fire:source-nat
| | | +--rw (to)
| | | | +--:(interface)
| | | | | +--rw fire:interface?
| | | | | +--:(address)
| | | | | | +--rw fire:address? inet:ip-address
| +--rw fire:destination
| | +--rw fire:rule-set [name]
| | | +--rw fire:name sec:word-string
| | | +--rw fire:rule [id]
| | | | +--rw fire:id uint32
| | | | +--rw fire:match
| | | | | +--rw fire:protocol? protocol
| | | | | +--rw fire:src-address?
| | | | | | +--rw fire:not?
| | | | | | +--rw (type)
| | | | | | | +--:(address)
| | | | | | | | +--rw fire:address? inet:ipv4-prefix
| | | | | | | | +--:(address-range)
| | | | | | | | | +--rw fire:address-range
| | | | | | | | | | +--rw fire:from inet:ip-address
| | | | | | | | | | +--rw fire:to? inet:ip-address
| | | | | | | | | | +--:(address-set)
| | | | | | | | | | | +--rw fire:address-set? leafref
| | | | | | | | | | | +--rw fire:add-interface-address? boolean
| | | | +--rw fire:dst-address?
| | | | +--rw fire:not?
| | | | +--rw (type)
| | | | | +--:(address)
| | | | | | +--rw fire:address? inet:ipv4-prefix
| | | | | | +--:(address-range)
| | | | | | | +--rw fire:address-range
| | | | | | | | +--rw fire:from inet:ip-address

```

```

| | | | +--rw fire:to? inet:ip-address
| | | | +---:(address-set)
| | | | | +--rw fire:address-set? leafref
| | | | | +--rw fire:add-interface-address? boolean
| | | | | +--rw fire:dst-port? inet:port-number
| | | +--rw fire:destination-nat
| | | | +--rw fire:address inet:ip-address
| | | | +--rw fire:port? inet:port-number
+--rw snmp:snmp
| +--rw snmp:SNMPv1-enabled? boolean
| +--rw snmp:SNMPv2c-enabled? boolean
| +--rw snmp:SNMPv3-enabled? boolean
| +--rw snmp:ipv4-bind-ips* leafref
| +--rw snmp:ipv6-bind-ips* leafref
| +--rw snmp:port? inet:port-number
| +--rw (engine-id-method)?
| | +---:(from-ip)
| | | +--rw snmp:from-ip? leafref
| | +---:(from-mac-address)
| | | +--rw snmp:from-mac-address? empty
| +--rw snmp:max-message-size? int32
+--rw ssh:ssh
| +--rw ssh:enabled? boolean
| +--rw ssh:port? inet:port-number
| +--rw ssh:ipv4-bind-ips* leafref
| +--rw ssh:ipv6-bind-ips* leafref
+--rw vpn:vpn
| +--rw vpn:enabled? boolean
| +--rw vpn:strict-crl-policy? boolean
| +--rw (type)?
| | +---:(type-ipsec)
| | | +--rw vpn:ike?
| | | | +--rw vpn:policy [name]
| | | | | +--rw vpn:name sec:word-string
| | | | | +--rw vpn:version? ike-version
| | | | | +--rw vpn:mode? ike-v1-mode
| | | | | +--rw vpn:auth-method ike-auth-method
| | | | | +--rw vpn:pre-shared-key? string
| | | | | +--rw vpn:pki?
| | | | | | +--rw vpn:cert-type enumeration
| | | | | | +--rw vpn:cert-id string
| | | | | | +--rw vpn:key-id string
| | | | | | +--rw vpn:ca-cert-id string
| | | | | +--rw vpn:ciphersuite [name]
| | | | | | +--rw vpn:name sec:word-string
| | | | | | +--rw vpn:encryption-algo encryption-algo
| | | | | | +--rw vpn:mac-algo mac-algo
| | | | | | +--rw vpn:dh-group? dh-group
| | | | | +--rw vpn:life-time? uint16
| | | | | +--rw vpn:reauth? boolean
| | | +--rw vpn:peer [name]
| | | | +--rw vpn:name sec:word-string
| | | | +--rw vpn:ike-policy leafref
| | | +--rw vpn:local-endpoint
| | | | +--rw (ike-endpoint-type)?
| | | | | +---:(any)
| | | | | | +--rw vpn:any?
| | | | | +---:(address)
| | | | | | +--rw vpn:address? inet:ip-address
| | | | | +---:(fqdn)
| | | | | | +--rw vpn:fqdn? string
| | | +--rw vpn:local-identity
| | | | +--rw (ike-identity-type)?
| | | | | +---:(default)
| | | | | | +--rw vpn:default?
| | | | | +---:(address)

```

```

| | +--rw vpn:address? inet:ip-address
| | +---:(fqdn)
| | +--rw vpn:fqdn? string
| | +---:(user-fqdn)
| | +--rw vpn:user-fqdn? string
| | +---:(dn)
| | +--rw vpn:dn? string
+--rw vpn:peer-endpoint
| +--rw (ike-endpoint-type)
| +---:(any)
| | +--rw vpn:any?
| | +---:(address)
| | +--rw vpn:address? inet:ip-address
| | +---:(fqdn)
| | +--rw vpn:fqdn? string
+--rw vpn:peer-identity
| +--rw (ike-identity-type)?
| +---:(default)
| | +--rw vpn:default?
| | +---:(address)
| | +--rw vpn:address? inet:ip-address
| | +---:(fqdn)
| | +--rw vpn:fqdn? string
| | +---:(user-fqdn)
| | +--rw vpn:user-fqdn? string
| | +---:(dn)
| | +--rw vpn:dn? string
+--rw vpn:peer-identity-no-idr? boolean
+--rw vpn:role? enumeration
+--rw vpn:dpd-enabled? boolean
+--rw vpn:dpd-interval? uint16
+--rw vpn:ipsec?
+--rw vpn:policy [name]
| +--rw vpn:name sec:word-string
+--rw vpn:ciphersuite [name]
| | +--rw vpn:name sec:word-string
| | +--rw vpn:encryption-algo encryption-algo
| | +--rw vpn:mac-algo mac-algo
| | +--rw vpn:dh-group? dh-group
+--rw vpn:life-time? uint16
+--rw vpn:connection [name]
| +--rw vpn:name sec:word-string
| +--rw vpn:ike-peer leafref
| +--rw vpn:ipsec-policy leafref
| +--rw (conn-type)
| | +---:(net-to-net)
| | | +--rw vpn:local-ip-subnet? inet:ipv4-prefix
| | | +---:(host-to-net)
| | | +--rw vpn:local-source-ip-address? inet:ip-address
| +--rw vpn:remote-ip-subnets* inet:ipv4-prefix
+--rw vpn:is-out-of-band-ima? boolean
+--rw vpn:failure-retry-interval? uint8
+--rw vpn:periodic-retry-interval? uint8
+--ro vpn:ipsec-status
+--ro vpn:connection [name]
| +--ro vpn:name sec:word-string
| +--ro vpn:state? enumeration
| +--ro vpn:failure-reason? string
| +--ro vpn:last-timestamp? yang:date-and-time
| +--ro vpn:ima-evaluation? string
| +--ro vpn:ima-recommendation? string
+--rw web:web
+--rw web:http
| +--rw web:enabled? boolean
| +--rw web:port? inet:port-number
| +--rw web:ipv4-bind-ips* leafref

```

