



StreamCaster 4000 series MIMO Radio User Manual

Document Number	10017C000
Version	5.0.0.0c
Date	10/28/2024

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Revision History

Version	Date	Changes
1.0	April 8, 2020	Original
4.0.0.0	April 17, 2020	Updated 7.2.1 N2N server capability
4.0.0.0	May 1, 2020	Added mounting hole information to mechanical drawings in section 4.3. Revised default setting for auto noise estimation Renamed Local Broadcast feature to MANET Multicast/Broadcast in section 5.1.2.3
4.0.0.0	May 7, 2020	Updated GI mode description in section 5.1.1.2 Removed section 12.1 LED troubleshooting and revised section 4.1 to include correct LED status description Corrected referenced figures throughout user manual
4.0.0.3	February 9, 2020	Updated to match production release version Removed Auto Noise Estimation (will always be enabled moving forward) Added color coding to pins on primary and aux cables for 4200E/4400E radios Added SL4200 to product line Revised USB2 to USB0 naming scheme Added more details to login authentication Added HMAC key and Wrapping key in Encryption Added MCS sensitivity tables for 1.25 & 2.5 MHz Revised SC4200E P/N to SC4200EP
4.0.0.10	March 26, 2021	Update section 5.1.2 Networking. Added DLEP, DHCP server, and infrastructure network sections. Typo on section 9.3 Updated SL4200 specifications Added note for primary cable color scheme valid after 6/1/19 Revised "beam forming" to "beamforming" Added note that MAN-IA disables Tx beamforming Updated FIPS compliance/certified Updated section 5.0 initial description Added IPv6 support details Revised typo in section 5.1.2.7

		Added MPS zeroize details Removed End-to-End ARQ Added details in section 5.1.2.7 for scan on start, and failover mode
4.0.0.11	August 20, 2021	Revised description of DHCP in section 5.1.2.4 Revised description of infrastructure networks in section 5.1.2.7 Revised the narrow bandwidth sensitivity chart radio name table 19 and 20 Revised section 5.1.2.3 to note that WiFi dongle SC-WIFI-DNGL2-RGD-ODU supports WPA2-PSK-AES encryption Revised table 25 in section 9.1 to show that report type 5000, 5001, 5002, 5003, and 5004 should take full dBm steps, not half. Updated section 1.1 Health & Safety section
4.0.2.3	September 10, 2021	Added some clarification on the mapping section of network management section 5.2.2 Update SL4200 mechanical drawing in section 4.3.3 Add a section on MAN-IM in section 5.3.2
4.0.2.8	December 3, 2021	Added section 16. MIC Japan Notice Revised table 19-23 columns for sensitivity of type of radio Revised description of radio mesh type in Infrastructure Networks section 5.1.2.7 Revised typo on table 10 pin 11 Replace SL4200 pin out diagram. Add high power radio versions 10W and 20W Added explanation that zeroize will require a radio reboot to sections 5.5.3 and 5.6.2. Updated sensitivity figures on table 19
4.0.2.10	December 28, 2021	Update RSSI reporting format on table 25 Added MAN-IC section 5.3.4 Added mention of x-pol antenna config when beamforming disabled in section 5.1.1.2 Updated Encryption section 5.4.1 Updated Languages section 5.5.4 Updated Basic section 5.1.1.1 to include routing mode Added serial server to section 5.1.4 Added link to DLEP document in section 5.1.2.2
4.0.3.0	February 11, 2022	Updated section 5.2.2 Mapping. OpenStreetMap no longer supported. OpenStreetMap (US) still available. Updates to section 5.3.4 MAN-IC. Updated section 5.1.2.5 Multicast. Added description for Default Multicast Algorithm, Broadcast, and Flooding Multicast. Added note on multicast method for CoT in section 5.2.2.

		Added note on PTT multicast method in section 5.1.5.
4.0.3.6	April 8, 2022	Added description of VLAN Filter in section 5.1.2.1. Added description of LED bright control bar in section 5.5.2. Updated figure 77 and Login Authentication section 5.4.4. Added mention of port 1234 for PTT in section 5.1.5. Revised MCS throughput numbers to two decimal points in section 5.1.1.2 tables 19, 20, 21, 22, and 23. Added section 5.2.6 SNMP support Updated section 5.5.3 factory reset section to include quick zeroize parameter. Added caption for table 11 SL4200 supported USB modes Adjusted table spacing for pin out tables 2-19 Added Switchcraft P/N EN3C6FX to pin out tables 3, 7, 13, & 17 Updated section 4 spacing Adjusted table spacing for MCS tables 20-24
4.0.3.7	April 14, 2022	Removed the mention that WIFI is not available on SL4200. SL4200 does support WIFI. Added description for Broadcast FIPS mode, view key, and generate random key in section 5.4.1
4.0.3.11	October 26, 2022	Added section 13.10 FCC ID N2S-SL42-245
4.0.3.14	December 9, 2022	Revised Silvus logo on cover page and header Added temperature log example to section 5.5.2 Updated section 5.6.2 with new MPS features Added DHCP sample settings in section 5.1.2.4 Added notes of static or DHCP assigned IP requirements to WiFi settings section 5.1.2.3 Updated section 5.1.2.1 to include VPN buffer sizes and IPv6 settings Updated section 5.1.2.6 to include ping priority, and AIFS/MCS/retransmissions under Advanced parameters Update section 5.1.2.1 to indicate that VPN/WAN links will not create a continuous green LED Updated Basic RF section 5.1.1.1 to include apply network and save and apply network Updated Firmware upgrade section 5.5.1.2 to include instructions of how to load user manual into GUI. Created section 5.4.5 SSH service
5.0.0.0	November 7, 2023	Update section 5.4 Security section Update section 6 (FIPS)
5.0.0.0a	November 17, 2023	Updated section 3 to follow SS5 IP scheme.

5.0.0.0a-C1	November 17, 2023	FCC: N2S-SL42-245 update
5.0.0.0a-C2	November 17, 2023	EU/CE markings: “-139” & “235467”, 6x radios models
5.0.0.0a-C3	November 30, 2023	UKCA markings: “-139” & “235467”, 6x radios models
5.0.0.0b	July 30, 2024	FCC modular: N2S-SL42-245-OEM update
5.0.0.0c	October 28, 2024	FCC: N2S-SC421-235, N2S-SC424-235, N2S-SC42A-235, N2S-SC421-235467, N2S-SC424-235467, N2S-SC42A8-235467, N2S-SC441-235, N2S-SC448-235, N2S-SC44K-235, N2S-SC441-235467, N2S-SC448-235467, N2S-SC44KG-235467 update

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1. General Safety Information

The information that follows, together with local site regulations, should be studied by personnel concerned with the operation or maintenance of the equipment, to ensure awareness of potential hazards.

Switch off supplies before removing covers or disconnecting any RF cables, and before inspecting damaged cables or antennas.

Avoid standing in front of high gain antennas (such as a dish) and never look into the open end of a waveguide or cable where strong RF power may be present.

Users are strongly recommended to return any equipment that requires RF servicing to Silvus Technologies.

CAUTION: This system contains MOS devices. Electro-Static Discharge (ESD) precautions should be employed to prevent accidental damage.

1.1 Health & Safety

Exposure to Non-Ionizing (RF) Radiation/Safe Working Distances

The safe working distance from a transmitting antenna may be calculated from the relationship:

$$D = \sqrt{\frac{P_T \cdot G_R}{4\pi \cdot 10 \cdot w}}$$

In which D = safe working distance (meters)

PT = total transmit power (watts)

GR = antenna gain ratio = $10^{(\frac{G}{10})}$ where G is the antenna gain in dBi.

w = maximum allowed RF power density (mW/cm²)

The maximum allowed RF power density value is determined by reference to regulatory safety guidelines for exposure of the human body to non-ionizing radiation. It is important to note that the guidelines adopted differ throughout the world and are from time-to-time re-issued with revised guidelines. For use in the United States, one can find the FCC guideline at the following link as of this writing:

“https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf”.

Specifically, page 67 of this link contains the table of RF power density limits for different frequency bands.

Below is a table of some example safe distances calculated based on the FCC guidelines using the limits for occupational/controlled exposure. For countries other than the US, please use the limits in the local guideline to adjust the calculation.

Frequency	Antenna			Transmitter Power					FCC limits
	Type	Gain (dBi)	Gain Ratio (GR)	1W	2W	4W	10W	30W	
2400 MHz	Omni	3	2	0.06	0.08	0.11	0.18	0.31	5 mW/cm ²
1370 MHz	Sector	20	100	0.42	0.59	0.84	1.32	2.29	4.567 mW/cm ²
4700 MHz	Parabolic Dish	35	3162	2.24	3.17	4.5	7.1	12.3	5 mW/cm ²
				Minimum Safe Distance (meters)					

Table 1 Safe Working Distances

Important Note: It must be remembered that any transmitting equipment radiating power at frequencies of 100kHz and higher, has the potential to produce thermal and a-thermal effects upon the human body.

To be safe:

- Operators should not stand or walk in front of any high gain antenna such as dish antennas, nor should they allow anyone else to do so.
- Operators should not operate any RF transmitter or power amplifier with any of its covers removed, nor should they allow anyone else to do so.

General Safety Notes

- A flashing/steady Red LED status indication is a normal condition and is not meant to convey a fault condition.
- The Power Disconnect Device for the product is the connector for the external AC/DC Adapter or other DC power source.
- Although the Low Voltage DC powered units are approved for Outdoor use (Dust/Temporary Immersion), the optional AC power option with AC/DC power supply is only certified for indoor use.
- The unit housing serves as a heatsink and must be mounted on a non-combustible surface.
- The units are not User Serviceable. Contact the manufacturer for further instructions on servicing or repair.

- All symbols, markings and warning statements marked on the equipment are shown below for reference.

Product Symbols

This table describes the symbols marked on the device.

Symbol	Description
	Caution Read User Manual Please follow all instructions in this User Manual including all warnings, cautions, and precautions before using the Logamele. Unit is not user serviceable. Contact the manufacturer if defective or damaged.
	RoHS Compliant The product is compliant with the RoHS 2 Directive 2011/65/EU (RoHS 2). [Notes: This Symbol may not be marked on device]
	CE Product complies with the European Union Low Voltage Directive (LVD), RoHS 2 and EMC Directives.
	HOT SURFACE SYMBOL Please avoid bodily contact with the product housing and do not mount the product on a combustible surface.
	Disposal Per the European WEEE Directive, please dispose the product in accordance with local regulations

Figure 1 Product Symbols with Definition

- Product cleaning should only be done with a soft cloth and mild detergent, do not use any solvents that might remove case markings or labels.
- The unit, at the end of its useful life is to be disposed in accordance with local regulations or may be returned to the manufacturer.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment and/or equipment performance may be impaired.

2. Introduction

The StreamCaster family of MIMO radios was designed with operator ease of use in mind. Each radio is capable of operating in a multitude of configurations that are accessed via simple web pages within the radio. Settings such as transmit power, frequency, channel bandwidth, link adaptation and range control can be accessed by simply using a web browser to log into any radio within the network. This user manual contains all essential information for the user to configure the StreamCaster radio as well as how to run an iperf network test.

3. StreamCaster Network

Each StreamCaster MIMO radio that is loaded with StreamScape 5 firmware has a fixed static IP address in the range of 172.16.xx.yy to 172.32.xx.yy network which is on the 255.240.0.0 subnet mask. The radio operates as a network switch; the user equipment does not need to be on the same subnet as the radio during operation. It is possible to setup a secondary IP address and subnet on the radio if the user finds this feature convenient. Setting up a secondary IP address is useful if the user wishes to access the radio's web interface in their network.

4. StreamCaster Hardware Overview

4.1 Hardware Interfaces

SC4400E

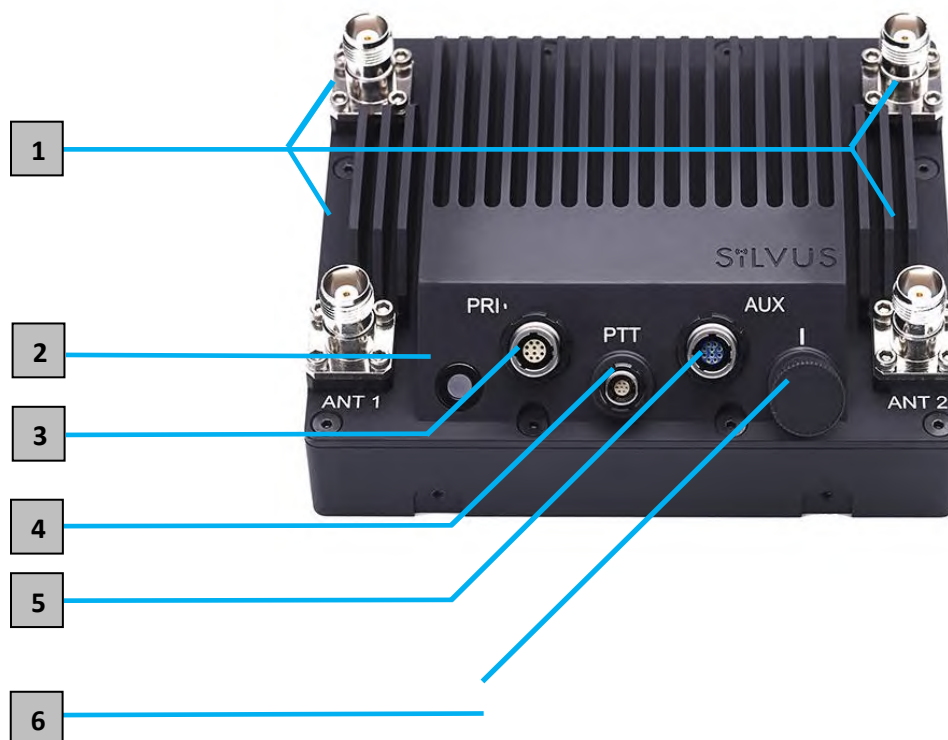


Figure 2 StreamCaster 4400E Ruggedized Enclosure

- 1 RF Channels 1-4 Connectors [TNC Female]
- 2 Bi-Color Status LED
 - Red – Radio is in the process of booting up
 - Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
 - Green – Radio is wirelessly connected to at least one other radio
 - Flashing Red – Spectrum Scan in Progress
 - Flashing Red – Radio has recovered from a bad state.
 - Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.
- 3 Power (9-20V), Ethernet, and Serial Port Connector [ODU GK0YAR-P10UC00-000L]
- 4 Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]
- 5 AUX Connector [ODU GK0YCR-P10UC00-000L]

- 6** Power Switch [15-Position Rotating]

SC4200EP

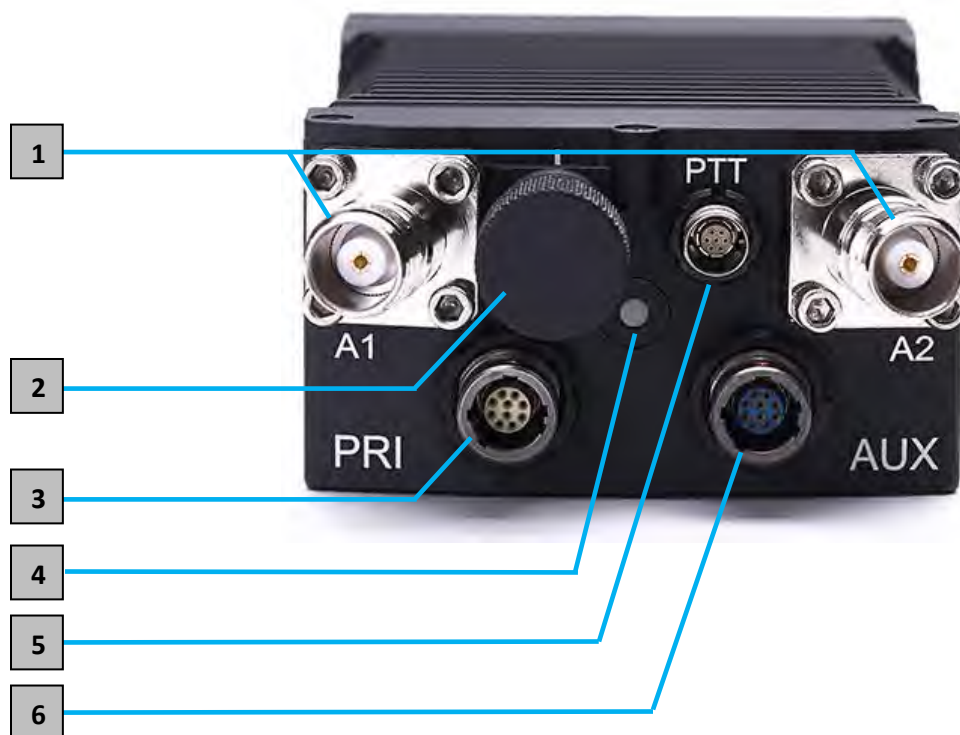


Figure 3 StreamCaster 4200EP Ruggedized Enclosure

- 1** RF Channels 1-2 Connectors [TNC Female]
- 2** Power Switch [15-Position Rotating]
- 3** Power (EB Version Only, 9-20V), Ethernet, and Serial Port Connector [ODU GK0YAR-P10UC00-000L]
- 4** Bi-Color Status LED
 - Red – Radio is in the process of booting up
 - Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
 - Green – Radio is wirelessly connected to at least one other radio
 - Flashing Red – Spectrum Scan in Progress
 - Flashing Red – Radio has recovered from a bad state.
 - Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.
 - Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

- 5** Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]
- 6** AUX Connector [ODU GK0YCR-P10UC00-000L]