```
| +--rw web:ipv6-bind-ips* leafref
+--rw web:https
 +--rw web:enabled? boolean
 +--rw web:port? inet:port-number
 +--rw web:ipv4-bind-ips* leafref
 +--rw web:ipv6-bind-ips* leafref
 +--rw web:tls-certificate? string
 +--rw web:tls-priv-key? string
```

## 6.0 APPENDIX B – COMMAND LINE INTERFACE (CLI) FEATURES

### Operational Mode

Operational Mode is the initial mode that the CLI is in right after logging in. Users can view operational and configuration data but cannot change configuration data. The prompt will show a “>” character when it is in operational mode.

### Configuration Mode

Configuration mode is entered when the user types “configure” after logging in. Configuration Mode can be exited by typing “exit”, which brings the user back to Operational Mode. Configuration data can only be altered while the user is in Configuration Mode. The prompt will have a “%” character when it is in configuration mode.

### Changing configuration data

Configuration data can only be changed while the CLI is in Configuration Mode. Changing configuration requires the two-step process described earlier, where changes can be made first and then must be committed to complete the process.

Once all the changes have been made, they can be committed using the “commit” command. If there is an error during the commit due to missing data, conflicting settings, or other issue, then none of the changes will be committed and the CLI will provide feedback regarding the error. The changes that were pending will still be pending at that point. This gives the user the opportunity to discard the changes or to modify them and then try to commit them again.

### Inputting values

The format for each node in the data model is encoded in the data model itself. The CLI enforces the user input to be compliant to that format. There are several different formats of input, including numerics, strings, and limitations on the range and length of input. The CLI will provide assistance to the user when inputting values when the tab-completion feature is used (see Tab-completion section below).

The example below shows the “possible completions” when the TAB key is pressed after the word “location”. In this case, the node “location” can take a value that is a string with 0-255 characters.

```
admin@(none) 00:56:26% set system location
```

```
Possible completions:
```

```
<string, min: 0 chars, max: 255 chars>
```

```
admin@(none) 00:56:26% set system location “Rochester, NY”
```

```
[ok][2012-06-19 00:56:49]
```

```
[edit]
```

```
admin@(none) 00:56:49% commit
```

```
Commit complete.
```

```
[ok][2012-06-19 00:57:01]
```

## Inputting a list of values

A node can take a list of values if it has been defined that way in the data model. The CLI will indicate a node can take a list by displaying a bracket [, as shown below at the end of the possible completions information. Items in the list are separated by a space character.

This example shows that there are three ways to input values to a list node:

```
admin@(none) 00:31:02% set system dns search
Possible completions:
<IP address> <string, min: 1 chars, max: 253 chars> [
```

1. Without brackets, the value will be appended to the existing list **gemds**

```
admin@(none) 00:31:02% set system dns search gemds
[ok][2012-06-19 00:49:28]
```

2. With brackets, for a list that contains one value: “ [ **gemds** ] ”

```
[edit]
admin@(none) 00:49:28% set system dns search [gemds]
[ok][2012-06-19 00:49:34]
```

3. With brackets, for a list that contains more than one value: “ [ **ge gemds** ] ”

```
[edit]
admin@(none) 00:49:34% set system dns search [ge gemds]
[ok][2012-06-19 00:49:39]
```

## Tab-completion

Tab-completion is a powerful feature that presents CLI users with assistance while typing. Depending on the text that was already typed, tab-completion will display different possible completions.

When the tab key is pressed and no text has been typed, the CLI shows all of the possible commands that can be typed, as shown below. In this example, the CLI is in configuration mode and the following commands are relevant to configuration mode only.

```
admin@(none) 01:05:03%
```

Possible completions:

```
annotate - Add a comment to a statement
commit - Commit current set of changes
compare - Show configuration differences
copy - Copy a dynamic element
delete - Delete a data element
edit - Edit a sub-element
exit - Exit from this level
help - Provide help information
insert - Insert a parameter
move - Move a parameter
quit - Exit from this level
rename - Rename an identifier
request - Make system-level requests
```

**resolved** - Conflicts have been resolved  
**revert** - Copy configuration from running  
**rollback** - Roll back database to last committed version  
**run** - Run an operational-mode command  
**set** - Set a parameter  
**show** - Show a parameter  
**status** - Display users currently editing the configuration  
**tag** - Manipulate statement tags  
**top** - Exit to top level and optionally run command  
**up** - Exit one level of configuration  
**validate** - Validate current configuration

When the tab key is pressed after a typed command, then the CLI will show the user all the possible options that are pertinent to that command. In the example below the tab key was pressed after the word “set”. The list of possible completions are shown to user.

```
admin@(none) 01:06:49% set
```

Possible completions:

**SNMP-Community-MIB**

**SNMP-Target-MIB**

**SNMP-User-Based-SM-MIB**

**SNMP-View-Based-ACM-MIB**

**file-servers** -

**interfaces** - Interface parameters.

**logging** -

**pki** - Public Key and Certificate Options

**routing** -

**services** - Services which are configurable on this system

**system** - System group configuration.

When the tab key is pressed after the name of a data node that the user is trying to configure, then the CLI will show the user the format of the data that is acceptable for that data node. In the example below, the tab key was pressed after the word “search”. In this case, the node “search” can take a list of values that are IP addresses or strings, each with 0-255 characters.

```
admin@(none) 00:31:02% set system dns search
```

Possible completions:

```
<IP address> <string, min: 1 chars, max: 253 chars> [
```

```
admin@(none) 00:31:02% set system dns search mds
```

```
[ok][2012-06-19 00:49:28]
```

## CLI Environment

There are a number of session variables in the CLI. They are only used during the session and are not persistent. Their values are inspected using “show cli” and set using “set” in operational mode.

```
admin@(none) 17:19:11> show cli
autowizard true;
complete-on-space true;
display-level 99999999;
history 100;
idle-timeout 1800;
ignore-leading-space false;
output {
 file terminal;
}
paginate true;
prompt1 \u@\h\M \t> ;
prompt2 \u@\h\M \t% ;
screen {
 length 24;
 width 80;
}
show {
 defaults false;
}
terminal linux;
[ok][2012-06-19 17:19:12]
admin@(none) 17:19:12>
```

The different values control different parts of the CLI behavior.

### **autowizard (true | false)**

When enabled, the CLI will prompt the user for required settings when a new identifier is created and for mandatory action parameters.

For example, the “filename” parameter will be requested from the user since it is mandatory and yet it was not supplied in the initial request:

```
admin@(none) 00:09:38% request system firmware reprogram-inactive-image preconfig-
ured-file-server { configuration_name fs1 }
Value for 'filename' (<string>): fw.pkg
[ok][2012-06-19 00:09:48]
```

To avoid prompting, it is recommended to disable the autowizard before pasting in a list of commands. A good practice is to start all such scripts with a line that disables the autowizard:

```
set autowizard false
...
set autowizard true
```

### **complete-on-space (true | false)**

Controls if command completion should be attempted when <space> is entered. Entering <tab> always results in command completion.

### **ignore-leading-space (true | false)**

Controls if leading spaces should be ignored or not. This is useful to turn off when pasting commands into the CLI.

### **history (<integer>)**

Size of CLI command history.

### **idle-timeout (<seconds>)**

Maximum idle time before being logged out. Use 0 (zero) for infinity.

### **paginate (true | false)**

Some commands paginate their output, for example. This can be disabled or enabled. It is enabled by default.

### **screen width (<integer>)**

Current width of terminal. This is used when paginating output to get proper line count.

### **screen length (<integer>)**

Current length of terminal. This is used when paginating output to get proper line count.

### **terminal (string)**

Terminal type. This setting is used for controlling how line editing is performed. Supported terminals are: **dumb**, **vt100**, **xterm**, **linux**, and **ansi**. Other terminal types may also work, but have no explicit support.

## **Command output processing**

It is possible to process the output from a command using an output redirect. This is done using the **|** character. The commands can be chained to achieve more complex processing.