SL4200

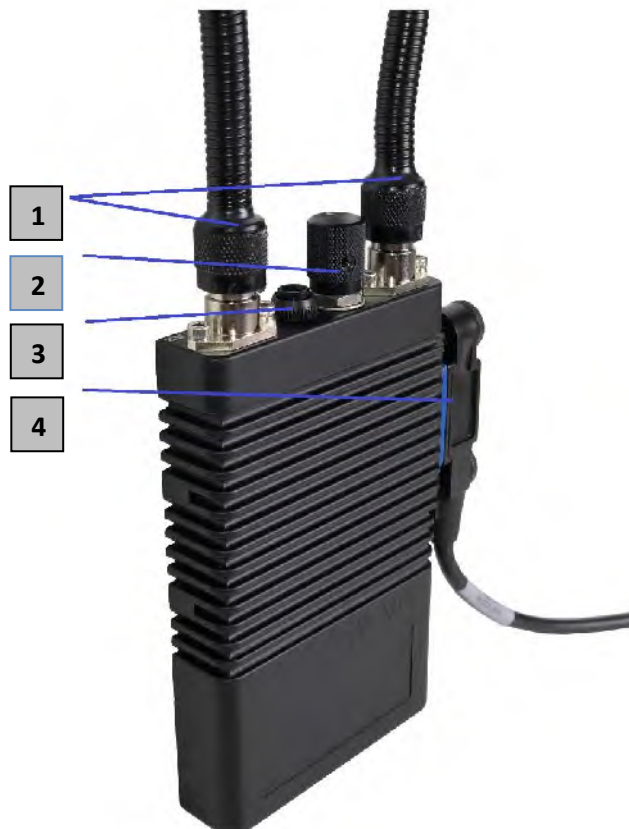
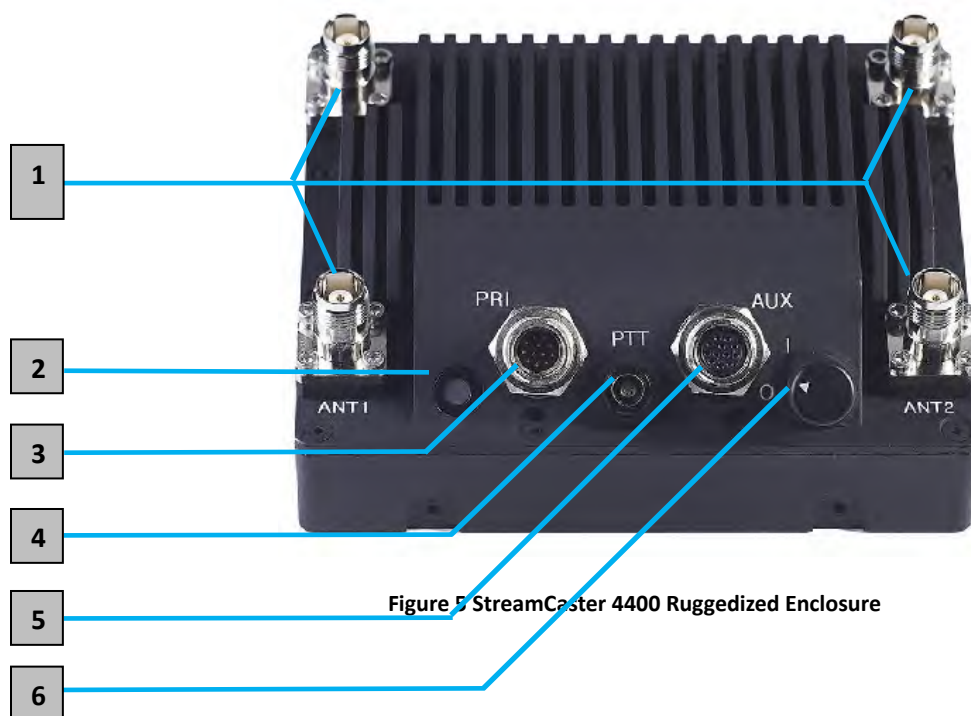


Figure 4 StreamCaster SL4200 Ruggedized Enclosure

- 1** RF Channels 1-2 Connectors [TNC Female]
- 2** Power Switch [2-Position Rotating]
- 3** Bi-Color Status LED
 - Red – Radio is in the process of booting up
 - Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
 - Green – Radio is wirelessly connected to at least one other radio
 - Flashing Red – Spectrum Scan in Progress
 - Flashing Red – Radio has recovered from a bad state and has reverted to factory default settings.
 - Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds.

- 4** 20-pin pogo style connector
- 8-32VDC input / USB-C PD (9VDC)
 - 2x USB 2.0 (Host / OTG)
 - Serial RS-232
 - +5VDC output

SC4400:



- 1** RF Channels 1-4 Connectors [TNC Female]
- 2** Bi-Color Status LED
- Red – Radio is in the process of booting up
 - Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
 - Green – Radio is wirelessly connected to at least one other radio
 - Flashing Red – Spectrum Scan in Progress
 - Flashing Red – Radio has recovered from a bad state.
- 3** Power (9-20V), Ethernet, and Serial Port Connector [Hirose LF10WBRB-12PD]
- 4** Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]
- 5** AUX Connector [Hirose LF10WBRB-12SD]
- 6** Power Switch [2-Position Rotating]

SC4200:

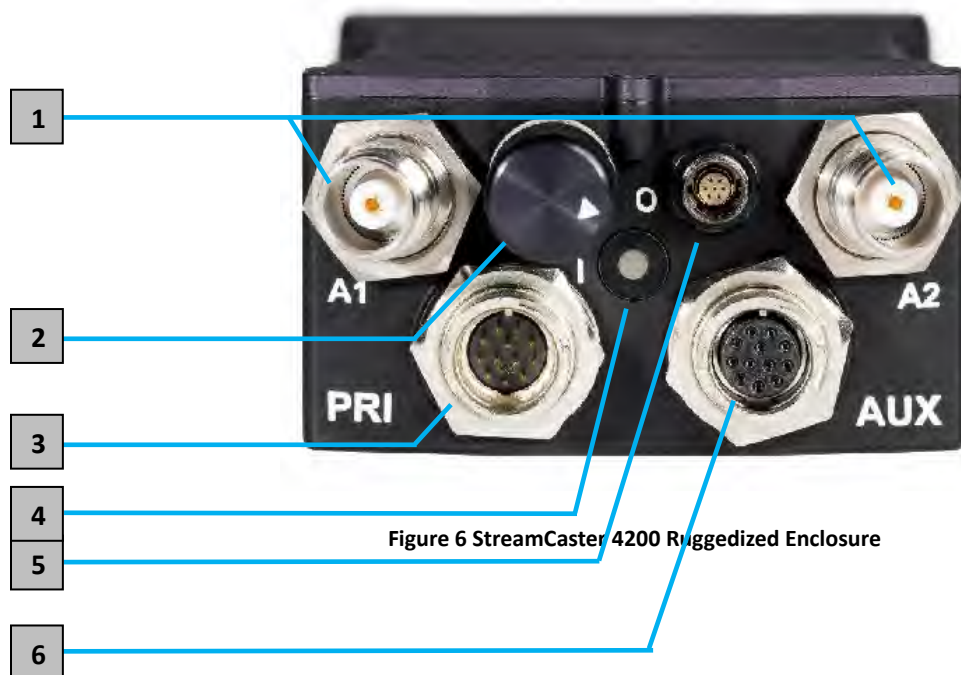


Figure 6 StreamCaster 4200 Ruggedized Enclosure

- 1** RF Channels 1-2 Connectors [TNC Female]
- 2** Power Switch [2-Position Rotating]
- 3** Power (EB Version Only, 9-20V), Ethernet, and Serial Port Connector [Hirose LF10WBRB-12PD]
- 4** Bi-Color Status LED
 - Red – Radio is in the process of booting up
 - Flashing Green – Radio is fully booted but not wirelessly connected to any other radio
 - Green – Radio is wirelessly connected to at least one other radio
 - Flashing Red – Spectrum Scan in Progress
 - Flashing Red – Radio has recovered from a bad state.
- 5** Push-to-Talk (PTT) Connector [ODU GKCWAM-P07UB00-000L]
- 6** AUX Connector [Hirose LF10WBRB-12SD]

4.2 Connector Pinouts

4.2.1 SC4400E Pinouts

SC4400E Primary Power/Ethernet/Serial Connector Pinout			
Enclosure PWR/COMM (GK0YAR-P10UC00-000L)	Signal	Switchcraft Pinout (EN3C2F16X)	Color of wires coming from ODU connector
1	5V OUT (For External GPS Puck)	NC	Pink
2	GND IN	2	Yellow/Blue
3	VCC IN	1	Green/Violet
4	ETH0_MX2N (RX-)	NC	Black
5	ETH0_MX2P (RX+)	NC	Brown
6	ETH0_MX1P (TX+)	NC	Red
7	RS232_RXD	NC	Gray
8	RS232_TXD	NC	White
9	GND	NC	Light Green
10	ETH0_MX1N (TX-)	NC	Orange

Table 2 SC4400E Primary Power/Ethernet/Serial Connector Pinout

*color scheme is valid for cables built after 6/1/19

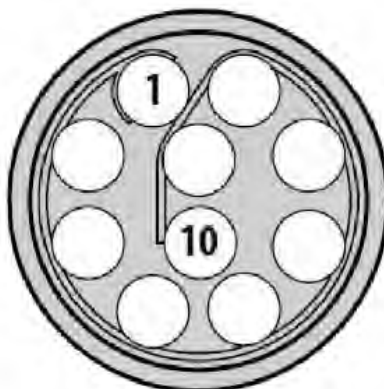


Figure 7 SC4400E Primary Power/Serial/Ethernet Pinout Diagram (Radio Side)

SC4400E RS-232 Pinout		
RS-232 (DB9)	Signal	Switchcraft Pinout (EN3C6FX)
3	TxD	2
2	RxD	1
NC	NC	4
NC	5V OUT	6
NC	NC	5
5	Ground	3

Table 3 SC4400E Serial and GPS Pinout

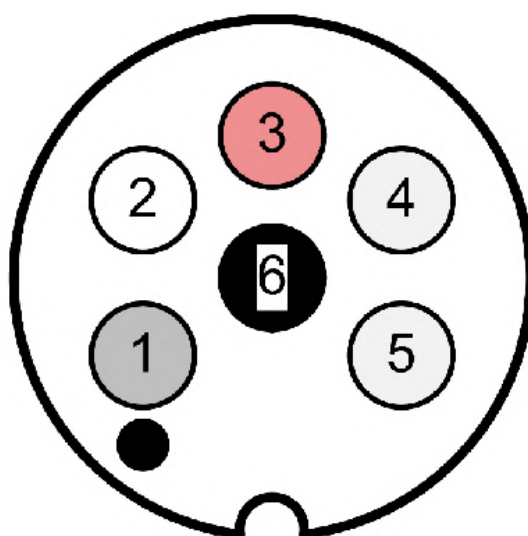


Figure 8 Switchcraft connector on Primary/Power cable

SC4400E AUX Connector Pinout		
Enclosure AUX (GK0YCR-P10UC00-000L)	Signal	Color of wires coming from ODU connector
1	USB GND	Yellow/Blue
2	USB1_D-	Red
3	USB1_VBUS	Green
4	USB0_VBUS	Violet
5	GPIO1 (BDA control)	Pink
6	USB0_D+	Black
7	USB0_D-	Brown
8	GND	Light Green
9	USB1_ID	Gray
10	USB1_D+	Orange

Table 4 SC4400E USB/GPIO Connector Pinout

*color scheme is valid for cables built after 6/1/19

**{USB1 is USB 2.0 OTG, USB0 is USB 2.0 Host Mode Only}

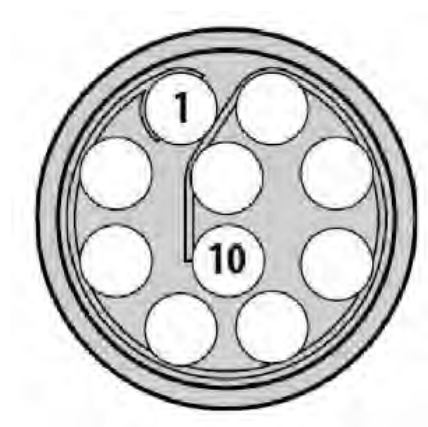


Figure 9 SC4400E AUX Pinout Diagram (Radio Side)

SC4400E PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	Signal
1	5V_OUT (Up to 400mA)
2	COR/DUAL_PTT
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 5 SC4400E PTT Connector Pinout

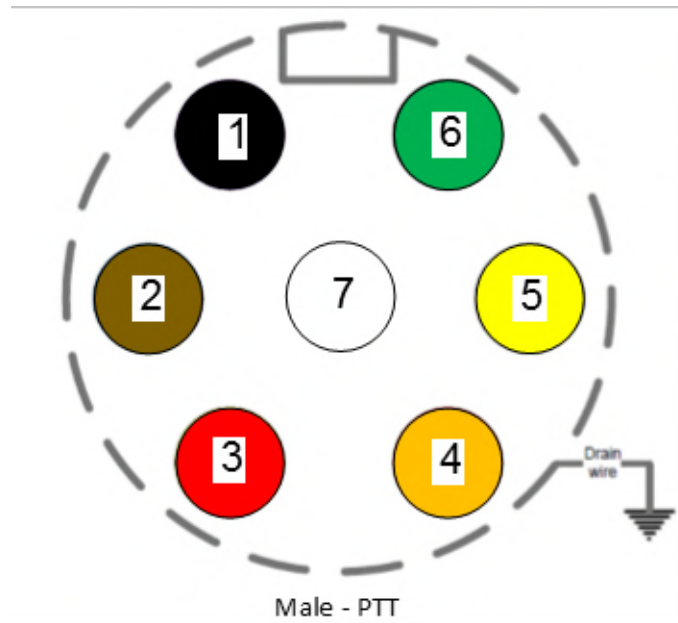


Figure 10 SC4400E PTT Pinout Diagram (Cable Side)

4.2.2 SC4200EP Pinouts

SC4200EP Primary Power/Ethernet/Serial Connector Pinout			
Enclosure PWR/COMM (GK0YAR-P10UC00-000L)	Signal	Switchcraft Pinout (EN3C2F16X)	Color of wires coming from ODU connector
1	5V OUT (For External GPS Puck)	NC	Pink
2	GND IN	2	Yellow/Blue
3	VCC IN	1	Green/Violet
4	ETH0_MX2N (RX-)	NC	Black
5	ETH0_MX2P (RX+)	NC	Brown
6	ETH0_MX1P (TX+)	NC	Red
7	RS232_RXD	NC	Gray
8	RS232_TXD	NC	White
9	GND	NC	Light Green
10	ETH0_MX1N (TX-)	NC	Orange

Table 6 SC4200EP Primary Power/Ethernet/Serial Connector Pinout

*color scheme is valid for cables built after 6/1/19

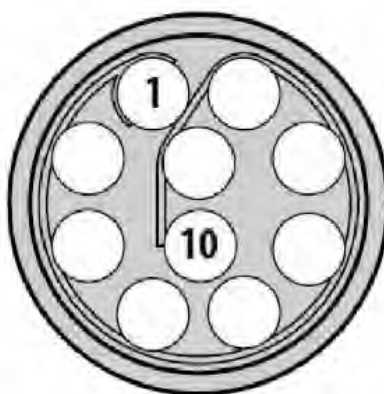


Figure 11 SC4200EP Primary Power/Serial/Ethernet Pinout Diagram (Radio Side)

SC4200EP RS-232 Pinout		
RS-232 (DB9)	Signal	Switchcraft Pinout (EN3C6FX)
3	TxD	2
2	RxD	1
NC	NC	4
NC	5V OUT	6
NC	NC	5
5	Ground	3

Table 7 SC4200EP Serial and GPS Pinout

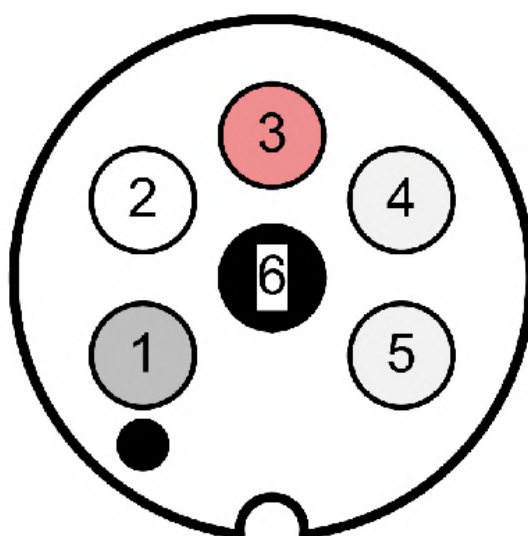


Figure 12 Switchcraft connector on Primary/Power cable

SC4200EP AUX Connector Pinout		
Enclosure AUX (GK0YCR-P10UC00-000L)	Signal	Color of wires coming from ODU connector
1	USB GND	Yellow/Blue
2	USB1_D-	Red
3	USB1_VBUS	Green
4	USB0_VBUS	Violet
5	GPIO1 (BDA control)	Pink
6	USB0_D+	Black
7	USB0_D-	Brown
8	GND	Light Green
9	USB1_ID	Gray
10	USB1_D+	Orange

Table 8 SC4200EP AUX USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB0 is USB 2.0 Host Mode Only)

*color scheme is valid for cables built after 6/1/19

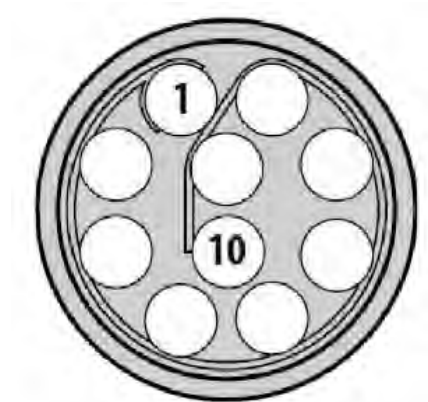


Figure 13 SC4200EP AUX Pinout Diagram (Radio Side)

SC4200EP PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	Signal
1	5V_OUT (Up to 400mA)
2	COR/DUAL_PTT
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 9 SC4200EP PTT Connector Pinout

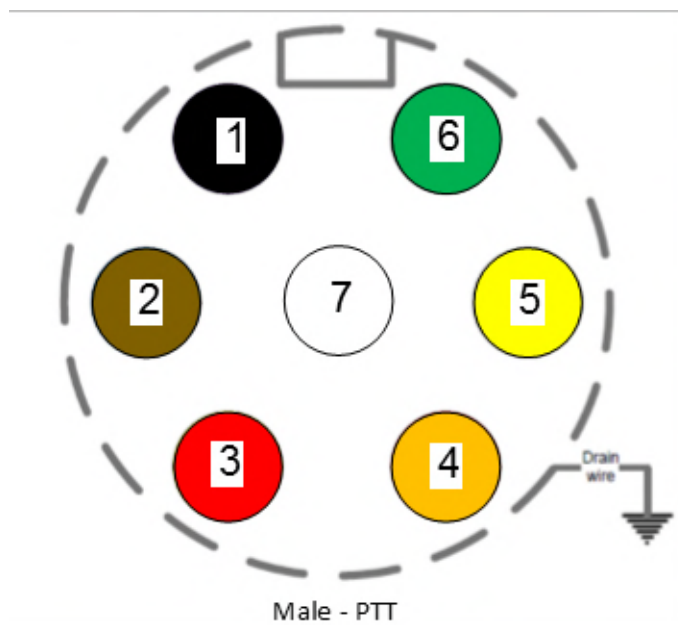


Figure 14 SC4200EP PTT Pinout Diagram (Cable Side)

4.2.3 SL4200 Pinouts

SL4200 POGO Connector Pinout	
Pin	Signal
1	Vbat 8-32 VDC input *
2	RS232 TXD
3	RS232 RXD
4	GPIO1
5	CC2 (PD mode-config)
6	CC1 (CC) (PD mode-config)
7	USB PD VBUSS (+9 VDC) *
8	USB0 Vbus (USB 0 always in host mode)
9	USB0 D+
10	USB0 D-
11	USB0_GND
12	N/C
13	N/C
14	GND *
15	USB1_GND
16	USB1 D+
17	USB1 D-
18	USB1 ID (Gnd for Host Mode; Float for Client mode)
19	N/C
20	VCC_5V0 OUT * (500 ma max (GPS Puck); connect to USB1 Vbus in host mode (e.g, USB-A pin 1))

Table 10 SL4200 POGO Connector Pinout

*Note: Pins 1,7,14,20 rated for 3A, 36V

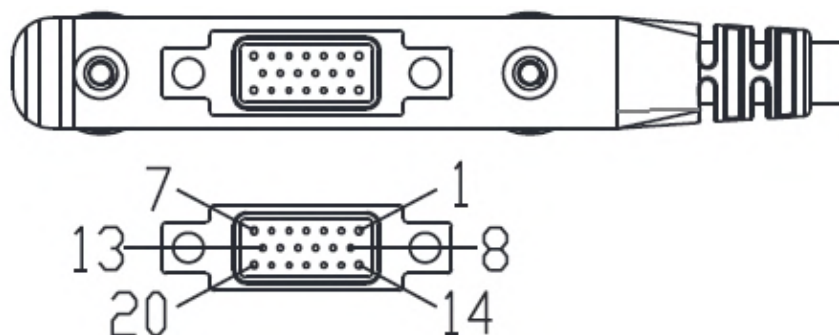


Figure 15 SL4200 20 pin POGO connector

Supported USB 1 Modes	Wiring instruction
USB-PD and USB 2.0 from the same source	USB1_ID floating and USB1 in client mode. Connect VCC_5V to USB1_VBUS on the pogo plug side or in the cable
USB 1 as client but not using USB-PD or PD comes from a different source	USB1_ID floating and USB1 in client mode, standard USB 2.0 wiring
USB 1 as host but not using USB-PD or PD comes from a different source	USB1_ID grounded and USB1 in host mode, standard USB 2.0 wiring

Table 11 SL4200 supported USB modes

4.2.4 SC4400 Pinouts

SC4400 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	Signal	Switchcraft Pinout (EN3C2F16X)
1	5V OUT (For External GPS Puck)	NC
2	GND IN	2
3	GND IN	2
4	VCC IN	1
5	VCC IN	1
6	100-Base T ETH0 M2N (RX-)	NC
7	100-Base T ETH0 M2P (RX+)	NC
8	100-Base T ETH0 M1P (TX+)	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N (TX-)	NC

Table 12 SC4400 Primary Power/Ethernet/Serial Connector Pinout

SC4400 RS-232 and PS/2 (GPS) Pinout			
RS-232	PS/2 (GPS)	Signal	Switchcraft Pinout (EN3C6FX)
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	5V OUT	6
NC	NC	NC	5
5	1	Ground	3

Table 13 SC4400 Serial and GPS Pinout

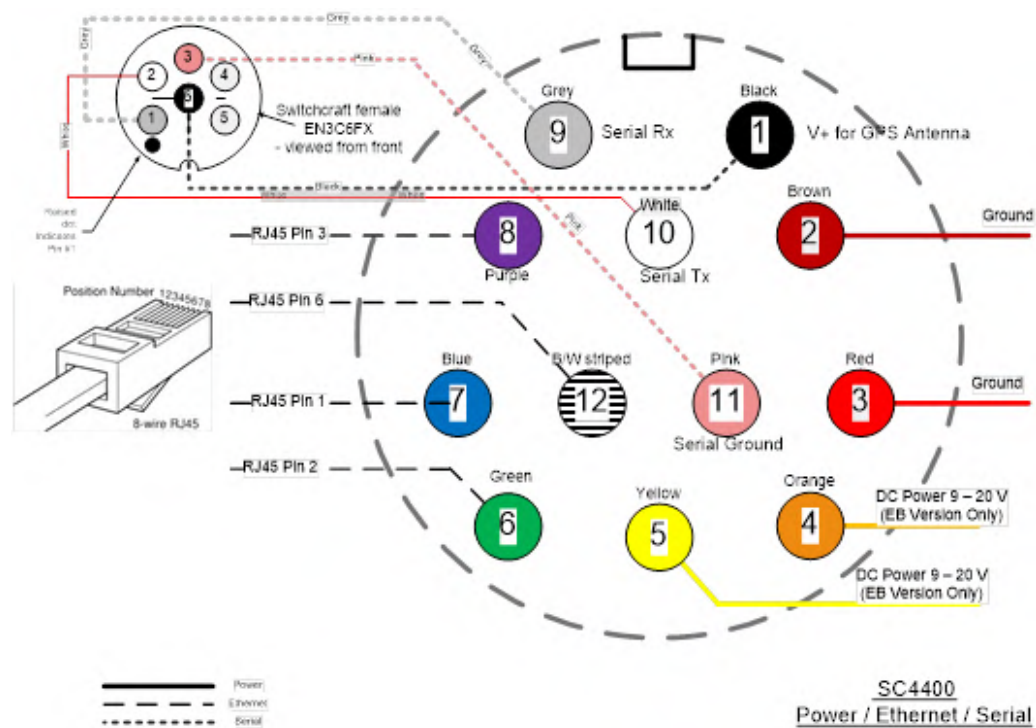


Figure 16 SC4400 Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)

SC4400 AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	Signal
1	USB1_GND
2	USB1_D-
3	USB1_VBUS
4	USB0_VBUS
5	GPIO1 (PA Enable 3.3V)
6	USB0_D+
7	USB0_D-
8	RESERVED (Do Not Connect)
9	GND
10	USB1_Sense
11	USB1_D+
12	USB0_GND

Table 14 SC4400 AUX USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB0 is USB 2.0 Host Mode Only)

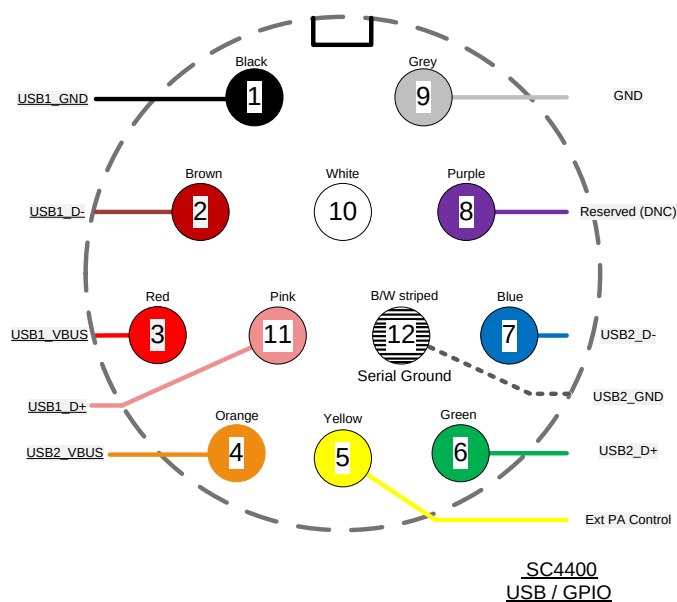


Figure 17 SC4400 AUX Pinout Diagram (Cable Side)

SC4400 PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	Signal
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 15 SC4400 PTT Connector Pinout

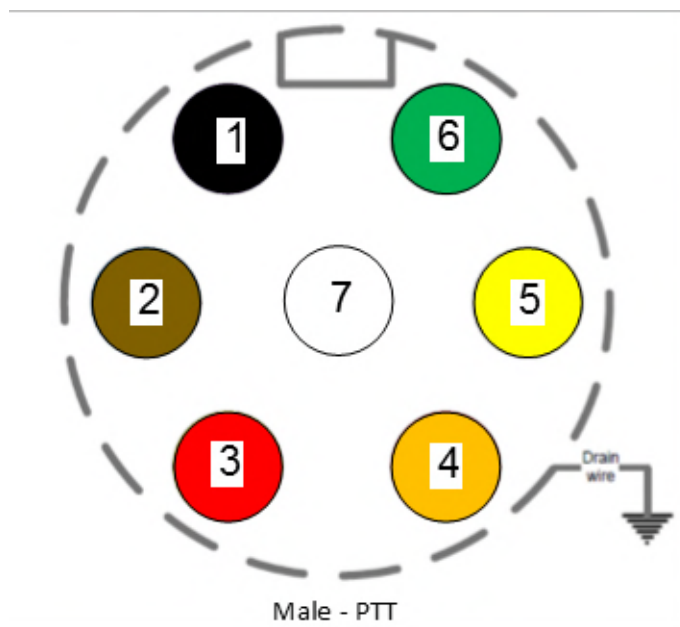


Figure 18 SC4400 PTT Pinout Diagram (Cable Side)

4.2.5 SC4200 Pinouts

SC4200 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	Signal	Switchcraft Pinout (EN3C2F16X)
1	5V OUT (For External GPS Puck)	NC
2	GND IN (External Power Option Only)	2
3	GND IN (External Power Option Only)	2
4	VCC IN (External Power Option Only)	1
5	VCC IN (External Power Option Only)	1
6	100-Base T ETH0 M2N (RX-)	NC
7	100-Base T ETH0 M2P (RX+)	NC
8	100-Base T ETH0 M1P (TX+)	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N (TX-)	NC

Table 16 SC4200 Primary Power/Ethernet/Serial Connector Pinout

SC4200 RS-232 and PS/2 (GPS) Pinout			
RS-232	PS/2 (GPS)	Signal	Switchcraft Pinout (EN3C6FX)
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	5V OUT	6
NC	NC	NC	5
5	1	Ground	3

Table 17 SC4200 Serial and GPS Pinout

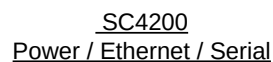


Figure 19 SC4200 Primary Power/Serial/Ethernet Pinout Diagram (Cable Side)

SC4200 AUX Connector Pinout	
Enclosure AUX (LF10WBRB-12SD)	Signal
1	USB1_GND
2	USB1_D-
3	USB1_VBUS
4	USB0_VBUS
5	GPIO1 (PA Enable 3.3V)
6	USB0_D+
7	USB0_D-
8	RESERVED (Do Not Connect)
9	GND
10	USB1_Sense
11	USB1_D+
12	USB0_GND

Table 18 SC4200 AUX USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB0 is USB 2.0 Host Mode Only)

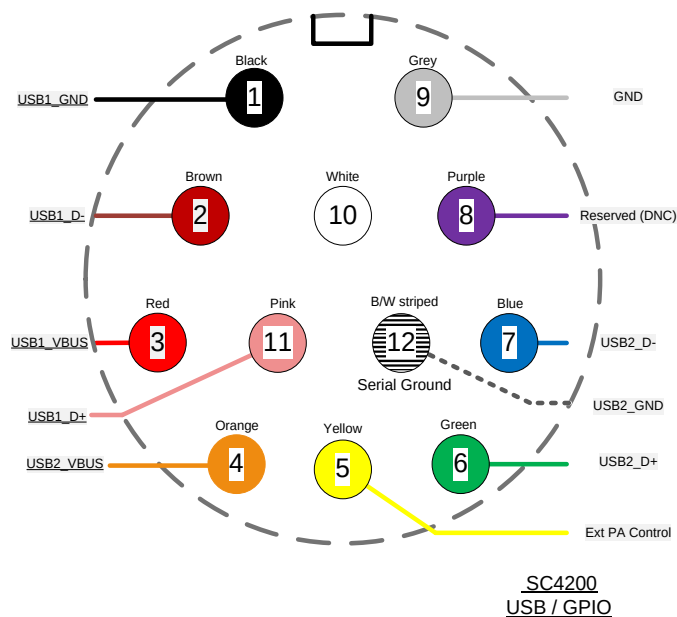


Figure 20 SC4200 AUX Pinout Diagram (Cable Side)

SC4200 PTT Connector	
Enclosure PTT Connector (ODU GKCWAM-P07UB00-000L)	Signal
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN
7	RESERVED (Do Not Connect)

Table 19 SC4200 PTT Connector Pinout

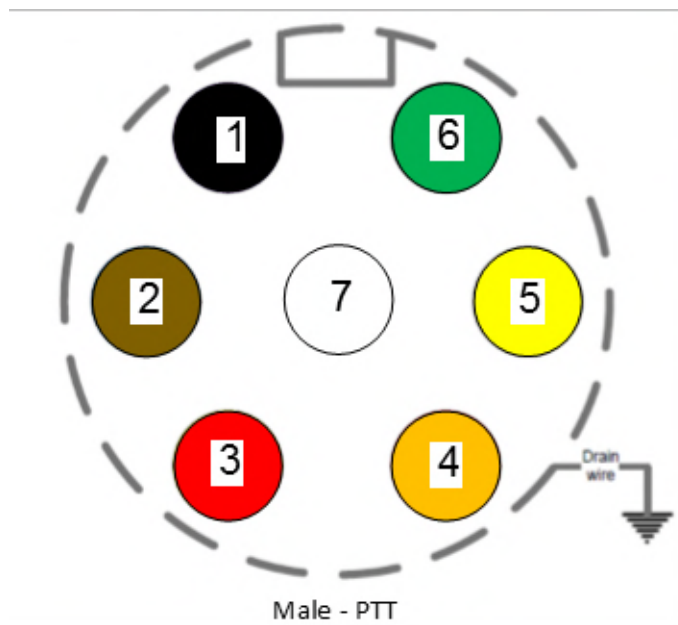


Figure 21 SC4200 PTT Pinout Diagram (Cable Side)

4.3 Mechanical and Operating Specifications

SC4400E:

Mechanical

- Ambient Temp. -40° to +65° C
- IP Rating IP-68 (Dust / Submersible in Water to 20m)**
- Dimensions 5.25" x 4.5" x 1.8" (Excluding Connectors)
- Weight 2.5 lbs. (40 oz./1.13 kg.)
- Color Black Anodized
- Mounting 4-Hole Mounting Pattern

Power

- Voltage/Current 9 – 20 VDC (± 5%), 5A
- Power Consumption
 - 8 W – 100 W @ 20 W TX Power
 - 8 W – 43 W @ 8 W TX Power
 - 8 W – 24 W @ 1 W TX Power
- Optional External Power Supply (for indoor only) 12VDC, 5A

Interfaces

- RF 4 x TNC(f)
[N(f) Optional]
- Primary Ruggedized Push/Pull Connector
[1 x Ethernet, 1 x RS232, DC Input]
- Auxiliary Ruggedized Push/Pull Connector
[1 x USB 2.0 Host, 1 x USB 2.0 OTG]
- PTT (Push-to-Talk) Ruggedized Break away Connector (Front Panel)
- Status Indicator Tri-Color LED
- Control Interface Multi-Position Switch
- 13 presets plus zeroize crypto
- Web-Based StreamScape™ Network Manager

Mechanical – OEM

- Dimensions 4.29" x 3.3" x 0.82"
- Weight 9.1 oz (w/ Outer Shields)
- RF Connectors SMP (m)

(**) Must have all connectors mated with IP68+ cables/antennas

SC4200EP:

Mechanical

- Ambient Temp. -40° to +65° C
- IP Rating IP-68 (Dust / Submersible in Water up to 20m)**
- Dimensions 4.00" x 2.63" x 1.51" (Excluding Connectors)
- Weight 0.94 lbs. (15 oz./0.43 kg.)
- Color Black Anodized
- Mounting 4-Hole Mounting Pattern (Through-Hole)

Power

- Voltage/Current 9 – 20 VDC (± 5%), 5A
- Power Consumption 4.8 W – 48 W @ 10W TX Power
4.8 W – 24 W @ 4W TX Power
4.8 W – 16 W @ 1W TX Power
- Battery Life Up to 12 Hours (6.8Ah MBITR Battery)
- Power Options Twist-Lock Battery or Front Panel
- Optional External Power Supply (for indoor only) 12VDC, 5A

Interfaces

- RF TNC(f) (2 Each)
- Primary Ruggedized Push/Pull Connector (Front Panel)
1 x Ethernet, 1x RS232, DC Input (Optional)
- Auxiliary Ruggedized Push/Pull Connector (Front Panel)
1 x USB 2.0 Host, 1 x USB 2.0 OTG
- PTT (Push-to-Talk) Ruggedized Breakaway Connector (Front Panel)
- Status Indicator Tri-Color LED
- Management Interface Multi-Position Switch
13 presets plus zeroize crypto
Web-Based StreamScape™ Network Manager

Mechanical – OEM

- Dimensions 3.61" x 2.15" x 0.71"
- Weight 4.1 oz (w/ Outer Shields)
- RF Connectors SMP (m)

(**) Must have all connectors mated with IP68+ cables/antennas

SL4200:

Mechanical

- Ambient Temp. -40° to +65° C
- IP Rating IP-67 (Dust / Submersible in Water up to 1m)**
- Dimensions 119 x 74 x 18 mm (Excluding Connectors)
- Weight 295 grams
- Color Black Anodized Aluminum

Power

- Voltage/Current 8-32VDC input / USB-C PD (9VDC)
- Power Consumption 4.8 W – 17 W @ 1 W TX Power

Interfaces

- RF TNC(f) (2 Each)
- Power/Data 20-pin “POGO” style connector
8-32VDC input / USB-C PD (9VDC)
2x USB 2.0 (Host / OTG)
Serial RS-232
+5VDC output
- Status Indicator Tri-Color LED
- Management Interface On/Off Switch

Web-Based StreamScape™ Network Manager

Mechanical – OEM

- Dimensions 0.45” x 2.15” (ears: 2.74”)x 3.83”
- Weight 105 g (Module)
45 g (PCBA only)
- RF Connectors SMA