```
admin@(none) 17:20:27> show configuration |
Possible completions:
 annotation - Show only statements whose annotation matches a pattern
 context match - context match
 count - Count the number of lines in the output
 csv - Emit table output in CSV format
 de-select - select columns to not include
 details - Display details
 display - Display options
 except - Show only text that does not matches a pattern
 extended - Show referring elements
 find - Search for the first occurrence of a pattern
 hide - Hide display options
 linnum - Enumerate lines in the output
 match - Show only text that matches a pattern
 match-all - All selected filters must match
 match-any - At least one filter must match
 more - Paginate output
 nomore - Suppress pagination
 select - Select additional columns
 tab - Enforce table output
 tags - Show only statements whose tags matches a pattern
 until - Display until the first occurrence of a pattern
admin@(none) 17:20:27> show configuration |
```

## Count the Number of Lines in the Output

This redirect target counts the number of lines in the output. For example:

```
admin@io 13:28:07> show configuration | count
[ok][2007-08-31 13:49:44]
Count: 99 lines
admin@io 13:49:44> show configuration interfaces | count
[ok][2007-08-31 13:50:12]
Count: 90 lines
admin@io 13:50:12>
```

## Search for a String in the Output

The match target is used to only include lines matching a regular expression. For example:

```
admin@(none) 00:19:57> show configuration logging | match date
event-rules date_time_from_ntp {
event-rules date_time_from_user {
event-rules date_time_not_set {
[ok][2012-06-19 00:20:02]
admin@(none) 00:20:02>
```

In the example above only lines containing “date” are shown. Similarly lines not containing a regular expression can be included.

```
admin@(none) 00:22:13> show interfaces | except counters
interfaces supported-interfaces bridge true
interfaces interface eth0
if-index 2
status mac-address 1e:ed:19:27:1a:b3
status mtu 1500
status link up
status ipv4 address [192.168.1.10/24]
status ipv6 address [fe80::1ced:19ff:fe27:1ab3/64]
[ok][2012-06-19 00:22:19]
admin@(none) 00:22:19>
```

It is also possible to display the output starting at the first match of a regular expression, using the find target. For example:

```
admin@(none) 00:23:51> show interfaces | find tx
status counters tx_aborted_errors 0
status counters tx_bytes 238574
status counters tx_carrier_errors 0
status counters tx_compressed 0
status counters tx_dropped 0
status counters tx_errors 0
status counters tx_fifo_errors 0
status counters tx_heartbeat_errors 0
status counters tx_packets 1731
status counters tx_window_errors 0
[ok][2012-06-19 00:23:53]
admin@(none) 00:23:53>
```

Output can also be ended when a line matches a regular expression. This is done with the until target. For example:

```
admin@none 00:24:37> show interfaces | find tx | until compressed
status counters tx_aborted_errors 0
status counters tx_bytes 250246
status counters tx_carrier_errors 0
status counters tx_compressed 0
[ok][2012-06-19 00:24:43]
admin@none 00:24:43>
```

## Regular expressions

The regular expressions is a subset of the regular expressions found in egrep and in the AWK programming language. Some common operators are:

|           |                                                                                                                                                |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------|
| .         | Matches any character.                                                                                                                         |
| ^         | Matches the beginning of a string.                                                                                                             |
| \$        | Matches the end of a string.                                                                                                                   |
| [abc...]  | Character class, which matches any of the characters abc...                                                                                    |
| [^abc...] | Character ranges are specified by a pair of characters separated by a -<br>negated character class, which matches any character except abc.... |
| r1   r2   | Alternation. It matches either r1 or r2.                                                                                                       |
| r1r2      | Concatenation. It matches r1 and then r2.                                                                                                      |
| r+        | Matches one or more rs.                                                                                                                        |
| r*        | Matches zero or more rs.                                                                                                                       |
| r?        | Matches zero or one rs.                                                                                                                        |
| (r)       | Grouping. It matches r.                                                                                                                        |

For example, to only display uid and gid you can do the following:

```
admin@io 15:11:24> show configuration | match "(uid)|(gid)"
uid 1000;
gid 100;
uid 1000;
gid 100;
uid 1000;
gid 100;
uid 1000;
gid 100;
```

## Display line numbers

The linnum target causes a line number to be displayed at the beginning of each line in the display.

```
admin@io 15:11:24> show configuration | match "(uid)|(gid)" | linnum
1: uid 1019;
2: gid 1013;
3: uid 1019;
4: gid 1013;
5: uid 1019;
6: gid 1013;
7: uid 1019;
8: gid 1013;
```

## Showing Information

### Control Sequences

The default key strokes for editing the command line and moving around the command history are as follows.

|                                                              |                                         |
|--------------------------------------------------------------|-----------------------------------------|
| Move the cursor back one character                           | Ctrl-b or Left Arrow                    |
| Move the cursor back one word                                | Esc-b or Alt-b                          |
| Move the cursor forward one character                        | Ctrl-f or Right Arrow                   |
| Move the cursor forward one word                             | Esc-f or Alt-f                          |
| Move the cursor to the beginning of the command line         | Ctrl-a or Home                          |
| Move the cursor to the end of the command line               | Ctrl-e or End                           |
| Delete the character before the cursor                       | Ctrl-h, Delete, or Backspace            |
| Delete the character following the cursor                    | Ctrl-d                                  |
| Delete all characters from the cursor to the end of the line | Ctrl-k                                  |
| Delete the whole line                                        | Ctrl-u or Ctrl-x                        |
| Delete the word before the cursor                            | Ctrl-w, Esc-Backspace, or Alt-Backspace |
| Delete the word after the cursor                             | Esc-d or Alt-d                          |
| Insert the most recently deleted text at the cursor          | Ctrl-y                                  |
| Scroll backward through the command history                  | Ctrl-p or Up Arrow                      |
| Scroll forward through the command history                   | Ctrl-n or Down Arrow                    |
| Search the command history in reverse order                  | Ctrl-r                                  |
| Show a list of previous commands                             | run the "show cli history" command      |
| Capitalize the word at the cursor                            | Esc-c                                   |
| Change the word at the cursor to lowercase                   | Esc-l                                   |
| Change the word at the cursor to uppercase                   | Esc-u                                   |
| Abort a command/Clear line                                   | Ctrl-c                                  |
| Quote insert character                                       | Ctrl-v/ESC-q                            |
| Redraw the screen                                            | Ctrl-l                                  |
| Transpose characters                                         | Ctrl-t                                  |
| Enter multi-line mode                                        | ESC-m                                   |

### Commands

The commands available to the user differs, depending on whether the CLI is in operational mode or configuration mode. The following commands are describe in the next sections:

| Operational Mode Commands | Configuration Mode Commands |
|---------------------------|-----------------------------|
| commit                    | annotate                    |
| configure                 | commit                      |
| exit                      | compare                     |
| help                      | copy                        |
| ping                      | delete                      |
| quit                      | edit                        |
| script                    | exit                        |
| set                       | help                        |
| request                   | insert                      |
| set-path                  | move                        |
| show                      | quit                        |
| ssh                       | rename                      |
| telnet                    | request                     |
| top                       | resolved                    |
| traceroute                | revert                      |
| up                        | rollback                    |
|                           | run                         |
|                           | set                         |
|                           | show                        |
|                           | status                      |
|                           | tag                         |
|                           | top                         |
|                           | up                          |
|                           | validate                    |
|                           | exit                        |

### *Operational mode commands*

#### **commit (abort | confirm) [persist-id <id>]**

Abort or confirm a pending confirming commit. A pending confirming commit will also be aborted if the CLI session is terminated without doing commit confirm (default is confirm). If the confirming commit was initiated with a persist argument, then the same token needs to be supplied using the persist-id argument to this command.

#### **Configure (private, exclusive, shared)**

Enter configure mode. The default is private.

##### **Private**

Edit private copy of running configuration.

##### **Exclusive**

Lock and edit candidate configuration.

##### **Shared**

Edit candidate configuration without locking it.

#### **exit**

Exits the CLI session.

#### **help <command>**

Display help text related to <command>.

#### **ping**

Ping an IP address or hostname.

#### **quit**

Quit current operation.

#### **request**

Performs a Remote Procedure Call, which instructs the device to perform some operation, i.e., a reboot.

#### **script**

Script actions (description in CLI)

#### **set [environment]**

See section “CLI Environment”

#### **set-path**

Set relative show path

#### **show [path]**

Display CLI properties.

##### **show configuration**

The “show” command can be used to view information. Notice the information displayed is different, depending on which mode the CLI is in. The text which follows on the next page shows operational data when the CLI is in operational mode. Note that the following are examples and will vary from one system to the next:.