() Must have all connectors mated with IP67+ cables/antennas**

SC4400:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-67 (Dust / Immersion in Water up to 1m)**
- **Dimensions** 5.25" x 4.5" x 1.8" (Excluding Connectors)
- **Weight** 2.5 lbs. (40 oz./1.13 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 8 W – 43 W @ 8 W TX Power
8 W – 24 W @ 1 W TX Power
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** 4 x TNC(f)
[N(f) Optional]
- **Primary** Ruggedized Circular Connector
[1 x Ethernet, 1 x RS232, DC Input]
- **Auxiliary** Ruggedized Circular Connector
[1 x USB 2.0 Host, 1 x USB 2.0 OTG]
- **PTT (Push-to-Talk)** Ruggedized Break away Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Management Interface** Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 4.29" x 3.3" x 0.82"
- **Weight** 9.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

() Must have all connectors mated with IP67+ cables/antennas**

SC4200:

Mechanical

- **Ambient Temp.** -40° to +65° C
- **IP Rating** IP-67 (Dust / Immersion in Water up to 1m)**
- **Dimensions** 4.00" x 2.63" x 1.51" (Excluding Connectors)
- **Weight** 0.94 lbs. (15 oz./0.43 kg.)
- **Color** Black Anodized
- **Mounting** 4-Hole Mounting Pattern (Through-Hole)

Power

- **Voltage/Current** 9 – 20 VDC (± 5%), 5A
- **Power Consumption** 4.8 W – 24 W @ 4W TX Power
4.8 W – 16 W @ 1W TX Power
- **Battery Life** Up to 12 Hours (6.8Ah MBITR Battery)
- **Power Options** Twist-Lock Battery or Front Panel
- **Optional External Power Supply (for indoor only)** 12VDC, 5A

Interfaces

- **RF** TNC(f) (2 Each)
- **Primary** Ruggedized Circular Connector (Front Panel)
1 x Ethernet, 1x RS232, DC Input (Optional)
- **Auxiliary** Ruggedized Circular Connector (Front Panel)
1 x USB 2.0 Host, 1 x USB 2.0 OTG
- **PTT (Push-to-Talk)** Ruggedized Break away Connector (Front Panel)
- **Status Indicator** Tri-Color LED
- **Management Interface** Web-Based StreamScape™ Network Manager

Mechanical – OEM

- **Dimensions** 3.61" x 2.15" x 0.71"
- **Weight** 4.1 oz (w/ Outer Shields)
- **RF Connectors** SMP (m)

() Must have all connectors mated with IP67+ cables/antennas**

4.3.1 SC4400E Enclosure Mechanical Drawing

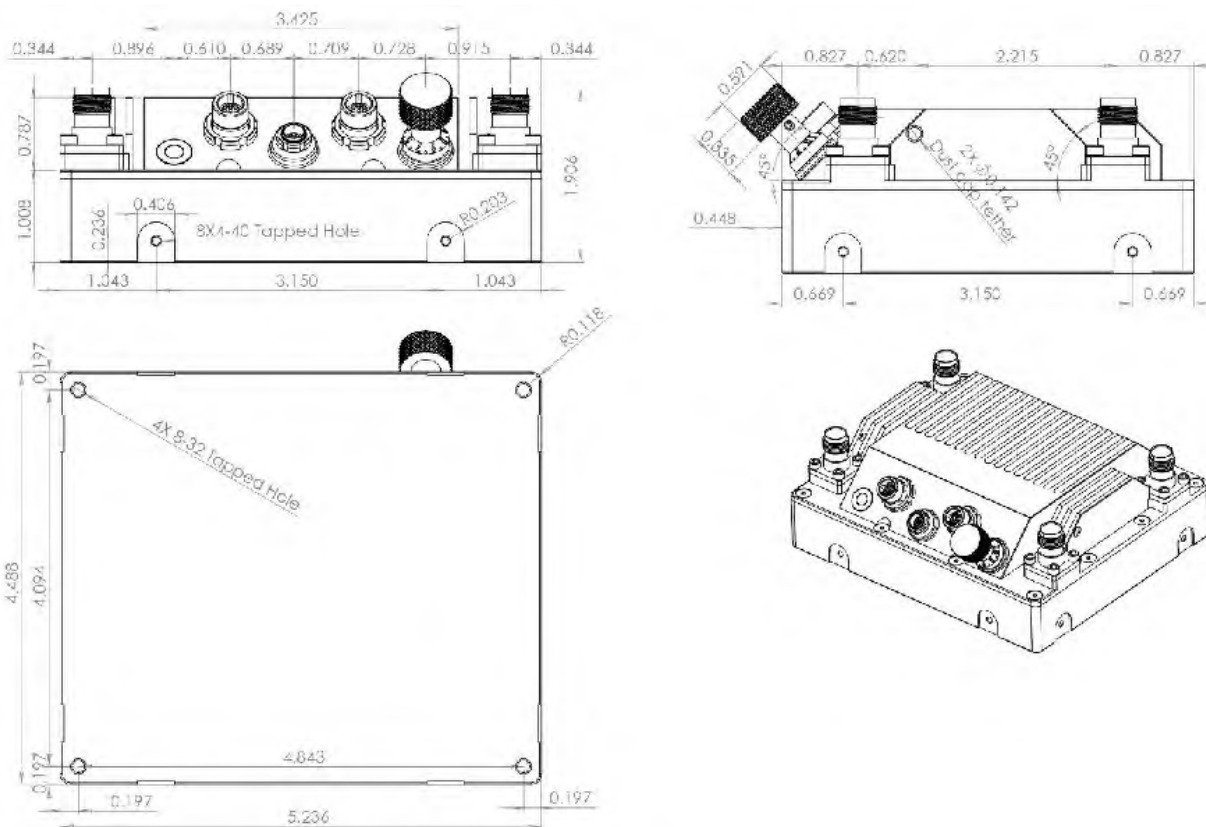


Figure 22 SC4400E Mechanical Drawing (top) and Mounting Pattern (bottom)

*Tapped mounting holes are available on bottom (8-32) and on the sides (4-40) of radio as indicated in

4.3.2 SC4200EP Enclosure Mechanical Drawing

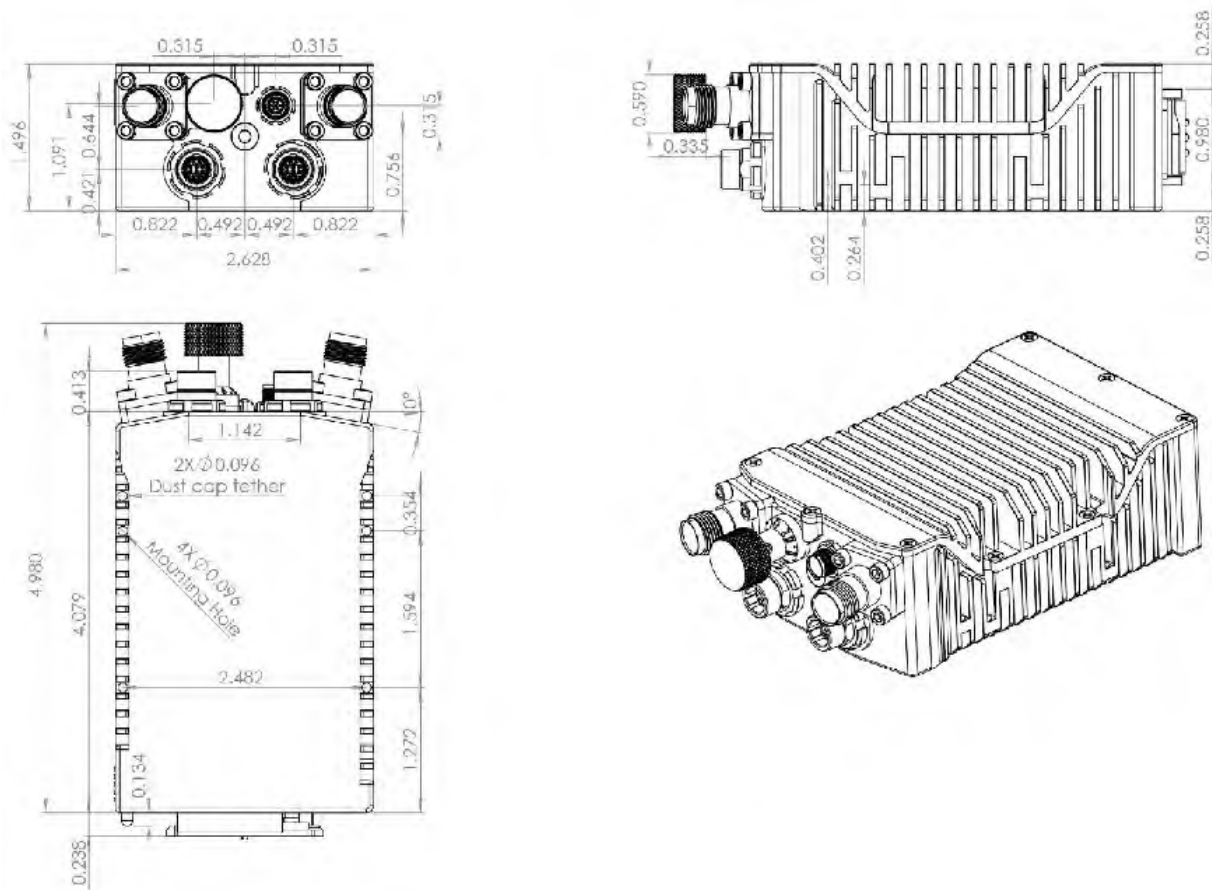


Figure 23 SC4200EP Mechanical Drawing (top) and Mounting Pattern (bottom)

*mounting holes utilize <https://www.mcmaster.com/96006a234> or equivalent. Hex head (5/64" drive), 2-56 thread, head diameter 9/64"; stainless steel; 3/8" length or longer

4.3.3 SL4200 Enclosure Mechanical Drawing

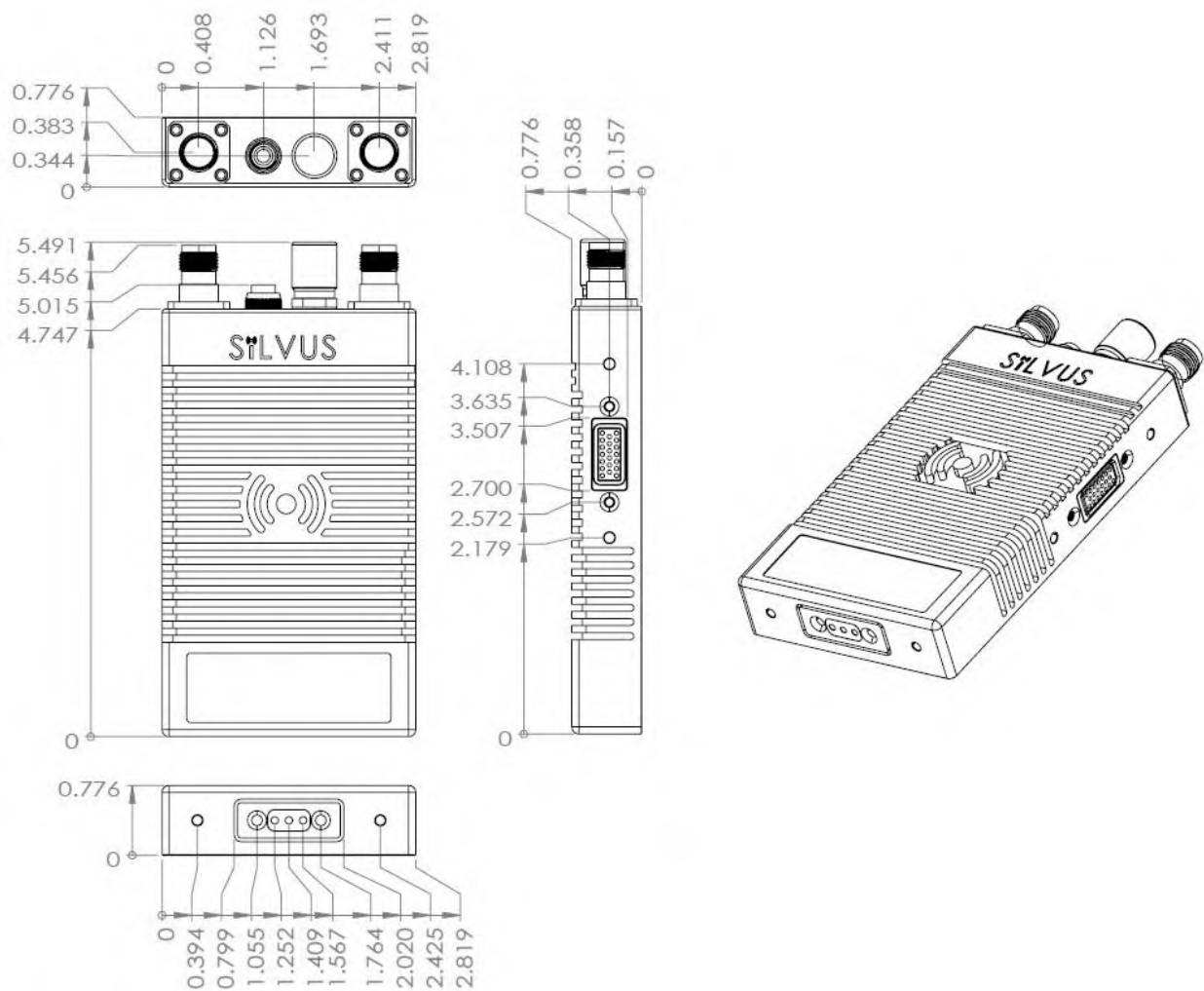
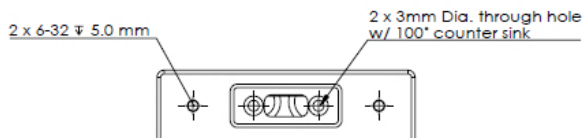


Figure 24 SL4200 Mechanical Drawing

* Tapped mounting holes are available on bottom 6-32 screw, 0.196inch (5.0mm) depth.



4.3.4 SC4400 Enclosure Mechanical Drawing

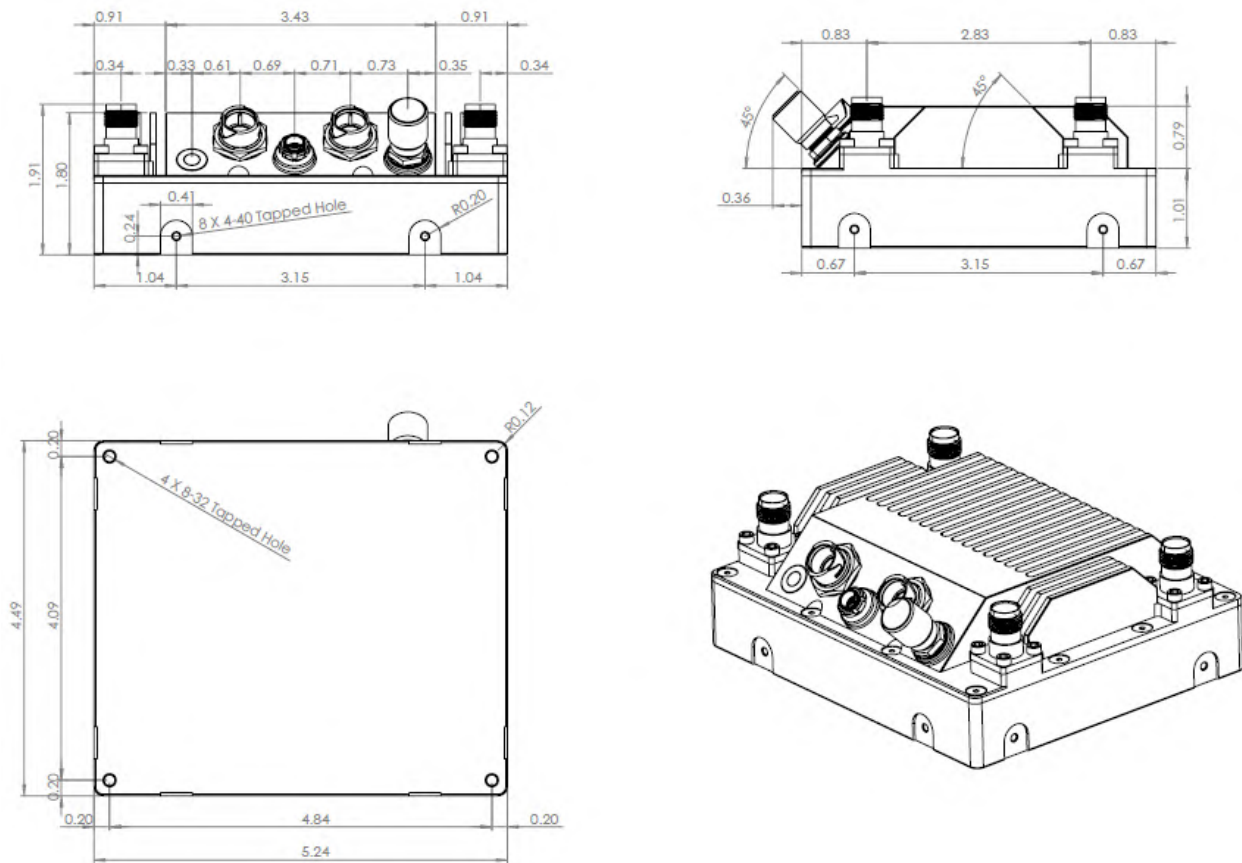


Figure 25 SC4400 Mechanical Drawing (top) and Mounting Pattern (bottom)

*Tapped mounting holes are available on bottom (8-32) and on the sides (4-40) of radio as indicated in **Figure 25 SC4400 Mechanical Drawing (top) and Mounting Pattern (bottom)**.