```
admin@Orbit1 15:49:46> show configuration system
system platform os-name Linux
system platform os-release 3.0.35-mds-gffe71b5
system platform os-version "#1 SMP PREEMPT Fri Aug 23 08:45:46 EDT 2013"
system platform machine armv7l
system platform nodename Orbit1
system clock current-datetime 2013-10-11T15:49:49-04:00
system clock boot-datetime 2013-09-24T13:12:28-04:00
system serial-number-core 2318460
system serial-number-platform 2316776
system product-configuration Unset
system guid 0010220000000000001000000002359E8
system authentication group-memberships admin,tech,oper
system support support-transfer-status state inactive
system support support-transfer-status detailed-message ""
system support support-transfer-status size 0
system support support-transfer-status bytes-transferred 0
system support support-transfer-status percent-complete 0
system configuration-files transfer-status state complete
system configuration-files transfer-status detailed-message ""
system configuration-files transfer-status size 30003
system configuration-files transfer-status bytes-transferred 30003
system configuration-files transfer-status percent-complete 100
system uptime seconds 1465584
system uptime text "up 16 days, 23:06:24"
system temperature 31
system firmware reprogramming-status state inactive
system firmware reprogramming-status detailed-message ""
system firmware reprogramming-status size 0
system firmware reprogramming-status bytes-transferred 0
system firmware reprogramming-status percent-complete 0
system firmware versions 1
version 1.1.8
active false
```

#### CERTIFICATE

##### SIGNING

| INDEX | CERTIFICATE SHA256 |
|-------|--------------------|
|-------|--------------------|

|   |                                                                  |
|---|------------------------------------------------------------------|
| 1 | 3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990 |
|---|------------------------------------------------------------------|

```
system firmware versions 2
```

```
version 1.1.9
```

```
active true
```

#### CERTIFICATE

##### SIGNING

| INDEX | CERTIFICATE SHA256 |
|-------|--------------------|
|-------|--------------------|

|   |                                                                  |
|---|------------------------------------------------------------------|
| 1 | 3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990 |
|---|------------------------------------------------------------------|

```
system recovery snapshots
```

```
identifier Factory
```

```
description "Factory Default Configuration"
```

```
date 2013-09-24T13:09:58-04:00
```

```
version 1.1.9
```

```
hash 0x497825203283c9ce47977885aa6625c0
```

| IDENTIFIER    | FUNCTION | STATUS | DATE CREATED              | DATE REVOKED | USER |
|---------------|----------|--------|---------------------------|--------------|------|
| factory-reset | useable  |        | 2013-09-24T17:47:15+00:00 |              |      |

Showing configuration data when the CLI is in operational mode:

```
admin@(none) 01:24:05> show configuration system name
name "Device#42";
[ok][2012-06-19 01:24:30]

admin@(none) 01:24:30> show configuration system
name "Device#42";
location "North_Site"
clock {
 timezone-location America/New_York;
}
geographical-location {
 latitude 43.118376;
 longitude -77.61152;
 altitude 1.0;
}
[ok][2012-06-19 01:24:31]
admin@(none) 01:24:31>
```

Showing configuration data when the CLI is in configuration mode:

```
admin@(none) 01:25:36% show system
name "Device#42";
location "North_Site"
clock {
 timezone-location America/New_York;
}
geographical-location {
 latitude 43.118376;
 longitude -77.61152;
 altitude 1.0;
}
[ok][2012-06-19 01:25:43]

[edit]
admin@(none) 01:25:43%
```

Normally, only those values explicitly set by the user will be displayed. Users can selectively view those nodes that assumed a default value by using the “details” modifier on the CLI, like the example shown on the next page.

Showing the user's configuration and any nodes that assumed a default value:

```
admin@(none) 16:28:52> show configuration interfaces interface ETH1 | details
type ethernetCsmacd;
enabled true;
ipv4 {
 enabled true;
 ip-forwarding false;
 address 192.168.1.10 {
 prefix-length 24;
 }
}
ipv6 {
 enabled true;
 ip-forwarding false;
 dup-addr-detect-transmits 1;
 autoconf {
 create-global-addresses true;
 create-temporary-addressed false;
 temporary-valid-lifetime 604800;
 temporary-preferred-lifetime 86400;
 }
}
[ok][2012-06-19 16:28:55]
admin@(none) 16:28:55>
```

Showing the complete data model that the user has access to, while using additional CLI features:

```
admin@(none) 23:51:18> show configuration | details | display set | nomore
set logging event-rules console_login description ""
set logging event-rules console_login local true
set logging event-rules console_login priority notice
```

.....

<Remaining text omitted for brevity>

.....

#### **ssh**

Open a secure shell on another host

#### **telnet**

Open a telnet session

#### **top**

Exit to top level and optionally run command

#### **traceroute**

Trace the route to a remote host

#### **up**

Exit one level of configuration

## Configure mode commands

### **annotate <statement> <text>**

Associate an annotation with a given configuration statement. To remove an annotation leave the text empty.

### **commit (check | and-quit | confirmed [<timeout>] [persist <token>] to-startup) [comment <text>] [label <text>] [persist-id <id>]**

Commit current configuration to running.

#### **check**

Validate current configuration.

#### **and-quit**

Commit to running and quit configure mode.

#### **confirmed**

Commits the current configuration to running with a timeout. If no **commit confirm** command has been issued before the timeout expires, then the configuration will be reverted to the configuration that was active before the **commit confirmed** command was issued. If no timeout is given then the confirming commit will have a timeout period of 10 minutes. The configuration session will be terminated after this command since no further editing is possible. Only available in configure exclusive and configure shared mode.

The confirming commit will be rolled back if the CLI session is terminated before confirming the commit, unless the persist argument is given. If the persist command is given then the CLI session can be terminated and a later session may confirm the pending commit by supplying the persist token as an argument to the commit command using the persist-id argument.

#### **comment <text>**

Associate a comment with the commit. The comment can later be seen when examining rollback files.

#### **label <text>**

Associate a label with the commit. The label can later be seen when examining rollback files.

#### **persist-id <id>**

If a prior confirming commit operation has been performed with the persist argument, then to modify the ongoing confirming commit process the persist-id argument needs to be supplied with the same persist token. This makes it possible to, for example, abort an ongoing persist commit, or extend the timeout.

### **compare running [brief]**

If changes have been made, but have not yet been committed, then those changes can be reviewed prior to committing them by using the “compare” command. Differences will be annotated with - (removed) and + (added). If the brief option is specified, then only the differences will be shown.

#### **copy**

Copy a list entry.

#### **delete**

Delete a data element.

**edit**

Edit a sub-element.

**exit (level | configuration-mode)****level**

Exit from current mode. If performed on the top level, will exit configure mode. This is the default if no option is given.

**configuration-mode**

Exit from configuration mode regardless of mode.

**help <command>**

Shows help text for command.

**insert <path>**

Inserts a new element. If the element already exists and has the indexedView option set in the data model, then the old element will be renamed to element+1 and the new element inserted in its place.

**insert <path>[first|last|beforekey|afterkey]**

Insert a new element into an ordered list. The element can be added first, last (default), before or after another element.

**move <path>[first|last|beforekey|afterkey]**

Move an existing element to a new position in an ordered list. The element can be moved first, last (default), before or after another element.

**quit**

Exit from this level.

**rename <instance path> <new id>**

Rename an instance.

**request**

Make system level requests.

**resolved**

Conflicts have been resolved.

**revert**

If changes have been made, but have not yet been committed, then those changes can be committed, reverted, or ignored by quitting the configuration mode of the CLI. Reverting the changes can be done using the “revert” command.

**rollback [<number>]**

Return the configuration to a previously committed configuration. The system stores a limited number of old configurations. If more than the configured number of configurations are stored, then the oldest configuration is removed before creating a new one. The most recently committed configuration (the running configuration) is number 0, the next most recent 1, etc.

Example:

```
admin@(none)% rollback 1
[ok][2012-06-19 16:28:55]
admin@(none)%
```

**run**

Run an operational-mode command.

**set**

Set a parameter.

**show**

Show a parameter.

**status**

Display users currently editing the configuration.

**tag <add|clear|del>**

```
tag add <statement> <tag>
```

Add a tag to a configuration statement.