4.3.5 SC4200 Enclosure Mechanical Drawing

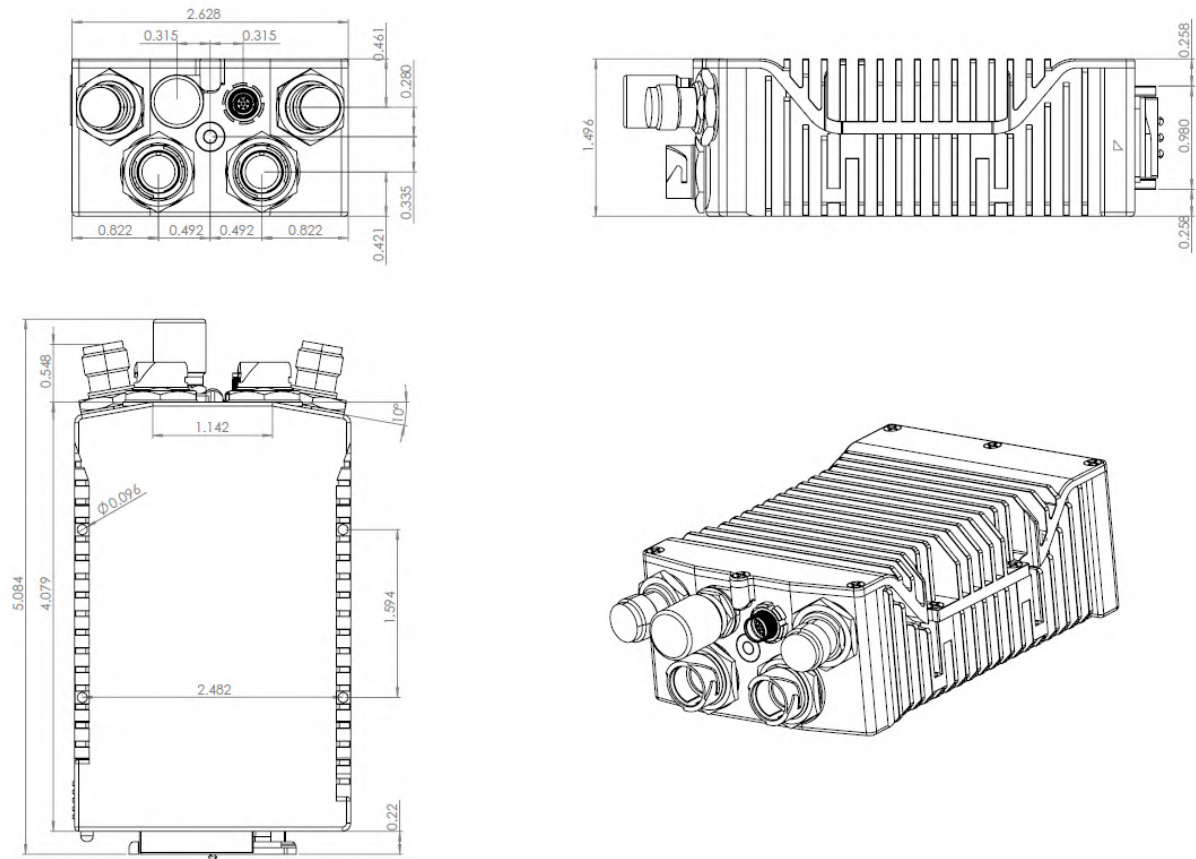


Figure 26 SC4200 Mechanical Drawing (top) and Mounting Pattern (bottom)

*mounting holes utilize <https://www.mcmaster.com/96006a234> or equivalent. Hex head (5/64" drive), 2-56 thread, head diameter 9/64"; stainless steel; 3/8" length or longer

4.4 SC4400E Specifications

General

- **Waveform** Mobile Networked MIMO (MN-MIMO™)
- **Modulation** BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** DES Standard, AES/GCM 128/256 Optional (FIPS 140-2 Level 2 certified), Suite B
- **Tuning Step Size** 1kHz
- **Data Rates** Up to 100 Mbps (Adaptive)
- **Error Correction** 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beamforming
- **No. of Spatial Streams** 1-2
- **No. of Antennas** 4

Performance

- **Latency** 7ms Average (20MHz BW)
- **Sensitivity** -102 dBm @ 5MHz BW
- **Frequency Bands** Bands from 400MHz to 6GHz Available
Dual Band Optional
- **Onboard Storage** 64 GB*

Frequency Band Options

<u>Band (Freq. Code)</u>	<u>Frequency Range</u>	<u>Band (Freq. Code)</u>	<u>Frequency Range</u>
UHF (042)	400-450	Low C Band (455)	4400-4700
ISM 900 (091)	902-928	Federal C-1 (467)	4400-4940
L Band (137)	1350-1390	High C Band (485)	4700-5000
Upper L (181)	1780-1850	5.2GHz ISM (520)	5150-5250
Broadcast B (206)	2025-2110	5.8GHz ISM (580)	5725-5875
Federal S (225)	2200-2300		
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

4.5 SC4200EP Specifications

General

- **Waveform** Mobile Networked MIMO (MN-MIMO™)
- **Modulation** BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** DES Standard, AES/GCM 128/256 Optional (FIPS 140-2 Level 2 certified), Suite B
- **Tuning Step Size** 1kHz
- **Data Rates** Up to 100 Mbps (Adaptive)
- **Error Correction** 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beamforming
- **No. of Spatial Streams** 1-2
- **No. of Antennas** 2

Performance

- **Latency** 7ms Average
- **Sensitivity** -99 dBm @ 5MHz BW
- **Frequency Bands** Bands from 400MHz to 6GHz Available
- **Onboard Storage** Dual Band Optional 64 GB*

Frequency Band Options

<u>Band (Freq. Code)</u>	<u>Frequency Range</u>	<u>Band (Freq. Code)</u>	<u>Frequency Range</u>
UHF (042)	400-450	Low C Band (455)	4400-4700
ISM 900 (091)	902-928	Federal C-1 (467)	4400-4940
L Band (137)	1350-1390	High C Band (485)	4700-5000
Upper L (181)	1780-1850	5.2GHz ISM (520)	5150-5250
Broadcast B (206)	2025-2110	5.8GHz ISM (580)	5725-5875
Federal S (225)	2200-2300		
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

SC4400E/SC4200EP PTT

Supported Mic Type

Moving Coil or Condenser
(Software Configurable)

- **Max Avg. Speaker Output Power** 2.65W with 4 Ohm Speaker Impedance
- **MIC Bias** 2.15V or 3V (Software Configurable); Applied via a 2K Ohm Resistor
- **Recommended Speaker Impedance (Handset)** 4 Ohm to 16 Ohm
- **Recommended Speaker Impedance (Headset)** 75 Ohm to 300 Ohm
- **Recommended MIC impedance** <= 1K Ohm
- **Peak Speaker Output Voltage** 5.5V
- **Absolute MIC Input Voltage** 3.3V

4.6 SL4200 Specifications

General

- **Waveform** Mobile Networked MIMO (MN-MIMO™)
- **Modulation** BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** 1.25, 2.5 or 5 MHz
- **Encryption** DES Standard, AES/GCM 128/256 Optional (FIPS 140-2)
- **Tuning Step Size** 1kHz
- **Data Rates** Up to 20 Mbps (Adaptive)
- **Error Correction** 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** Spatial Multiplexing, Space-Time Coding,
TX Eigen Beamforming, RX Eigen Beamforming
- **No. of Spatial Streams** 1-2
- **No. of Antennas** 2

Performance

- **Latency** 28ms Average (5MHz BW)
- **Sensitivity** -104 dBm @ 1.25MHz BW
- **Frequency Bands** 2.2 - 2.5 GHz
4.4-4.94 GHz
(additional bands in development)

4.7 SC4400 Specifications

General

- **Waveform** Mobile Networked MIMO (MN-MIMO™)
- **Modulation** BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** DES Standard, AES/GCM 128/256 Optional (FIPS 140-2 Level 2 certified), Suite B
- **Tuning Step Size** 1kHz
- **Data Rates** Up to 100 Mbps (Adaptive)
- **Error Correction** 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beamforming
- **No. of Spatial Streams** 1-2
- **No. of Antennas** 4

Performance

- **Latency** 7ms Average (20MHz BW)
- **Sensitivity** -102 dBm @ 5MHz BW
- **Frequency Bands** Bands from 400MHz to 6GHz Available
Dual Band Optional
- **Onboard Storage** 64 GB*

Frequency Band Options

<u>Band (Freq. Code)</u>	<u>Frequency Range</u>	<u>Band (Freq. Code)</u>	<u>Frequency Range</u>
UHF (042)	400-450	Low C Band (455)	4400-4700
ISM 900 (091)	902-928	Federal C-1 (467)	4400-4940
L Band (137)	1350-1390	Federal C-2 (469)*	4400-4990
Upper L (181)	1780-1850	High C Band (485)	4700-5000
Broadcast B (206)	2025-2110	5.2GHz ISM (520)	5150-5250
Federal S (225)	2200-2300	5.8GHz ISM (580)	5725-5875
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

4.8 SC4200 Specifications

General

- **Waveform** Mobile Networked MIMO (MN-MIMO™)
- **Modulation** BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** 5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption** DES Standard, AES/GCM 128/256 Optional (FIPS 140-2 Level 2 certified), Suite B
- **Tuning Step Size** 1KHz
- **Data Rates** Up to 100 Mbps (Adaptive)
- **Error Correction** 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** Spatial Multiplexing, Space-Time Coding, TX Eigen Beamforming, RX Eigen Beamforming
- **No. of Spatial Streams** 1-2
- **No. of Antennas** 2

Performance

- **Latency** 7ms Average
- **Sensitivity** -99 dBm @ 5MHz BW
- **Frequency Bands** Bands from 400MHz to 6GHz Available
- **Onboard Storage** Dual Band Optional 64 GB*

Frequency Band Options

<u>Band (Freq. Code)</u>	<u>Frequency Range</u>	<u>Band (Freq. Code)</u>	<u>Frequency Range</u>
UHF (042)	400-450	Low C Band (455)	4400-4700
ISM 900 (091)	902-928	Federal C-1 (467)	4400-4940
L Band (137)	1350-1390	Federal C-2 (469)*	4400-4990
Upper L (181)	1780-1850	High C Band (485)	4700-5000
Broadcast B (206)	2025-2110	5.2GHz ISM (520)	5150-5250
Federal S (225)	2200-2300	5.8GHz ISM (580)	5725-5875
S Band (235)	2200-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

Note: If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

SC4400/SC4200 PTT

Supported Mic Type

Moving Coil or Condenser
(Software Configurable)

- **Max Avg. Speaker Output Power** 2.65W with 4 Ohm Speaker Impedance
- **MIC Bias** 2.15V or 3V (Software Configurable); Applied via a 2K Ohm Resistor
- **Recommended Speaker Impedance (Handset)** 4 Ohm to 16 Ohm
- **Recommended Speaker Impedance (Headset)** 75 Ohm to 300 Ohm
- **Recommended MIC impedance** <= 1K Ohm
- **Peak Speaker Output Voltage** 5.5V
- **Absolute MIC Input Voltage** 3.3V

5. Web Interface

5.0 Getting Started

Connect a laptop to the StreamCaster radio using the supplied Ethernet cable and turn on the radio. Users can type “ping <IP address>” in order to determine whether the radio is fully booted. A web configuration will then be available by typing the radio IP address in a web browser. Please ensure that your laptop is on the same subnet as the radio (172.20.xx.xx by default). Users will initially see the link distance warning, then be directed to the Local Radio Configuration page. (See **Figure 27 Initial boot up warning**) You will be able to navigate to various configuration pages from the drop-down menu on the left-hand side. On the right, you can open additional details about the radio by selecting the four squares icon on the top right of the screen. After selecting, you will see details such as local radio IP, VIP, Node Label, temperature, voltage, and an option to use night mode or not. Night mode will have a dark background and below screen shots are an example of the GUI in night mode. Throughout the user interface, if there is a red bar below the parameter you will be able to click on it for either additional notes about the parameter or see additional options.

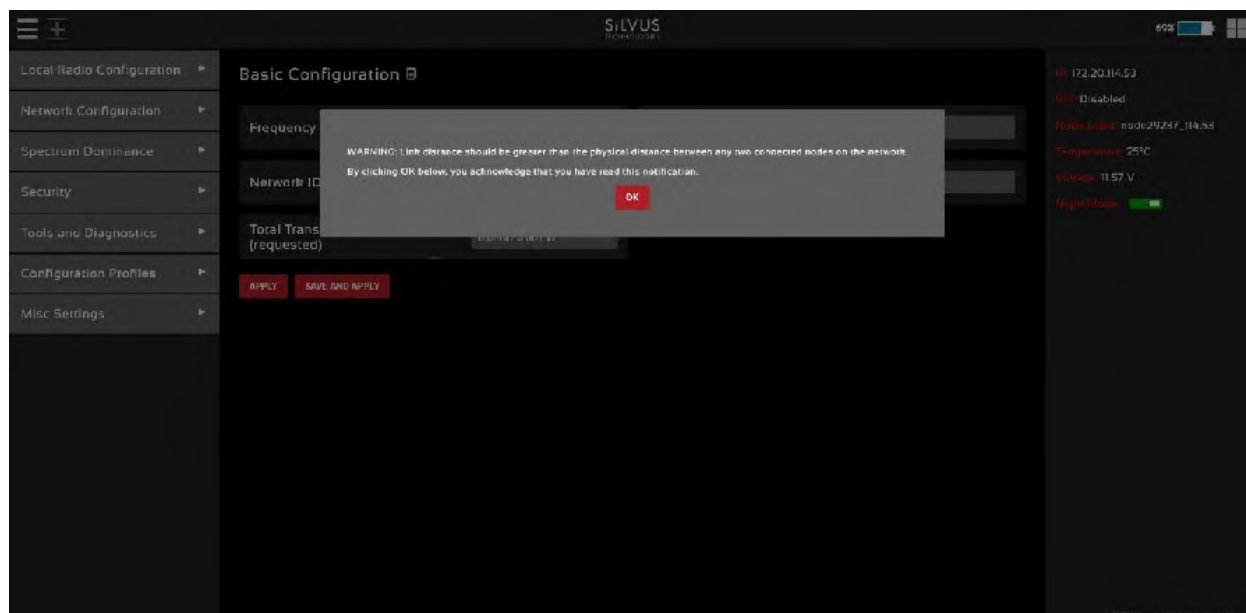


Figure 27 Initial boot up warning

Upon first boot up and login to the GUI, you will see a warning message. This message is meant to emphasize the importance of having the correct link distance setting.

5.1 Local Radio Configuration

The first group of configurations on the left side of the GUI is the Local Radio Configurations. This group of parameters can help adjust your network to perform better in various environments, conditions, and applications. You will be able to adjust the radio's RF characteristics, networking parameters, BDA configurations, serial/USB configurations, and PTT settings.

5.1.1 RF

The RF section of the Local Radio Configurations will let you adjust some Basic configurations as well as some Advanced parameters. These configurations will optimize the link performance in different types of deployments. To get radios to link and form a mesh network the center frequency, bandwidth, network ID, and Link Distance parameters in the Basic configuration page need to all match. To optimize the network's performance, you can make some adjustments to the MAC settings under the Advanced section.

5.1.1.1 Basic

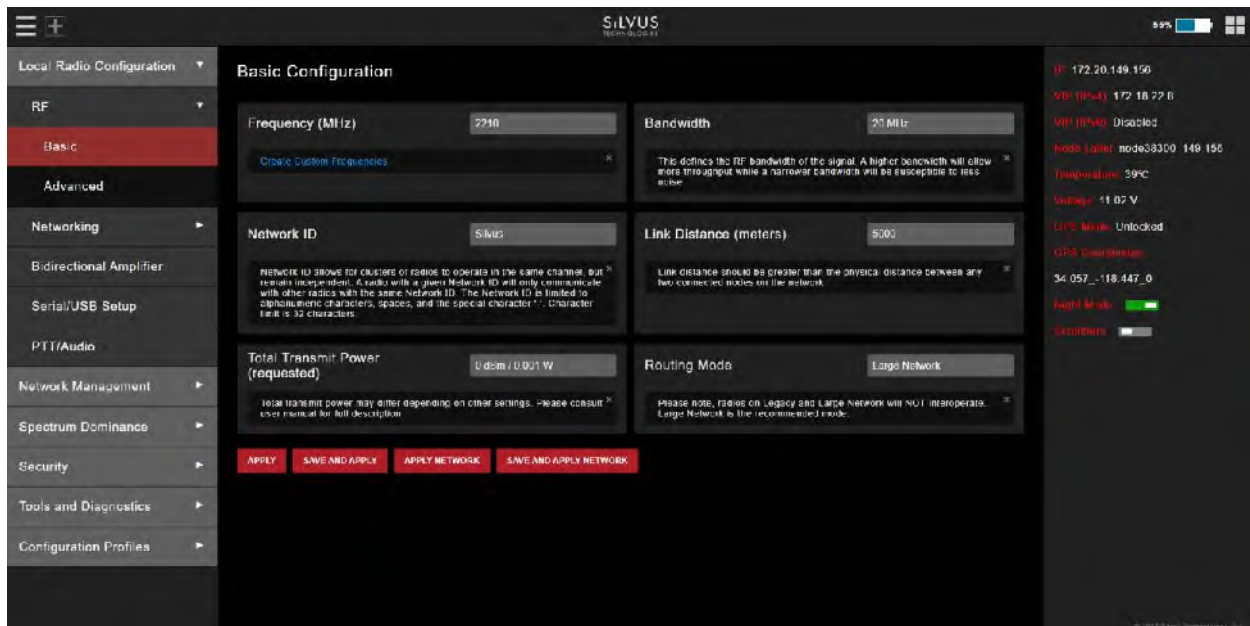


Figure 28 Basic Configuration Page

This page is used to set basic configurations. A brief description of each parameter is given below.

- **Frequency:** This defines the frequency of the signal. There is a drop-down menu for frequency selection. The frequency choices will vary depending on the StreamCaster model(s) you are using. In the additional information section of the frequency section (click on the red bar

directly below), you can select a link that will take you to create custom frequencies. Please see Section 8 Custom Frequency Plan for “Create Custom Frequencies” access and installation instructions.

- **Bandwidth:** This defines the RF bandwidth of the signal. A higher bandwidth will allow more throughput while a narrower bandwidth will be susceptible to less noise.
- **Network ID:** Network ID allows for clusters of radios to operate in the same channel but remain independent. A radio with a given Network ID will only communicate with other radios with the same Network ID. The Network ID is limited to alphanumeric characters, spaces, and the special character '-'. Character limit is 32 characters.
- **Link Distance:** Set to an approximate maximum distance between any two nodes in meters, e.g., 5000 for 5km (default). It is important to set the link distance to allow enough time for packets to propagate over the air. Failing to set the link distance to an approximate maximum distance can result in over the air collisions and a degradation of performance. It is recommended to set the link distance 10-15% greater than the actual maximum distance. Please note that this value should be set the same on all radios in the network.
- **Total Transmit Power:** This defines the total power of the signal (power is divided equally between the radio antenna ports). There is also an option to ‘Enable Max Power’ which will allow the radio to push to the highest TX power it can support. This will be slightly different on each radio.
- **Routing Mode:** Please note radios on Legacy and Large Network will NOT interoperate. Large network routing was designed to allow networks with a higher node count. However, there are marginal benefits even if operating smaller networks.
- **Apply:** Apply the new values. Values will change back to the default setting after reboot.
- **Save and Apply:** Apply the new values and set the new values as the default.
- **Apply Network:** Apply the new values to all nodes currently on the network.
- **Save and apply network:** Apply the new values and set the new values as the default to all nodes currently on the network.