```
tag del <statement> <tag>
```

Remove a tag from a configuration statement.

```
tag clear <statement>
```

Remove all tags from a configuration statement.

**top**

Exit to top level and optionally run command.

**up**

Exit one level of configuration.

**validate**

Validates current configuration. This is the same operation as commit check.



## 7.0 APPENDIX C – INTEGRITY MEASUREMENT AUTHORITY (IMA)

### Understanding

The MCR supports the integrity measurement and attestation architecture as described by Trusted Network Connect (TNC) specifications, jointly developed and published by Trusted Computing Group (TCG) and IETF NEA working group.

The MCR establishes secure IPsec VPN connection with the VPN gateway via mutual authentication based on certificates or pre-shared secrets. The TNC architecture adds the ability to measure, report and verify the security state of the MCR (e.g. integrity of critical system configuration file) as a part of IPsec VPN authentication and authorization process.

MCR supports TNCCS 2.0 protocol and subset of TCG's Platform trust Service (PTS). The MCR supports only file measurement capability of the PTS protocol. Also, only measurements for following files are supported:

1. **/tmp/system.config** - This file includes all current system configuration.

2. **/etc/tnc\_config**

Once the unit has been configured, the hash (sha256 or sha385) of system configuration file can be obtained via CLI (locally or remotely) and loaded into the Integrity Measurement Authority (IMA) database.

Typically, integrity measurement and attestation happens automatically as part of IPsec VPN “data” connection establishment using EAP-TTLS method (and EAP-TNC authentication within it) as instructed by the VPN-gateway. However, MCR also supports an out-of-band IMA connection, where the unit connects to a separate IMA server not to pass data but just to perform integrity measurement and attestation. The IMA server, in such a setup, can then publish the unit's “health” information to the VPN server that is terminating the actual data connections. This allows VPN server to enforce permit/deny policy for incoming VPN data connections from the unit.

### Configuring

The out of band IMA configuration is exactly similar to VPN configuration described in VPN section except that the IPsec connection is designated specifically as out-of-band IMA connection and local and remote ip subnet are all set 0.0.0.0/0 as shown below:

```
admin@(none) 21:51:32> admin@(none) 19:33:29% set services vpn ipsec connection IMA-CONN-1
is-out-of-band-ima true
```

```
admin@(none) 21:51:32> admin@(none) 19:33:29% set services vpn ipsec connection IMA-CONN-1
local-ip-subnet 0.0.0.0/0
```

```
admin@(none) 21:51:32> admin@(none) 19:33:29% set services vpn ipsec connection IMA-CONN-1
remote-ip-subnet 0.0.0.0/0
```

```
admin@(none) 21:51:32> admin@(none) 19:33:29% set services vpn ipsec connection IMA-CONN-1
periodic-retry-interval 60
```

The “periodic-retry-interval” applies only to the IPsec connection designated as an “out-of-band” IMA connection. The MCR attempts attestation every “periodic-retry-interval” if the previous attempt to connect with IMA server was unsuccessful.

In case of an out of band IMA server setup, the MCR needs to be configured with an IMA IPsec connection and a VPN-GWY IPsec connection. An example follows:

```
connection IMA-CONN-1 {
 ike-peer IMA-SERVER;
 ipsec-policy IPSEC-POLICY-IMA;
 local-ip-subnet 0.0.0.0/0;
 remote-ip-subnet 0.0.0.0/0;
 is-out-of-band-ima true;
 failure-retry-interval 1;
}
connection VPN-GWY-CONN-1 {
 ike-peer VPN-GWY;
 ipsec-policy IPSEC-POLICY-1;
 local-ip-subnet 192.168.1.0/24;
 remote-ip-subnet 192.168.2.0/16;
 failure-retry-interval 1;
}
```

IMA-CONN-1 is used for attestation and VPN-GWY-CONN-1 is used for VPN data connection.

If more than one IPsec connection is configured on the unit, the unit initiates connections in round-robin fashion. For example, MCR will follow the following sequence:

- Attempt connection to IMA-SERVER
- Attempt connection to VPN-SERVER (irrespective of IMA-SERVER connection outcome)
- Attempt connection to IMA-SERVER after failure-retry-interval if previous attempt to connect with it failed.
- Attempt connection to IMA-SERVER after periodic-retry-interval if previous attempt to connect with it succeeded.
- Attempt connection to VPN-SERVER after failure-retry-interval if it failed previously or got disconnected due to dead peer detection.
- and so on...

## Obtaining Configuration file hash

The following example shows the use of a request to get the system configuration hash:

```
admin@(none) 22:09:59> request services vpn ipsec get-config-hash hash-algo sha384
hash
e60429aa127cb2f23e10ae00b6c1553fa9d1f598b2a206926ad0dcdf9a758622eec77ad559b32f85ceea9013a
961041f
[ok][2013-01-18 22:10:15]
```

This hash can then be loaded in IMA database.

## Monitoring

The current attestation status of the IMA connection is displayed using same command as used to display regular VPN data connection status. The example on the following page shows that the IMA connection succeeded but the IMA Evaluation was “non-compliant” and IMA recommendation was “Quarantined”. This will happen is the system configuration file hash loaded in IMA does not match the actual hash of the current system configuration, indicating that system configuration was changed since last time the hash was loaded in the IMA database.

```
admin@(none) 22:10:15> show services vpn
services vpn ipsec ipsec-status connections connection IMA-CONN-1
state disconnected
failure-reason none
last-timestamp 2013-01-18T21:24:26+00:00
ima-evaluation "non-compliant major"
ima-recommendation Quarantined
[ok][2013-01-18 22:13:20]
```

Once it is determined through event logs that the configuration was changed by authorized user, the current configuration hash can be loaded in the IMA and then MCR can be instructed to re-attest with IMA server, as shown below.

```
admin@(none) 22:18:45> request service-vpn-ipsec-attest-with-ima conn-name IMA-CONN-1
```

The IMA status can then be checked again periodically for new attestation result:

```
admin@(none) 22:10:15> show services vpn
services vpn ipsec ipsec-status connections connection IMA
state disconnected
failure-reason none
last-timestamp 2013-01-18T22:19:02+00:00
ima-evaluation compliant
ima-recommendation "Access Allowed"
[ok][2013-01-18 22:19:37]
```

## IMA Troubleshooting

Follow the troubleshooting steps described in VPN section on troubleshooting IMA connection failure. Note that an IMA connection failure means that unit was unable to communicate or attest with IMA. It does not mean there was an IMA evaluation failure.

## 8.0 APPENDIX D – COMMON EVENT EXPRESSION (CEE)

Events will be categorized using a taxonomy based on the Common Event Expression (CEE) event profile (1). These events will be encoded using JavaScript Object Notation (JSON), and placed into the standard message body of a syslog message.

From the CEE website:

Common Event Expression (CEE™) improves the audit process and the ability of users to effectively interpret and analyze event log and audit data. This is accomplished by defining an extensible unified event structure, which users and developers can leverage to describe, encode, and exchange their CEE Event Records. (2)

CEE defines the structure of event messages via an XML schema referred to as the CEE Core Profile. The Core Profile consists of 3 reusable components: (2)

- **Event Taxonomy** — provides a listing of Event Tags that can be used to classify and identify events. The taxonomy supports common event categorization methods and identification of records that pertain to similar types of events.
- **Field Dictionary** — a listing of event record fields and field value types used to represent common event data. Selected fields and value types become associated with properties of a specific event instance.
- **CEE Event Schema** — defines the structure of an event record, including the minimum set of required fields. Event Extensions provide a mechanism for capturing additional data about an event.

One of the key features of the CEE Core Profile is that it can be extended by an organization so that they can add additional taxonomy categories and fields that describe vendor specific events.

### Event Taxonomy

The CEE Core Profile defines the following taxonomy categories:

- **Action** — The primary type of action that was undertaken as part of the event. The status or result of the action should be detailed in the status field.
- **Domain** — The environment or domain of the event. Typical event domains include network (net), operating system (os), and application (app).
- **Object** — The type of object that is targeted or otherwise affected by the event
- **Service** — The service the event involves. The service field value provides context to the event action or more precision to the event domain.
- **Status** — The end result or status of the event action identified by the action field.
- **Subject** — The type of object that initiated or started the event action identified by the action field.

With the exception of ‘subject’, the Core Profile defines valid values for each of these categories, some examples of the values include “access, copy, clone, encrypt” for action values, and “error, failure, ongoing, success” for status values.

All taxonomy fields are optional, however if given they *must* contain exactly one non-null value.

### Event Field Dictionary

The Core Profile defines a selection of common fields that may be used in event logs. Like the taxonomy categories, this dictionary can be extended by vendors by using a custom profile. All of the defined fields are optional with the exception of the following 3 mandatory fields that must be in every logged event:

- **host** – Hostname of the event source.
- **pname** – Process name that generated the event.
- **time** – Event start time

It may appear that having the time field is redundant, as the time is already in the syslog message; this is false for 2 reasons:

1. RFC 3164 (3) Syslog timestamps do not contain the year, and only have second resolution, whereas the CEE timestamps have microsecond resolution with full year. RFC 5424 (4) Syslog messages do include the year and support for microsecond resolution.
2. Syslog timestamps reflect the time that the event was sent to syslog, not necessarily the time that the event occurred. Depending on the situation, these times may be different.

## Event Encoding & Transport

CEE defines two different methods for encoding events for transport and storage, XML and JSON. CEE also explicitly defines how CEE messages are to be transported over syslog (5). The following requirements are stated:

- Syslog Header – The standard Syslog header **MUST** be used.
- Syslog Body – The CEE Event **MUST** be represented using the CLS (CEE common Log Syntax) JSON Encoding.
- CEE Event Flag – The beginning of the encoded CEE Event **MUST** be identified by the CEE Event Flag. Within Syslog, the CEE Event Flag is @cee:
- Character Encoding – If the syslog implementation is only 7-bit, all characters not in the ASCII character set **MUST** be escaped.

## Examples

A valid CEE JSON Event Record embedded within an RFC5424 Syslog transport:

```
<165>1 2011-12-20T12:38:06Z 10.10.0.1 process - example-event-1
@cee:{"pname":"auth","host":"system.example.com","time":"2011-12-20T12:38:05.123456-05:00"}
```

A valid CEE JSON Event Record used with a “legacy” Syslog transport:

```
<0>Dec 20 12:42:20 syslog-relay process[35]: @cee:
{"crit":123,"id":"abc","appname":"application","pname":"auth","pid":123,"host":"system.example.com","pri":10,"time":"2011-12-20T12:38:05.123456-05:00","action":"login","domain":"app","object":"account","service":"web","status":"success"}
```

The following example shows a series of events that may be generated by a host requesting an IP for its eth0 interface from a DHCP server (Syslog header left off for brevity, and formatted for clarity):

DHCP Request sent to the server:

```
@cee: {
 "host":"stout",
 "pname":" my_appname ",
 "time":"2012-08-22T11:20:10.559227-04:00",
 "action":"request",
 "domain":"net",
 "object":"interface",
 "service":"dhcp_client",
 "status":"ongoing",
 "event":"dhcp_client",
 "interface_name":"eth0",
 "profile":"http://gemds.com/cee_profile/1.0beta1.xsd"
}
```

DHCP Response from server, assigning the IP 192.168.2.3:

```
@cee: {
 "host": "stout",
 "pname": "my_appname",
 "time": "2012-08-22T11:20:10.559748-04:00",
 "action": "request",
 "domain": "net",
 "object": "interface",
 "service": "dhcp_client",
 "status": "success",
 "ipv4": "192.168.2.3",
 "event": "dhcp_client",
 "interface_name": "eth0",
 "profile": "http://gemds.com/cee_profile/1.0beta1.xsd"
}
```

The body of syslog messages of type “alert” is specified using RFC 5425 type key/value pairs. A few additional fields are also present.

### syslog PRIVAL

The “PRIVAL” field of the syslog “HEADER” shall to be set to 113 for alerts and between 104 and 111 for editable events.

### syslog APP-NAME

The “APP-NAME” field of the “HEADER” specified in the syslog RFC shall be set to “csmgr”.

RFC5424 states: “The APP-NAME field SHOULD identify the device or application that originated the message.” The semantics of the field have changed from the application that originated the event, to the application who should receive the event.

### syslog MSG

For events of type audit, the msg is vendor specific, whereas events of type alert must be in a specified format which contains a GUID, level and message. Using the CEE approach all of the requested information would be present in all messages.

Example of message using format

```
Jun 7 11:10:22 ccc99 csmgr[27417]: Source=' ABCDEF0123456789AB000000000000099' Level='5'
Message='Date/Time Changed by User'
```

Example of message using CEE format

```
Jun 7 11:10:22 ccc99 systemmgr[33212]: @cee: {"host": "ccc99", "guid": "
ABCDEF0123456789AB000000000000099", "syslog_priority": 5, "pname": "sys-
temmgr", "time": "2012-08-23T09:16:21.335592-04:00", "action": "modify", "domain": "os", "object": "datetime", "status": "success", "event": "date_time_from_user", "profile": "http://gemds.com/cee_profile/1.0beta1.xsd"}
```

### Configuring

The following shows how to configure the unit with a server to which events will be sent:

```
admin@(none) 03:58:13% set logging syslog server my_syslog_server ip 192.168.1.1 port 1999
protocol tls version RFC5424 tls-options tls-ca-certificate my_ca_cert tls-client-certif-
icate my_client_cert tls-client-key my_client_key
```

The following shows how to configure an event that will be logged locally, via syslog, and via net-conf-notifications:

```
admin@(none) 00:12:19% set logging event-rules cell_connected syslog true local true net-
conf-notification true
```

## Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
admin@(none) 00:14:24% show logging event-rules cell_connected
 description "cell connection established";
 local true;
 priority notice;
 syslog-facility user;
 syslog true;
 snmp-notification true;
 netconf-notification true;

admin@(none) 00:14:28% show logging event-rules cell_disconnected
 description "cell connection disconnected";
 local true;
 priority notice;
 syslog-facility user;
 syslog true;
 snmp-notification true;
 netconf-notification true;

[ok][2012-06-19 00:15:03]

[edit]
admin@(none) 00:15:03%
```

## 9.0 APPENDIX E– CONFIGURING FIRMWARE MANAGEMENT

The GE MDS code signing tool (CST) is a command line program that can be run on Windows or Linux. Running the CST and passing the “--help” argument will print the following usage info:

```
pkgsigner --help
```

```
GEMDS Firmware Packaging Signing Utility (pkgsigner) 06-6671A01 Rev. 0.3.0
Built: Jan 7 2013 11:25:34
```

**Usage:**

To verify and sign a package:

```
pkgsigner -v verifycert -k privkey -P password -p pubcert -f infile -o outfile
```

where: **verifycert** = The filepath a public certificate to be used to verify the signature of the infile if and the infile has been previously signed.