5.1.1.2 Advanced

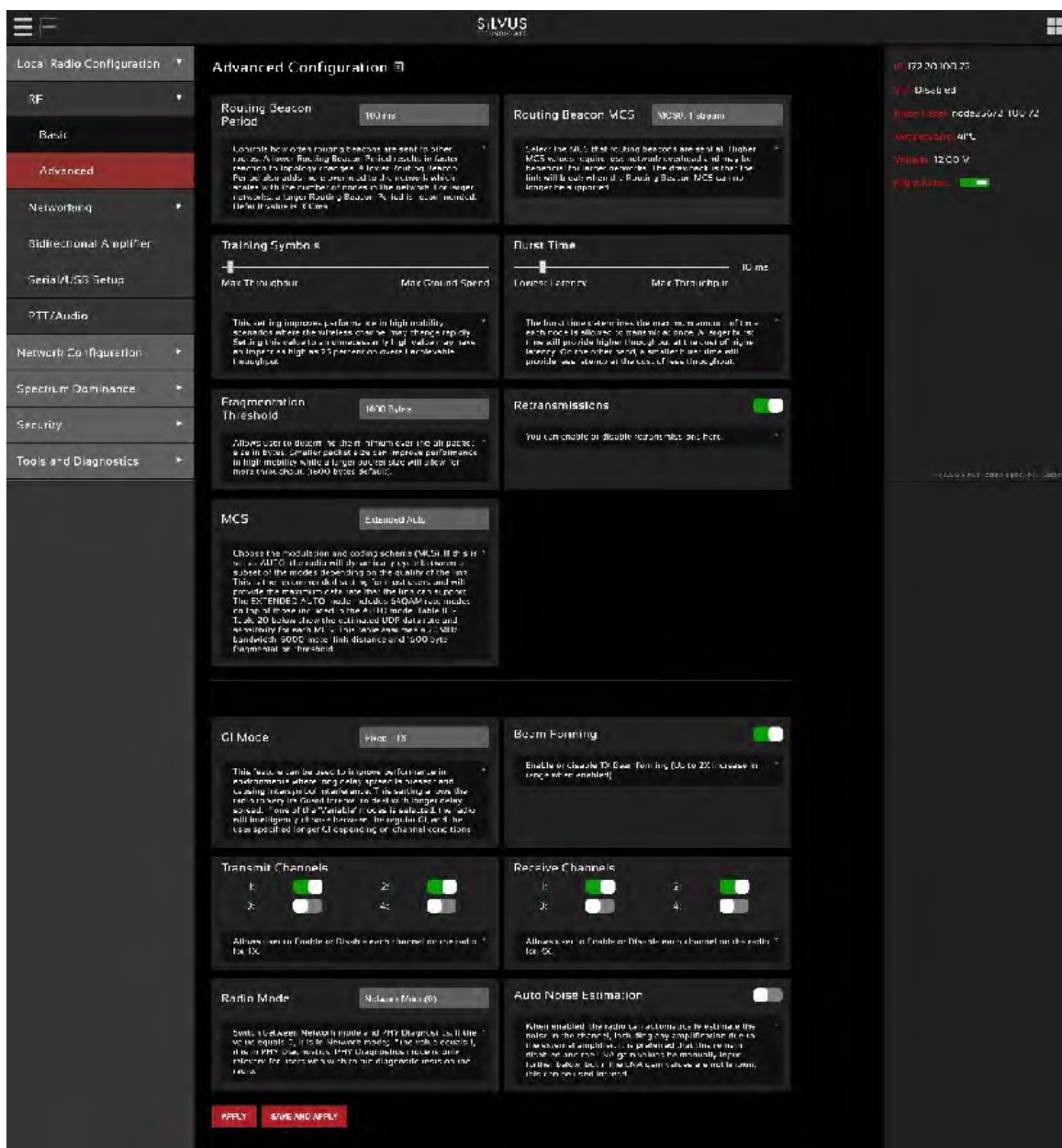


Figure 29 Advanced Configuration Page

This page is used to set the advanced settings. A brief description of each parameter is given below.

MAC Settings:

- Routing Beacon Period:** Controls how often routing beacons are sent to other radios. A lower Routing Beacon Period results in faster reaction to topology changes. A lower Routing Beacon

Period also adds more overhead to the network which scales with the number of nodes in the network. For larger networks, a larger Routing Beacon Period is recommended. Default value is 100ms.

- **Routing Beacon MCS:** Select the MCS that routing beacons are sent at. Higher MCS values require less network overhead and may be beneficial for larger networks. The drawback is that the link will break when the Routing Beacon MCS can no longer be supported.
- **Training Symbols:** This setting improves performance in high mobility scenarios where the wireless channel may change rapidly. Setting this value to an unnecessarily high value may have an impact as high as 25 percent on overall achievable throughput.
- **Burst Time:** The burst time determines the maximum amount of time each node is allowed to transmit at once. A larger burst time will provide higher throughput at the cost of higher latency. On the other hand, a smaller burst time will provide less latency at the cost of less throughput.
- **Fragmentation Threshold:** Allows user to determine the minimum over-the-air packet size in bytes. Smaller packet size can improve performance in high mobility while a larger packet size will allow for more throughput. (1600 bytes default).
- **Retransmissions:** You can enable or disable retransmissions here.
- **MCS:** Choose the modulation and coding scheme (MCS). If this is set as AUTO, the radio will dynamically cycle between a subset of the modes depending on the quality of the link. This is the recommended setting for most users and will provide the maximum data rate that the link can support. The EXTENDED AUTO mode includes 64QAM rate modes on top of those included in the AUTO mode. **Table 22** below show the estimated UDP data rate and sensitivity for each MCS. This table assumes a 5000 meter link distance, 10ms burst time, and 1600 byte fragmentation threshold.
- **GI Mode:** This feature can be used to improve performance in environments where long delay spread is present and causing intersymbol interference*. This setting allows the radio to vary its Guard Interval** to allow for longer delay spread. When set to 'Extended Auto – GI', the radio will choose between the regular GI, and the user specified longer GI (Cyclic Prefix Length in the next setting) depending on channel conditions. Delay spread is often seen in environments where there are high rise buildings with metal, glass, cement, or other material with a high potential for reflections. Using a low GI mode will allow more time used sending data and therefore give you more throughput, however a higher GI mode will give you less chance of seeing loss due to delay spread. Below are some criteria for when you might want to increase the amount of guard interval:
 - Reported loss rate is high
 - Interference is not the cause of high loss rate
 - Environment radios are deployed in has the potential for RF reflections

You will know that you have reach a more appropriate GI mode if the loss rate decreases after adjusting.

*(https://en.wikipedia.org/wiki/Intersymbol_interference)

**(https://en.wikipedia.org/wiki/Guard_interval)

- **Beamforming (SC4200/SC4400/SL4200):** Enable or disable TX Beamforming (Up to 2X increase in range when enabled) If beamforming is disabled while using cross polarized antennas, antennas should be arranged such that one polarity is on the odd ports and the other polarity on the even ports.
- **Transmit Channels:** Allows user to Enable or Disable each channel on the radio for TX.
- **Receive Channels:** Allows user to Enable or Disable each channel on the radio for RX.
- **Radio Mode:** Switch between Network mode and PHY Diagnostics. If the value equals 0, it is in Network mode; if the value equals 1, it is in PHY Diagnostics. PHY Diagnostics mode is only relevant for users who wish to run diagnostic tests on the radio.
- **Apply:** Applies the new values but does not save them to flash.
- **Save and Apply:** Save the new values to flash and apply.

Modulation Modes and Receiver Sensitivity

- Note that listed sensitivity values were measured using a controlled and cabled setup. Actual results may vary by +/- 2dB. Table assumes link distance of 5000m. 10ms, 20ms, and 40ms burst time for 20, 10, and 5MHz bandwidth respectively. 1600 byte Fragmentation Threshold.
- * Modes supported under the AUTO MCS option.
- * Modes supported under the EXTENDED AUTO MCS option in addition to AUTO MCS modes.
- *Modes currently not supported

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 SL4200 Sensitivity
1	0	BPSK 1/2	0.41	0.27	-108	-105
1	1	QPSK 1/2	0.81	0.55	-106	-103
1	2	QPSK 3/4	1.22	0.82	-103	-100
1	3	16-QAM 1/2	1.63	1.10	-101	-98
1	4	16-QAM 3/4	2.44	1.65	-98	-95
1	5	64 QAM 2/3	3.25	2.20	-93	-90
1	6	64 QAM 3/4	3.66	2.47	-91	-88
1	7	64 QAM 5/6	4.06	2.75	-86	-83
2	8	BPSK 1/2	0.81	0.55	-106	-103
2	9	QPSK 1/2	1.63	1.10	-103	-100
2	10	QPSK 3/4	2.44	1.65	-100	-97
2	11	16-QAM 1/2	3.25	2.20	-97	-94
2	12	16-QAM 3/4	4.88	3.30	-94	-91
2	13	64 QAM 2/3	6.50	4.35	-90	-87
2	14	64 QAM 3/4	7.31	4.75	-88	-85
2	15	64 QAM 5/6	8.13	5.10	-83	-80

Table 20 MCS vs. Sensitivity Chart (1.25MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 SL4200 Sensitivity
1	0	BPSK 1/2	0.81	0.55	-104.5	-101.5
1	1	QPSK 1/2	1.63	1.10	-102.5	-99.5
1	2	QPSK 3/4	2.44	1.65	-99.5	-96.5
1	3	16-QAM 1/2	3.25	2.20	-97.5	-94.5
1	4	16-QAM 3/4	4.88	3.30	-94.5	-91.5
1	5	64 QAM 2/3	6.50	4.40	-89.5	-86.5
1	6	64 QAM 3/4	7.31	4.95	-87.5	-84.5
1	7	64 QAM 5/6	8.13	5.5	-82.5	-79.5
2	8	BPSK 1/2	1.63	1.10	-102.5	-99.5
2	9	QPSK 1/2	3.25	2.20	-99.5	-96.5
2	10	QPSK 3/4	4.88	3.30	-96.5	-93.5
2	11	16-QAM 1/2	6.50	4.40	-94.5	-91.5
2	12	16-QAM 3/4	9.75	6.60	-90.5	-87.5
2	13	64 QAM 2/3	13.00	8.70	-86.5	-83.5
2	14	64 QAM 3/4	14.63	9.50	-84.5	-81.5

2	15	64 QAM 5/6	16.25	10.20	-79.5	-76.5
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Table 21 MCS vs. Sensitivity Chart (2.5MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 SL4200 Sensitivity
1	0	BPSK 1/2	1.63	1.03	-102	-99
1	1	QPSK 1/2	3.25	2.06	-100	-97
1	2	QPSK 3/4	4.88	3.09	-97	-94
1	3	16-QAM 1/2	6.50	4.12	-95	-92
1	4	16-QAM 3/4	9.75	6.18	-92	-89
1	5	64 QAM 2/3	13.00	8.25	-87	-84
1	6	64 QAM 3/4	14.63	9.28	-85	-82
1	7	64 QAM 5/6	16.25	10.30	-80	-77
2	8	BPSK 1/2	3.25	2.06	-100	-97
2	9	QPSK 1/2	6.50	4.12	-97	-94
2	10	QPSK 3/4	9.75	6.18	-94	-91
2	11	16-QAM 1/2	13.00	8.25	-91	-89
2	12	16-QAM 3/4	19.50	12.38	-88	-85
2	13	64 QAM 2/3	26.00	16.21	-84	-81
2	14	64 QAM 3/4	29.25	17.62	-82	-79
2	15	64 QAM 5/6	32.50	18.94	-77	-74

Table 22 MCS vs. Sensitivity Chart (5MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 SL4200 Sensitivity
1	0	BPSK 1/2	3.25	2.48	-99	-96
1	1	QPSK 1/2	6.50	4.96	-97	-94
1	2	QPSK 3/4	9.75	7.40	-94	-91
1	3	16-QAM 1/2	13.00	9.90	-92	-89
1	4	16-QAM 3/4	19.50	14.80	-89	-86
1	5	64 QAM 2/3	26.00	19.90	-84	-82
1	6	64 QAM 3/4	29.25	22.40	-82	-80
1	7	64 QAM 5/6	32.5	24.0	-77	-78
2	8	BPSK 1/2	6.50	4.96	-97	-94
2	9	QPSK 1/2	13.00	9.90	-94	-91
2	10	QPSK 3/4	19.50	14.80	-91	-88
2	11	16-QAM 1/2	26.00	19.90	-89	-86
2	12	16-QAM 3/4	39.00	29.90	-85	-82
2	13	64 QAM 2/3	52.00	39.70	-81	-79
2	14	64 QAM 3/4	58.50	43.50	-79	-77
2	15	64 QAM 5/6	65.00	48.10	-74	-75

Table 23 MCS vs. Sensitivity Chart (10MHz Bandwidth)*

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC4400/3500/3800 Sensitivity	SC4200/3822 SL4200 Sensitivity
1	0	BPSK 1/2	6.5	4.92	-96	-93
1	1	QPSK 1/2	13.00	9.82	-94	-91
1	2	QPSK 3/4	19.50	14.73	-91	-88
1	3	16-QAM 1/2	26.00	19.65	-89	-86
1	4	16-QAM 3/4	39.00	29.47	-86	-83
1	5	64 QAM 2/3	52.00	39.29	-82	-79
1	6	64 QAM 3/4	58.50	44.20	-80	-77
1	7	64 QAM 5/6	65.00	47.45	-78	-75
2	8	BPSK 1/2	13.00	9.82	-94	-91
2	9	QPSK 1/2	26.00	19.65	-91	-88
2	10	QPSK 3/4	39.00	29.47	-88	-85
2	11	16-QAM 1/2	52.00	39.29	-86	-83
2	12	16-QAM 3/4	78.00	57.04	-82	-79
2	13	64 QAM 2/3	104.00	75.00	-79	-76
2	14	64 QAM 3/4	117.00	85.00	-77	-74
2	15	64 QAM 5/6	130.00	94.00	-75	-72

Table 24 MCS vs. Sensitivity Chart (20MHz Bandwidth)*

*Sensitivity numbers reflect “typical” values. Actual sensitivity will vary by band.

5.1.2 Networking

The Networking section will allow you to configure the various networking parameters involved with the mesh network. This includes various LAN settings, WIFI settings, Multicast parameters, as well as QoS (quality of service) settings.

5.1.2.1 LAN Settings

The screenshot displays the LAN Settings page in the StreamCaster 4000 series MIMO Radio web interface. The interface is organized into a sidebar on the left, a top navigation bar, and a main content area. The sidebar lists various configuration categories, with 'LAN Settings' currently selected. The top navigation bar includes the Silvus logo and status indicators for power, signal, and temperature. The main content area is divided into two primary sections: 'LAN Settings' and 'VLAN Settings'. The 'LAN Settings' section contains several sub-sections: 'Virtual IP' (with a toggle for enabling/disabling the secondary IP), 'Virtual IPv4 Network' (with a text input for the network address), 'Virtual IPv6' (with a toggle for enabling/disabling the secondary IP), 'Virtual IPv6 Prefix' (with a text input for the prefix), 'VPN' (with a toggle for enabling/disabling the VPN), and 'VPN Server Port' (with a text input for the port number). The 'VLAN Settings' section includes 'VLAN Mode' (with a dropdown menu), 'Management VLAN' (with a text input), 'VLAN Filter' (with a text input), and 'Basic Settings' (with a toggle for 'Wired Backbone Gateway' and a toggle for 'Routing Beacon on Ethernet Port'). Each sub-section includes a brief description of the setting and a 'Save' button. The bottom of the page features a row of buttons: 'APPLY', 'SAVE AND APPLY', 'APPLY NETWORK', and 'SAVE AND APPLY NETWORK'.

Figure 30 LAN Settings Page

LAN Settings:

- **Virtual IP:** Enable or Disable the Secondary IP address for the radio.
- **Virtual IPv4 Address:** Set the secondary IP address for the radio. The user may set this to be on the user's IP network, e.g., 192.168.2.10. Once this secondary IP address is set, the user may access the radio web page using either the native IP address or the secondary IP address.
- **Virtual IPv4 Netmask:** Netmask for the Secondary IP address, e.g. 255.255.255.0. Please note that the secondary IP address should NOT be on the 172.20.xx.xx subnet.
- **Virtual IPv4 Gateway:** Gateway for local network to allow radio to connect to the internet.
- **Virtual IPv6:** Enable or disable the secondary IPv6 address for the radio.
- **Virtual IPv6 address:** An IPv6 address is made of 128 bits divided into eight 16-bits blocks. Each block is then converted into 4-digit Hexadecimal numbers separated by colon symbols.
- **Virtual IPv6 prefix:** The prefixes in IPv6 can be considered similar to the subnet mask used in IPv4 addresses. The IPv6 prefix must be an integer between 0-128.
- **Virtual IPv6 gateway:** This is the IPv6 address of the gateway for local network to allow radio to connect to the internet.
- **VPN:** For WAN wired backbone scenarios where radios from two different sites are connected via the internet, a public N2N server is needed to route the data. The radios will only show a solid green LED on the status LED if it is wirelessly connected to neighbor node. WAN connections will not create a solid green LED. Here is an example of how to setup an N2N server on a server hosted by Amazon AWS running Ubuntu 12.04:

Compile:

```
git clone https://github.com/lukablurr/n2n\_v2\_fork ### downloads the code
cd n2n_v2_fork
export N2N_OPTION_AES=no
make clean
make
```

Execute:

```
./supernode -l 9000 -v
```

Server will be running on port 9000.

- **VPN Server IP:** IP Address of N2N VPN Server
- **VPN Server Port:** Port that the N2N VPN server is configured to listen on.
- **VPN Buffer Size:** This sets the buffer size for WAN links. Note, all radios with WAN links should have this setting synced up. Higher values are recommended for WAN links that experience out-of-order packets. Lower values are recommended when the link is lossy.
- **Block DHCP packets on Mesh:** This is a feature that will drop all DHCP packets from all interfaces on the radio (wireless, ethernet, wifi, usb-ethernet). This includes DHCP request, DHCP response, DHCP release packets. Enable to prevent potential IP conflicts caused by multiple DHCP servers.

VLAN Settings:

VLANs allow users to segregate the Ethernet layer by assigning one or more VLAN IDs to the ports of a VLAN switch. Ethernet packets are only allowed to travel between ports that belong to the same VLAN. To allow concatenating multiple VLAN switches and/or a single physical interface residing on multiple VLANs, a VLAN ID can be inserted to the Ethernet packet header to indicate which VLAN the packet belongs to. This is called VLAN Tagging. A packet that contains a VLAN ID is called a tagged packet. A port on a VLAN switch typically operates in either access mode or trunk mode.

- **VLAN Mode:** Specify 'Access' or 'Trunk' mode for the radio per the 802.1Q standard.
- **Default (Native/PVID) VLAN:** This is the VLAN associated with untagged packets entering the radio. Tagged packets on this VLAN arriving at the radio will leave the radio untagged. The virtual IP of the radio is available on this VLAN. This is for Access mode only.
- **Virtual IP VLAN:** Virtual IP of the radio will be available on this VLAN. On this VLAN arriving at the radio will leave the radio untagged. The virtual IP of the radio is available on this VLAN.
- **Management VLAN:** This is the VLAN used for radio management (e.g. routing and network management). All radios on the network should have the same management VLAN. The 172.20.xx.yy IP of the radio is available only on this VLAN.
- **Trunk VLAN(s):** This setting enables the trunking of VLANs when the radio is connected to an 802.1Q switch. If left empty, only the native and management VLAN traffic will be allowed. User may enter a comma separated list of VLANs, e.g. 4,5,6 or an array of VLANs in the format of a:b:c where a and c are start and end, and b is step size, e.g. 4:1:7 translates to 4,5,6,7. Any combination of the above is allowed.
- **VLAN Filter:** VLANs in this list will not be sent over the mesh. Prevent certain VLAN ids from going on the network (VLAN RF Filter).

Basic Settings:

- **Wired Backbone Gateway:** This setting pertains to wired backbone functionality (See Section 7: Wired Backbone). For normal operation, set Wired Backbone Gateway to 'Auto'. If multiple radios will be connected to a wired backbone, all radios on the backbone should be set to 'Auto'.
- **Routing Beacons on Ethernet Port:** For radios to be able to communicate and transfer data over a wired link, routing information needs to be sent over the wireline. These packets are broadcast packets that are sent even if there is only one radio on the network. If wired backbone is not being utilized, the user can disable these routing beacons to prevent loading their local network with these routing packets.

5.1.2.2 DLEP

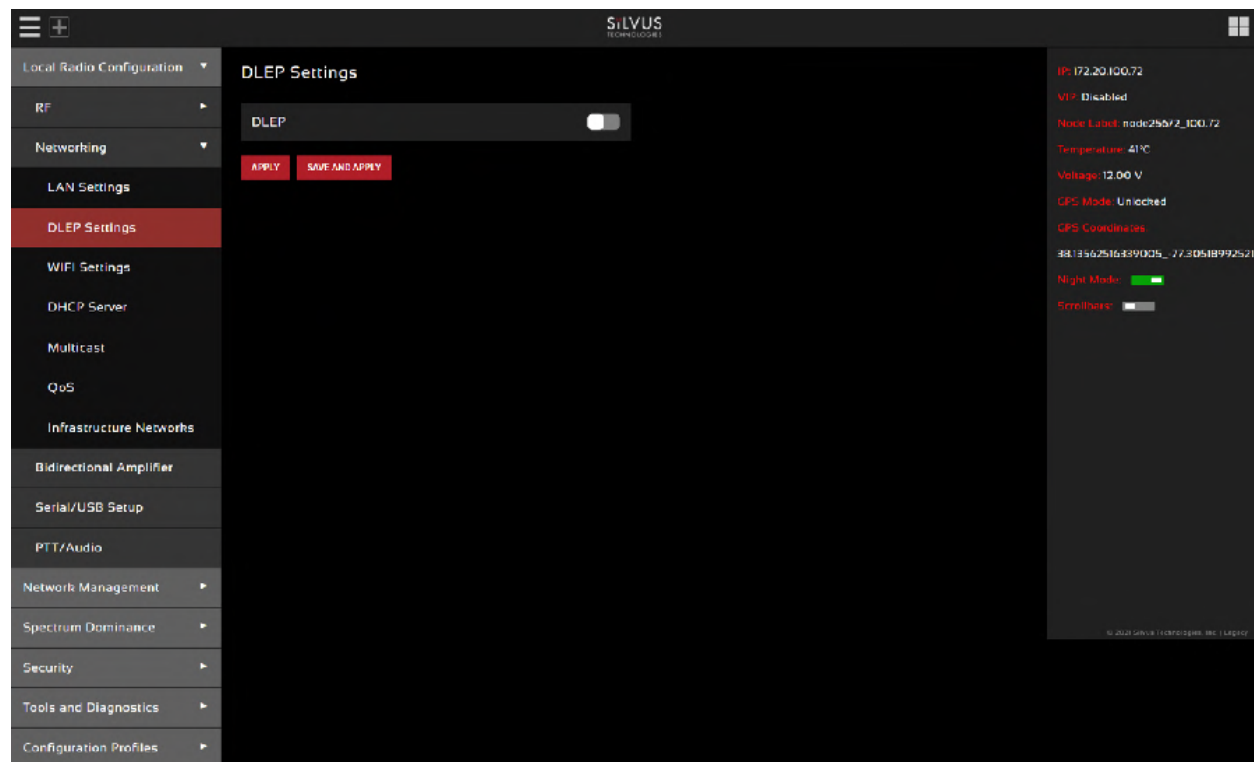


Figure 31 DLEP

DLEP Settings:

The Silvus radio supports Dynamic Link Exchange Protocol (DLEP). This is a feature where the Silvus radio would be able to pass feedback to a router to help optimize route selection. To enable DLEP you would need a DLEP capable router to connect to the radio ethernet connection. After that, come to this page and toggle the DLEP selection to the enable position will enable DLEP on the radio.

This feature has been tested with Cisco C5915 IOS Version 15.9(3)M1 by using OSPFv3 and EIGRP routing protocols.

Please see below link to DLEP document.

<https://drive.google.com/file/d/1Aa34tGmx-GwKXj0VsAgkNrBEWffkMJHL/view?usp=sharing>

Figure 32 WIFI AP Configuration Page

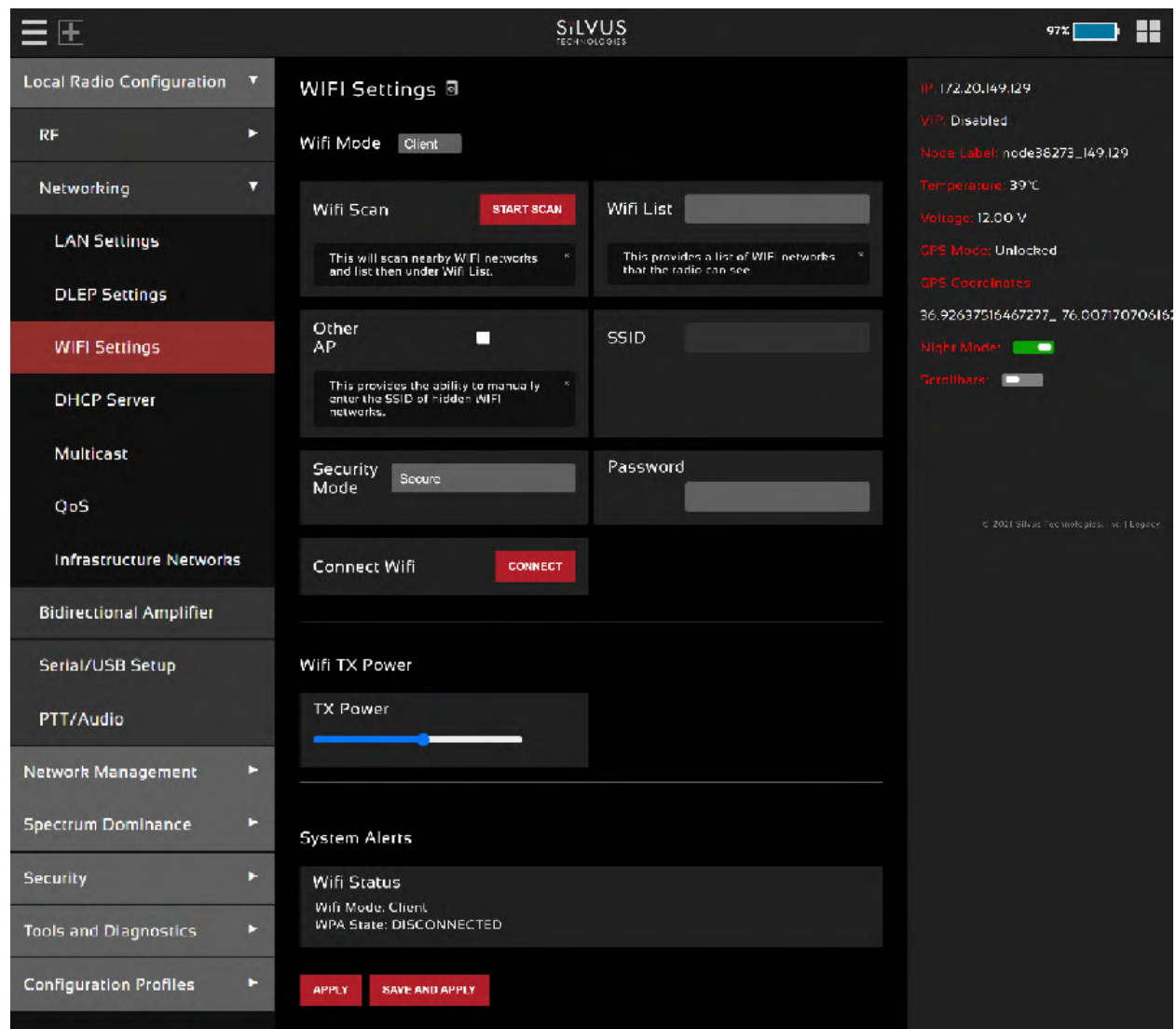


Figure 33 WIFI Client configuration page

WiFi Settings:

Note: Use of this feature requires a Silvus USB-WiFi adapter. The WiFi settings will only display if the WiFi dongle is attached to the radio's USB port before it is powered on. WiFi supports WPA2-PSK AES encryption on the wifi dongle part number SC-WIFI-DNGL2-RGD-ODU. Once a WiFi Access Point is configured, an end device will need either a static IP or DHCP assigned IP in order to connect to the access point. Section 5.1.2.4 goes over how to configure a DHCP server.

- **Wifi Mode:** Choose between AP, Client or Disabled. AP mode turns the WiFi dongle into a wireless AP. This mode is useful for connecting phones, tablets, laptops, etc. to the radio in order to pull

up the web interface and access other devices in the mesh network. Client mode allows the radio to connect to another wireless AP. This mode is useful for connecting to wireless cameras and other devices which generate their own 'hotspot'. Once set to client mode, a list of detected wireless networks will be displayed with an option to connect.

- **Mode:** When set to AP, the wireless can be configured to be in Bridge Mode or NAT mode. In Bridge mode, the wireless interface is bridged with the Ethernet interface and the rest of the mesh. This is the simplest mode as all data is transparent and at layer 2. NAT mode puts the WiFi wireless traffic on a LAN, and the rest of the Silvus mesh network on a WAN. In effect, this means that a device connected wirelessly via the NAT AP will be able to find any device in the larger mesh network, but not vice versa. NAT mode is recommended for more advanced users who wish to be able to segregate data.
- **SSID:** Define the SSID for the wireless network. Must be between 1-31 characters. User also has the option to prevent the AP from broadcasting it's SSID by checking the 'Hide' box.
- **Security Mode:** Determines whether the AP requires a password to connect.
- **Password:** If 'Security Mode' is set to 'Secure', a password between 8 and 63 characters must be set.
- **Wifi Channel:** The Silvus USB-Wifi adapter supports 20 different Wifi channels in both the 2.4GHz and 5GHz frequency ranges. It is recommended to set the Wifi channel to a frequency that has maximum separation from the mesh network frequency. (i.e. if mesh network is operating at 2.4GHz, it is recommended to set the Wifi frequency somewhere in the 5GHz range). Note that not all user devices support 5GHz Wifi.
- **Wifi Standard:** Specify 802.11b or g wifi standard. Some legacy devices may not be able to connect to an 802.11g network.
- **Wifi TX Power:** This slider can be used to control the Wifi TX power from 0dBm (1mW) up to 17dBm (50mW).
- **Wifi Status:** Provides status information of the wifi adapter. A list of connected clients will also be shown here.
- **Wifi Scan:** will scan nearby WIFI networks and list them under Wifi List.
- **Wifi List:** provides a list of WIFI networks that the radio can see.
- **Other AP:** provides the ability to manually enter the SSID of hidden WIFI networks.
- **Apply:** Applies the new values but does not save them to flash.
- **Save and Apply:** Save the new values to flash and apply.

5.1.2.4 DHCP Server

Figure 34 DHCP Server

DHCP Server Settings:

The Silvus radios have a built in DHCP server in them. Once you enable the DHCP server, the radio will automatically assign IP addresses to the devices that are connected to the mesh network. Below are the various parameters of the DHCP server.

- **DHCP:** When enabled, the DHCP server on the radio will assign IP addresses to devices connected to the Silvus network. Users should be careful to make sure that in the event there are multiple radios configured with DHCP to ensure that each DHCP server is serving a unique IP address range to prevent IP conflicts. When DHCP is enabled, the DHCP parameters must be set.
- **Start IP:** This will be the IP address that the DHCP starts to assign devices that are connected to the network
- **End IP:** This will be the last IP address that the DHCP will assign in sequential order from the start IP.

- **Netmask:** Netmask for the group of devices that the DHCP server will assign IP addresses for, e.g. 255.255.255.0.
- **Gateway:** Gateway for local network to allow radio or devices to connect to the internet
- **DNS:** The DNS is the domain name system and is an IP address that helps translate website URL addresses to IP addresses. You can specify the specific DNS you would like to use for your subnet of devices. A common one to use is Google's public DNS 8.8.8.8.
- **Lease Time:** Specifies the lease time (in seconds) of your IP address.
- **Interface:** This option only applies when VLAN is enabled. Determines if DHCP server serves Ips on the virtual ip VLAN or the management VLAN.
- **Default:** a button that will automatically configure some suggested parameters for the DHCP.
- **Disable DHCP Packets on Mesh:** This will disable all DHCP server packets on the network. This is a feature to prevent conflicting IP addresses that are being assigned to multiple devices by multiple DHCP servers.
- **Static IP addresses:** Devices with given MAC address will map to given IP address. MAC address is in format a1:b2:c3:d4:e5:f6. Be sure IP address is in subnet range.
- **DHCP Status client list:** This section will list all devices that the DHCP is assigning IP addresses to.

Sample settings:

In this example use of the DHCP server, you would assign devices within the 172.20.x.y subnet for them to communicate with the Silvus radio subnet. This would allow EUDs that are accepting DHCP IP addresses to be able to log into the Silvus GUI.

1. Log into the Silvus GUI and navigate to the DHCP configuration page.
2. Enable DHCP
3. Set start IP as 172.20.1.1
4. Set stop IP as 172.20.1.100 (make sure there are no radios or static devices within this range of IPs)
5. Set gateway as 0.0.0.0
6. Set subnet mask as 255.255.0.0
7. Click save and apply

5.1.2.5 Multicast

The screenshot displays the 'Multicast' configuration page in the Silvus Technologies web interface. The left sidebar contains a navigation menu with options: RF, Networking, LAN Settings, DLEP Settings, WIFI Settings, DHCP Server, Multicast (selected), QoS, Infrastructure Networks, Bidirectional Amplifier, Serial/USB Setup, PTT/Audio, Network Management, Spectrum Dominance, and Security.

The main content area is titled 'Multicast' and includes the following sections:

- Default Multicast Algorithm:** A dropdown menu set to 'Broadcast'. A tooltip explains that this algorithm is used for Multicast traffic if it does not match the group IP address in the Legacy Multicast Groups or the MANET Multicast Groups. The Legacy algorithm will send all traffic as multicast and works well for groups of 2-3 receivers per radio, while the Broadcast algorithm will work better for dense networks which still need high throughput. The Broadcast algorithm is the factory default and is suitable for legacy multicast. The flooding algorithm works well for low rate multicast in extremely dense networks (e.g., > 40 radios in a single hop). Note, currently this algorithm does not work correctly in networks with mixed backbones.
- Legacy Multicast:**
 - Multicast Groups:** A text input field for a list of Multicast IP(s) and IP(s) addresses separated by comma (e.g., 224.0.0.50, 224.0.0.51). Traffic for these multicast groups will be sent using the Legacy Multicast algorithm.
 - DSCP Matching:** A text input field for Multicast traffic marked with a DSCP value matching the list of DSCP values will trigger legacy multicast.
- IGMP Snooping:** A toggle switch set to 'On'.
 - Action for un-registered multicast traffic:** A dropdown menu set to 'Block (Default)'. A tooltip explains that this enables multicast local and remote forwarding behavior for multicast traffic. It controls forwarding behavior for un-registered multicast traffic on the mesh.
- Custom Pruning/Augmenting:** A toggle switch set to 'On'.
 - Multicast Stream 1 Configuration:** A text input field for Multicast IP address (e.g., 224.0.0.50, 224.0.0.51) and a text input field for a list of connected devices (e.g., 192.168.1.1, 192.168.1.2). A tooltip explains that if IGMP snooping is disabled, multicast traffic will only be forwarded to the radios in this list. If enabled, multicast traffic will only be forwarded to radios in this list that have client devices requesting this traffic. Traffic may be forced to go in a certain direction by adding the word with prefix '+', e.g., 224.0.0.50:50, 192.168.1.1:50. If sampling is disabled, 192.168.1.1 and 192.168.1.2 will receive traffic. If enabled, 192.168.1.1 will only receive traffic if connected clients ask for it. 192.168.1.2 will always receive traffic and 192.168.1.1 will never receive traffic. All other radios will not receive traffic. If receiver id is -1, it will stop multicast traffic for this group, e.g., to stop all traffic for group 224.0.0.50, set it to 224.0.0.50: -1. Configuration settings will accept both IP(s) and IPv6 formats.
 - Multicast Stream 2 Configuration:** A text input field.
 - Multicast Stream 3 Configuration:** A text input field.
 - Multicast Stream 4 Configuration:** A text input field.
 - Multicast Stream 5 Configuration:** A text input field.
- MANET Multicast/Broadcast:** A toggle switch set to 'On'.
 - Mode:** A dropdown menu set to 'Single-hop'. A tooltip explains that in single hop mode, multicast traffic will be transmitted to all radios reachable in a single hop. Traffic will terminate at those nodes. In multi-hop mode, multicast traffic will reach all radios in the mesh, subject to IGMP/custom pruning if applicable.
 - Single Receiver Optimization:** A toggle switch set to 'Enable'. A tooltip explains that if enabled, if there is only one downstream multicast receiver, convert to unicast.
 - MCS:** A dropdown menu set to 'MCS 1 stream'.
 - Fragmentation Threshold:** A text input field set to '1000 bytes'.
 - Multicast Groups:** A text input field for a list of Multicast IP(s) and IP(s) addresses separated by comma (e.g., 224.0.0.50, 224.0.0.51). Traffic for these multicast groups will be sent using MANET Multicast/Broadcast.
 - DSCP Matching:** A text input field for Multicast traffic marked with a DSCP value matching the list of DSCP values will trigger MANET multicast.
 - Target Latency:** A slider set to 10 ms. A tooltip explains that input is 0.05Mbps. Utilization: 0.00% of 1.10Mbps.
 - Amount of Error Correction:** A slider set to 200%. A tooltip explains that amount of additional error correction packets sent along with the data packets.