**privkey** = The filepath for the private key to be used to create a signed package.

**password** = The optional password, if the private key is encrypted

**pubcert** = The filepath for the public certificate corresponding to the privkey. This is use to store a hash of the certificate information, to aide lookup of the appropriate public key during signature verification

**infile** = The filepath for package file (input)

**outfile** = The filepath for signed package file (output)

To display package info and verification status:

```
pkgsigner -l -v verifycert -f infile
```

where: **verifycert** = The filepath a public certificate to be used to verify the signature of the infile if and the infile has been previously signed.

**infile** = The filepath for package file (input)

Users can verify that a firmware package file came from GE MDS by using the CST. The following example shows how to verify a signed firmware package file came from GE MDS by using the firmware file **ge\_signed\_package.mpk** and by using the GE MDS provided public certificate **ge\_pubcert.pem**.

```
./pkgsigner -l -v ge_pubcert.pem -f ge_signed_package.mpk
```

```
Processing file: 'ge_signed_package.mpk'
```

```
Package ID: 20121101
```

```
NumImages: 4
```

```
NumSignatures: 1
```

```
Image #0 : Bootloader version 2012.07-g644d99
```

```
Image #1 : Kernel version 3.0.15-mds-gc00
```

```
Image #2 : RootFS version 0.0.4
```

```
Image #3 : CompFS version 0.0.0
```

```
Package version: 0.0.4
```

```
Signature #1 validation was successful.
```

Signing a GE MDS firmware package is an optional step for users and is not required. Users may wish to sign a firmware package to ensure that only user-approved firmware package revisions from GE MDS can be loaded into a unit. An example of signing a firmware package is shown below:

```
./pkg signer -v ge_pubcert.pem -k user_key.pem -P "mypass" -p user_pubcert.pem -f
ge_signed_package.mpk -o user_signed_package.mpk
```

```
Processing file: 'ge_signed_package.mpk'
Package ID: 20121101
NumImages: 4
NumSignatures: 1
Image #0 : Bootloader version 2012.07-g644d99
Image #1 : Kernel version 3.0.15-mds-gc00
Image #2 : RootFS version 0.0.4
Image #3 : CompFS version 0.0.0
Package version: 0.0.4

Signature #1 validation was successful.

Packed file created in 'user_signed_package.mpk'.
```

Where:

- **ge\_signed\_package.mpk** is the firmware package provided by GE MDS that was signed by GE MDS. Firmware packages will typically be downloaded by users from GE MDS websites.
- **ge\_pubcert.pem** is the public certificate provided by GE MDS that is used to verify that the signed packaged is authentic. The GE MDS public certificate will typically be downloaded by users from the GE MDS website.
- **user\_key.pem** is a private key provided by the user.
- **mypass** is the password used to decrypt *user\_key.pem*, assuming the key is password protected. If the key is not password protected, then the **-P** option may be omitted.
- **user\_pubcert.pem** is the public certificate corresponding to *user\_key.pem*.
- **user\_signed\_package.mpk** the file that will be created that contains the GE MDS signature and the newly appended user signature.

When verifying a user-signed package, both the GE MDS public certificate and the user's public certificate must be provided to the CST:

```
./pkg signer -l -v ge_pubcert.pem -v user_pubcert.pem -f user_signed_package.mpk
```

```
Processing file: 'user_signed_package.mpk'
Package ID: 20121101
NumImages: 4
NumSignatures: 2
Image #0 : Bootloader version 2012.07-g644d99
Image #1 : Kernel version 3.0.15-mds-gc00
Image #2 : RootFS version 0.0.4
Image #3 : CompFS version 0.0.0
Package version: 0.0.4

Signature #2 validation was successful.
Signature #1 validation was successful.
```

## 10.0 APPENDIX F– OBTAINING PROVISIONED CELL SERVICE (VERIZON)

### Understanding

The MDS Orbit MCR-4G requires a mini SIM card (2FF type) provisioned for 4G cell operation. The unit's cellular interface will not function without a valid SIM card installed.

GE MDS does not provide SIM cards. Service can be obtained by contacting Verizon and requesting a provisioned SIM card for the appropriate M2M service plan.

Description of the SIM port and how to insert a SIM card is provided in “Connectors and Indicators” on Page 4 of this manual.

### Before Contacting Verizon

To enable service, Verizon will typically require the IMEI (International Mobile Equipment Identity) of the equipment in which the SIM card will be used.

The IMEI can be found by logging into the device and entering the following command:

```
admin@(none) 00:20:44> show interfaces interface Cell cell-status imei
cell-status imei 991000947608727
```

If MEID (Mobile Equipment Identifier) is needed, this is equal to the IMEI value *minus the last digit*.

---

**NOTE:** Do not run the command above unless a provisioned SIM card is installed in the unit. If an un-provisioned card is used, the cell-status may return an error code beginning with 0x instead of the proper IMEI value.

---

### Establishing a Cell Service Plan

Verizon offers a variety of service plans. Determine your data needs and contact your Verizon Wireless Business Representative to obtain the appropriate provisioned SIM cards.

Verizon provides the following link to assist in finding a service representative based on customer attributes and needs: <https://www.findmyrep.vzw.com/>



## 11.0 APPENDIX G – DEVICE MANAGER

The *Device Manager* is a built-in software tool that works with your PC's browser to provide an intuitive, web-style presentation of all unit information, settings, and diagnostics. Web management uses the unit's Ethernet RJ-45 connector.

---

**NOTE:** For security, web access can be enabled/disabled via the CLI using the command `% set services web http(s) enabled true/false`.

---

### 11.1 Web Browser Connection

#### Requirements

The remainder of this section describes connection and use of the built-in Device Manager. To connect to the unit and manage it via the Device Manager, you will need the following:

- A PC with a web browser program installed.
- An Ethernet cable connected between the PC and the MCR as shown in [Figure 26](#).
- The unit's IP address. Check with your Network Administrator, or determine the address via a command line interface connection. The default address for a factory supplied unit is **192.168.1.1**.
- The user name and password for the unit. Check with your Network Administrator, or, if a username and password have not been set, use the factory defaults of **admin** for both entries. (For security, a new password should be established as soon as possible after login.)

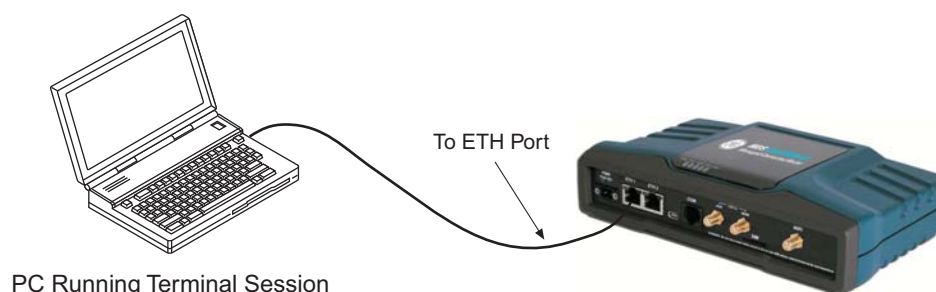


**Figure 26. PC Connection for Web Management**

#### Logging On

1. Connect the unit to a PC via an Ethernet connection.
2. Configure your PC network settings to an IP address on the same subnet as the unit. The default subnet mask is **255.255.255.0**.
3. Enter the unit's IP address in a web browser window, just as you would enter a website address. When the login screen appears ([Figure 27](#)), enter the User Name and Password for the unit. The default entries for a new unit are both **admin**. Click **OK**.

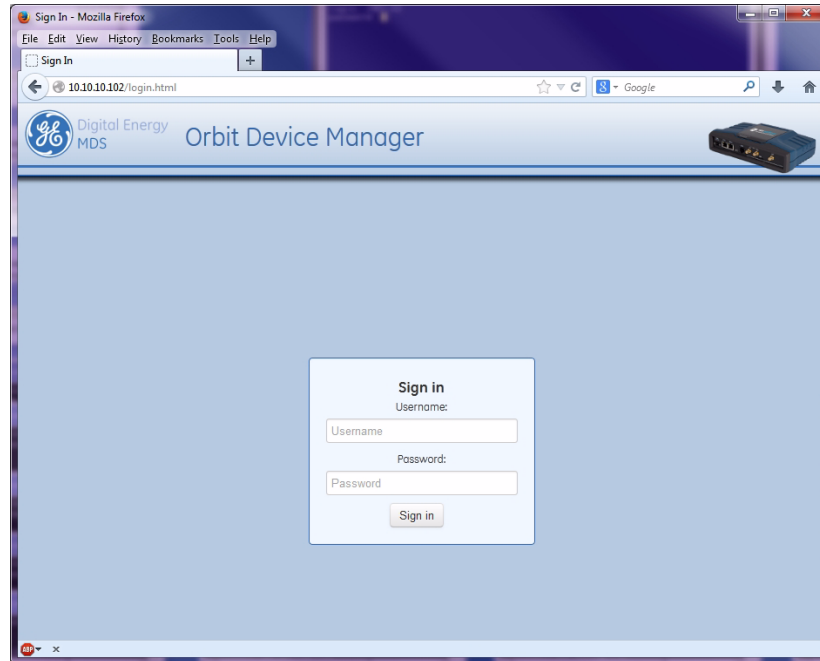


**Figure 27. Login Screen**

### **Getting an Overview of Unit Settings**

To get a top-level view of the key settings and operating parameters for the unit, select **Home** in the upper left hand side of the screen and a summary screen will be displayed. When finished, log out of the Device Manager by clicking **Logout** in the upper right hand side of the screen.

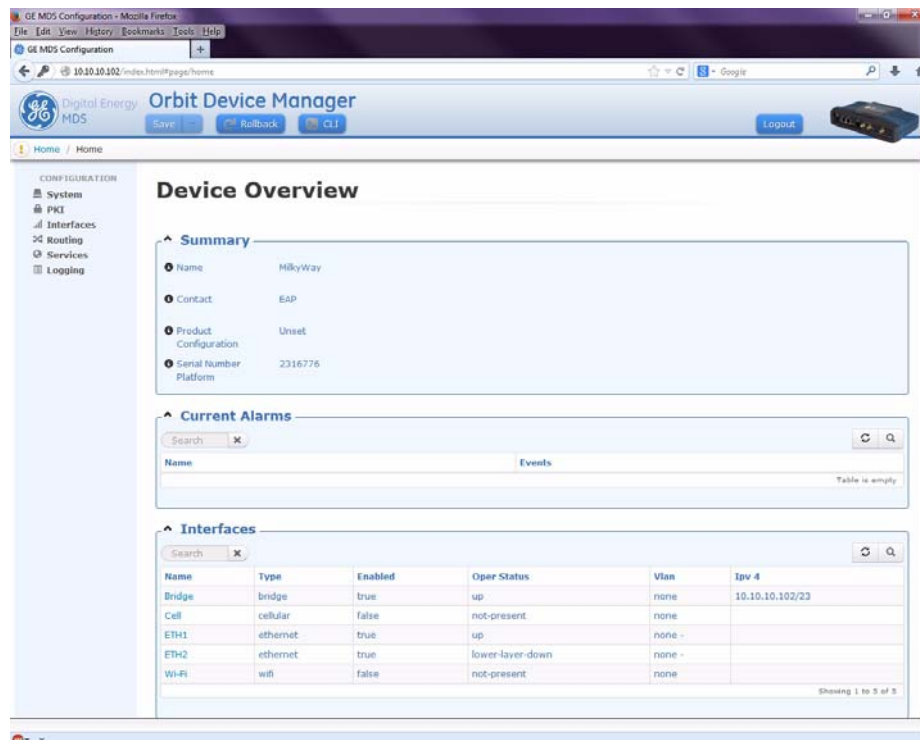


**Figure 28. Device Manager, Overview Screen**

## 12.0 APPENDIX H – LICENSES

+++++SQLCiper+++++

<<http://sqlcipher.net/license/>>

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[illegible]

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# NOTES

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## ***IN CASE OF DIFFICULTY...***

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GE MDS products are designed for long life and trouble-free operation. However, this equipment, as with all electronic equipment, may have an occasional component failure. The following information will assist you in the event that servicing becomes necessary.

### **TECHNICAL ASSISTANCE**

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Technical assistance for GE MDS products is available from our Technical Support Department during business hours (8:30 A.M.–6:00 P.M. Eastern Time). When calling, please give the complete model number of the radio, along with a description of the trouble/symptom(s) that you are experiencing. In many cases, problems can be resolved over the telephone, without the need for returning the unit to the factory. Please use one of the following means for product assistance:

Phone: 585 241-5510

E-Mail: [gemds.techsupport@ge.com](mailto:gemds.techsupport@ge.com)

FAX: 585 242-8369

Web: [www.gemds.com](http://www.gemds.com)

### **FACTORY SERVICE**

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Component level repair of this equipment is not recommended in the field. Many components are installed using surface mount technology, which requires specialized training and equipment for proper servicing. For this reason, the equipment should be returned to the factory for any PC board repairs. The factory is best equipped to diagnose, repair and align your radio to its proper operating specifications.

If return of the equipment is necessary, you must obtain a Service Request Order (SRO) number. This number helps expedite the repair so that the equipment can be repaired and returned to you as quickly as possible. Please be sure to include the SRO number on the outside of the shipping box, and on any correspondence relating to the repair. No equipment will be accepted for repair without an SRO number.

SRO numbers are issued online at [www.gedigitalenergy.com/Communications.htm](http://www.gedigitalenergy.com/Communications.htm). On the left side of the page, click “Login to my MDS” and once logged in, click “Service Request Order”. Your number will be issued immediately after the required information is entered. Please be sure to have the model number(s), serial number(s), detailed reason for return, “ship to” address, “bill to” address, and contact name, phone number, and fax number available when requesting an SRO number. A purchase order number or pre-payment will be required for any units that are out of warranty, or for product conversion.

If you prefer, you may contact our Product Services department to obtain an SRO number:

Phone Number: 585-241-5540

Fax Number: 585-242-8400

E-mail Address: [gemds.productservices@ge.com](mailto:gemds.productservices@ge.com)

The radio must be properly packed for return to the factory. The original shipping container and packaging materials should be used whenever possible. All factory returns should be addressed to:

GE MDS, LLC  
Product Services Department  
(SRO No. XXXX)  
175 Science Parkway  
Rochester, NY 14620 USA

When repairs have been completed, the equipment will be returned to you by the same shipping method used to send it to the factory. Please specify if you wish to make different shipping arrangements. To inquire about an in-process repair, you may contact our Product Services Group using the telephone, Fax, or E-mail information given above.



Digital Energy  
MDS

GE MDS, LLC  
175 Science Parkway  
Rochester, NY 14620  
Telephone: +1 585 242-9600  
FAX: +1 585 242-9620  
[www.gemds.com](http://www.gemds.com)