At the bottom of the main content area, there are four buttons: 'APPLY', 'SAVE AND APPLY', 'APPLY NETWORK', and 'SAVE AND APPLY NETWORK'.

The right sidebar shows system status information: IP: 172.20.149.166, MAC (HW): 182.168.1.58, MAC (FW): Disabled, Name: radio-50200-149.166, Temperature: 28°C, Voltage: 12.20 V, GPIO Mode: Unlocked, GPS: Not enabled, 31.057 -118.447 0, Night Mode: On, and Screenshot: On.

Figure 35 Multicast Configuration Page

- **Default Multicast Algorithm:** This controls which method of multicast transmission is used if it does NOT match the group IPs listed in the Legacy Multicast Groups or the MANET Multicast Groups. The Legacy algorithm will send all traffic as unicast and works well for sparse (~2-3 neighbors per radio) networks which need high throughput. Each link will send its own copy of the data payload to the receiving node, and optimize the transmission based on individual link conditions. The MANET multicast algorithm will work better for dense networks which still need high throughput. This multicast method will send the multicast data payload to each node at the same time and use the same MCS. For high receiving node counts, this could save significant airtime. The Broadcast algorithm is the factory default and is suitable for low-rate multicast. Each radio sends every multicast or broadcast packet 3 times if there are downstream radios. Broadcast uses routing tree to send packets. If node is not on the route the packet is thrown out. MCS used for this transmission will be the same as the routing beacon MCS. The Flooding algorithm works well for low-rate multicast in extremely dense networks (e.g., >40 radios in a single hop). All broadcast/multicast packets will be combined, compressed, and broadcasted out. Due to the way it is implemented, there is a possibility of out of order and duplicates. Note, currently this algorithm does not work correctly in networks with wired backbones.
- **Legacy Multicast (Multicast groups):** List of Multicast IPv4 and IPv6 addresses separated by comma (,), e.g., 224.50.50.50, 224.50.50.51. Traffic for these multicast groups will be sent using the Legacy Multicast algorithm.
- **Legacy Multicast (DSCP Matching):** Multicast traffic marked with a DSCP value matching this list of DSCP values will trigger legacy multicast.
- **IGMP Snooping:** Enable or Disable IGMP Snooping for Multicast traffic
- **Action for un-registered multicast traffic:** This option controls default behavior for local and mesh multicast traffic that has no IGMP snooping entries. If set to 'Block', all unregistered multicast traffic will be block. If set to 'Send to All', all unregistered multicast traffic will be sent to all radios.
- **Custom Pruning/Augmenting:** Enable or Disable the Multicast group. The format for the field is Multicast_ip_address, receiver_id1, ... receiver_idn If IGMP snooping is disabled, multicast traffic will only be forwarded to the radios in this list. If enabled, multicast traffic will only be forwarded to radios in this list that have client devices requesting this traffic. Traffic may be forced to go to a radio by adding the node with postfix "+". Traffic may be prevented from reaching a radio by adding postfix "-". (e.g. 224.50.50.50 1234, 1235-, 1236+) If receiver_id is -1, it will stop multicast traffic for this group.

Multicast Pruning Examples:

Data for multicast group 224.50.50.51 will be received only by radios with node-ids 1131 and 1261:

224.50.50.51, 1131, 1261

Data for multicast group 224.50.50.51 will be discarded at the transmitter and not put on the air:

224.50.50.51, -1

- **MANET Multicast/Broadcast:** Enable or Disable the MANET Multicast/Broadcast feature.
- **MANET Multicast/Broadcast (Mode):** The broadcast mode can be either single-hop or multi-hop. In single-hop mode, multicast traffic will be transmitted to all radios reachable in a single hop. Traffic will terminate at these nodes. In multi-hop mode, multicast traffic will reach all radios in the mesh, subject to IGMP/custom pruning if applicable.
- **MANET Multicast/Broadcast (single Receiver Optimization):** If enabled and there is only one downstream multicast receiver this multicast stream will convert to unicast.
- **MANET Multicast/Broadcast (MCS):** MCS that will be designated to all receive nodes for this multicast method. Typically a lower MCS is selected to allow lower SNR links to also obtain this transmission. Auto in this parameter will support MCS0, MCS1, MCS2, and MCS3 only.
- **MANET Multicast/Broadcast (fragmentation threshold):** This parameter will be designated to all receive nodes for this multicast method
- **MANET Multicast/Broadcast (Multicast Groups):** List of multicast IPv4 addresses separated by comma (,), e.g. 224.50.50.50, 224.50.50.51. Traffic for these multicast groups will be sent using this Broadcast feature.
- **MANET Multicast/Broadcast (DSCP Matching):** Multicast traffic marked with a DSCP value matching this list of DSCP values will trigger MANET multicast.
- **MANET Multicast/Broadcast (Target latency):** will make the node wait for the time set in parameter and collect all data and construct forward error correction packets to send out. Higher latencies are better since the low density parity check code can generate more robust codes resulting in better error correction on the receiver.
- **MANET Multicast/Broadcast (Amount of Error Correction):** This is the amount of additional error correction packets sent along with the data packets. A 100% amount of error correction equates to sending the data packets twice.

IPv6

The radios can support IPv6 for the following items:

- unique local ipv6 address
- QoS
- IGMP snooping
- custom Pruning/Augmenting

- MANET multicasting

5.1.2.6 Quality of Service (QoS)

The screenshot displays the QoS Configuration Page with the following sections:

- Port Classification:** A table for configuring port priorities for TCP, UDP, and Both protocols.

Priority	TCP	UDP	Both
Normal			
High			
Critical			
- Ping Classification:** A section for configuring ping priority, currently set to Normal.
- DSCP Mapping:** A table for mapping DSCP values to priorities.

Priority	DSCP
Normal	
High	
Critical	
- Advanced Parameters:**
 - Contention Window:** A table for configuring contention window parameters.

Priority	Min	Max
Normal	4	16
High	5	6
Critical	5	5
 - NFS Multiplier:** A table for configuring NFS multiplier parameters.

Priority	Multiplier
Normal	3
High	2
Critical	1
 - MCS:** A table for configuring MCS parameters.

Priority	MCS
Normal	Extended Rate
High	Extended Rate
Critical	Extended Rate
 - Retransmissions:** A table for configuring retransmission parameters.

Priority	Retransmissions
Normal	Enable
High	Enable
Critical	Enable

At the bottom of the page, there are buttons for **APPLY**, **SAVE PREVIOUS**, **RESET ALL**, and **SAVE AND RESET ALL**.

Figure 36 Quality of Service (QoS) Configuration Page

The Quality of Service configuration page allows the user to make a distinction between three priority levels for managing traffic. These levels are normal, high, and critical.

Critical priority traffic will always jump to the front of the queue and bypass any awaiting high and normal priority traffic. High priority traffic will pass through the network when bandwidth can support critical and high priority, but not normal priority.

Quality of Service Port Classification: To specify priority traffic, the user needs to simply input the port number that the traffic will be arriving on. Multiple ports of the same priority can be separated by a comma (i.e. 5001, 6001, 6002). Alternatively, the user can specify a range of ports using a dash (i.e. 5001-5006). Any combination of commas and dashes will work as well (i.e. 5001, 6001-6007, 8000). Any field can be

cleared by removing the text and clicking 'Apply' or 'Save and Apply'. If unspecified, traffic is treated as Normal Priority.

Ping Classification: You will be able to adjust the priority level of pings

DSCP Mapping: Another method of assigning priority levels is to use DSCP mapping. By designating DSCP header bits to data packets, you can distinguish priority levels of that data payload.

Advanced Parameters

Contention Window Control: The Quality of Service Contention Window Control tunes the aggressiveness of CSMA backoffs when collisions occur. The MAC takes random backoffs in the range $[0, 2^{cw_min}]$. Every time there is a collision/noise it will increase this cw_min by 1, until it is capped by cw_max .

E.g. 4,10 translates to random backoffs in the range $[0,16]$ in the beginning for a packet. If the first try results in a collision, it will pick another backoff in the range $[0,32]$, then $[0,64]$, until $[0,1024]$. After successful transmission, backoff is reset to $[0,16]$. The default is 4,10 for low priority, and 3,6 for high priority. For larger networks, it is recommended to increase the Low Priority minimum to reduce the chance of collisions occurring.

AIFS Multiplier: Arbitration inter-frame spacing is a method of prioritizing one access category over the other. Similar to contention window, the customizable multiplier is used to shorten or lengthen the wait time between retransmissions. Priority categories with higher values wait longer, allowing lower value categories to go through. However, this adds to the latency experienced by lower priority categories

MCS: The MCS can be customized to specific priority levels. Default is to have extended auto MCS on all levels, however by setting the MCS to a lower level you could potentially have a better chance of getting the data payload on the priority level through. Please note that this could potentially cause more airtime on the network leaving less bandwidth for the other priority levels.

Retransmissions: Retransmissions can be customized to specific priority levels. Default is to have all priority levels with retransmissions enabled.

5.1.2.7 Infrastructure Networks

This section controls two features in the Silvus radios. The Scan on Start feature and the failover mode. The Scan on Start feature will enable Edge configured radios to check for Infrastructure configured radios that are set with same center frequencies and bandwidths upon bootup. Based on the best SNR that can be obtained from infrastructure radios at boot up, the Edge radio will boot up connecting to that Infrastructure network with the best signal.

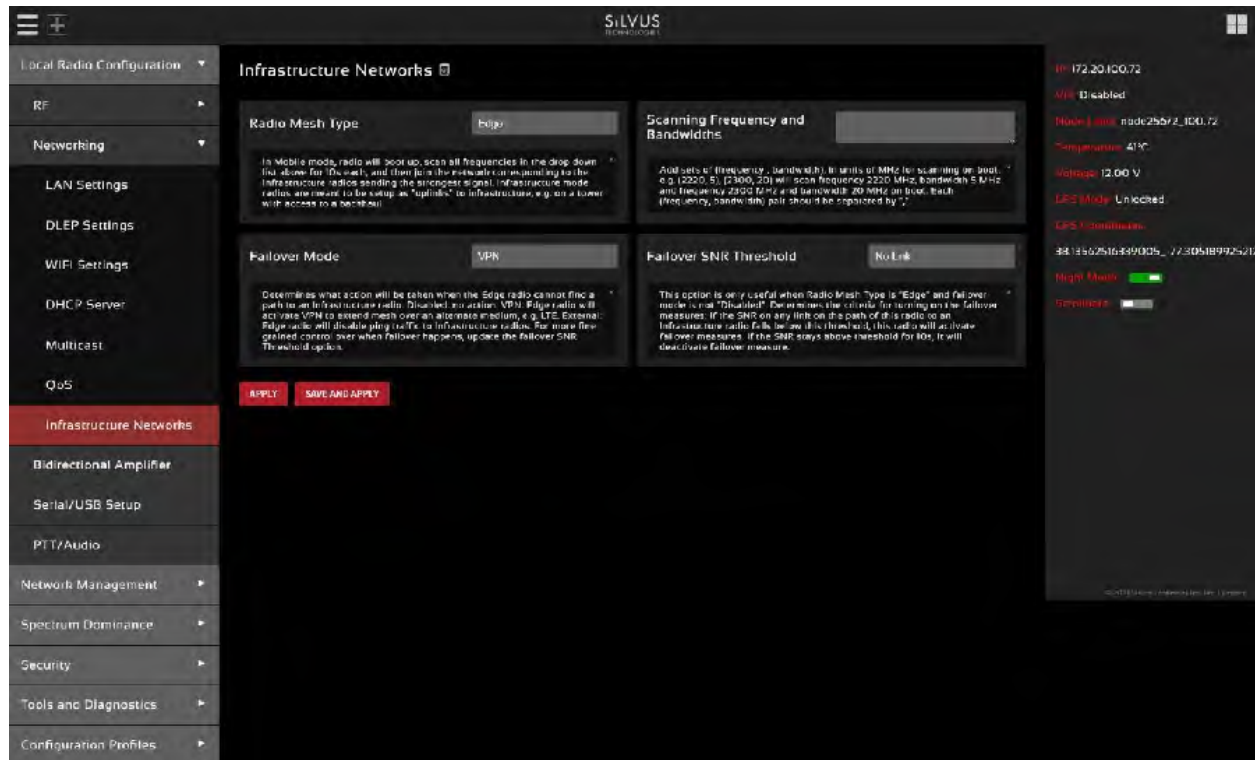


Figure 37 Infrastructure Networks

- Radio Mesh Type:** Mesh is the normal operating mode. The other options are related to large-scale city-wide network type deployments where you have several fixed sites that have backhaul to each other. In Edge mode, radio will boot up, scan all frequencies listed in the “scanning frequency and bandwidths” parameter on this page for 10s each, and then join the network corresponding to the infrastructure radios sending the strongest signal. Infrastructure mode radios are meant to be setup as "uplinks" to infrastructure, e.g. on a tower with access to a backhaul.
- Scanning Frequency and Bandwidths:** This field will populate after radio mesh type is set to Edge. Edge radios on the ground will connect to the tower radio that has the strongest signal. When the Edge radio is booting up, it either scan the frequencies from the supported frequencies (default) or from the Scanning Frequency and Bandwidths field (if specified). Input each frequency and bandwidth to scan in the (frequency, bandwidth) format. The radio will scan each frequency for 5.5 seconds, then it will pick the frequency with the best SNR,

and switch to that frequency. You'll see the edge radio join the network of the infrastructure mode.

- **Failover mode:** Determines what action will be taken when the Edge radio cannot find a path to an Infrastructure radio. Disabled: no action. VPN: Edge radio will activate VPN to extend mesh over an alternate medium, e.g. LTE. External: Edge radio will disable ping traffic to Infrastructure radios. For more fine grained control over when failover happens, update the failover SNR Threshold option.
- **Failover SNR Threshold:** This option is only useful when Radio Mesh Type is "Edge" and failover mode is not "Disabled". Determines the criteria for turning on the failover measures: If the SNR on any link on the path of this radio to an Infrastructure radio falls below this threshold, this radio will activate failover measures. If the SNR stays above threshold for 10s, it will deactivate failover measure.

5.1.3 Bidirectional Amplifier (not available on SL4200)

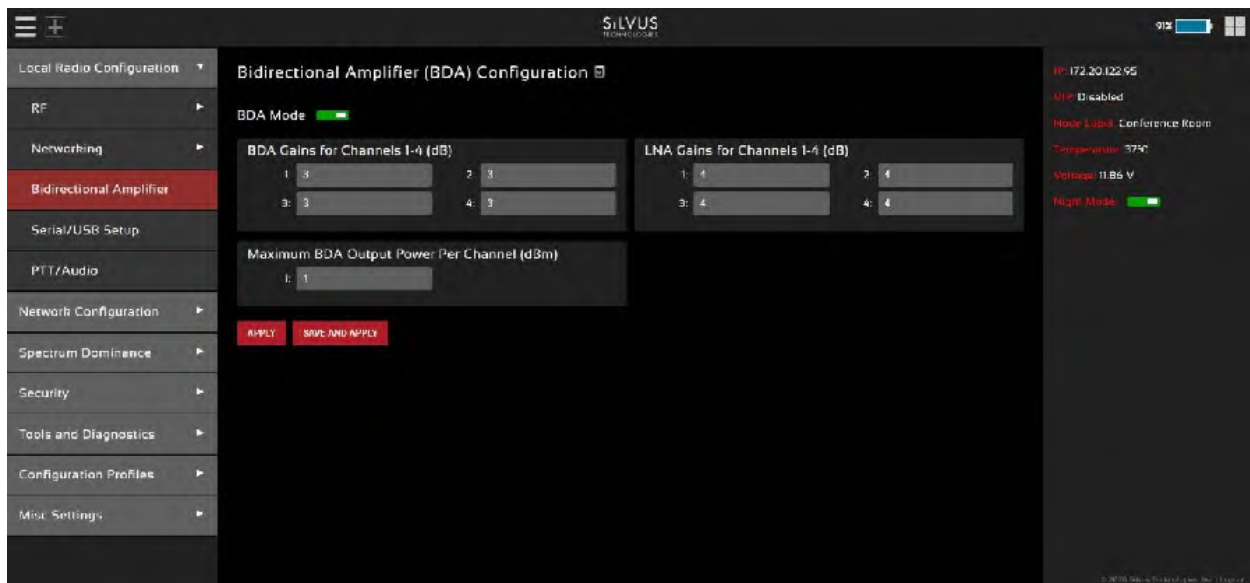


Figure 38 Bidirectional Amplifier (BDA) Configuration Page

The BDA Support page is used to configure the radio to work with an external bi-directional amplifier. These settings should be configured before connecting the amplifier to the radio.

- **BDA Mode:** You can enable or disable the BDA mode here.

Basic Settings:

- **BDA Gains for Channels 1-4:** Enter the gain (dB) for the power amplifier connected to each channel of the radio. This is sometimes labeled as Tx gains.
- **LNA Gains for Channels 1-4:** Enter the gain (dB) for the LNA connected to each channel of the radio. This is sometimes labeled as Rx gains.
- **Maximum BDA Output Power Per Channel (dBm):** Enter the maximum output power for each PA. If the dBm is not listed, you should be able to calculate this from the Watt rating of the amp.
- **Apply:** Apply the new values but does not save them to flash.
- **Save and Apply:** Save the new values to flash and apply.

5.1.4 Serial/USB Setup

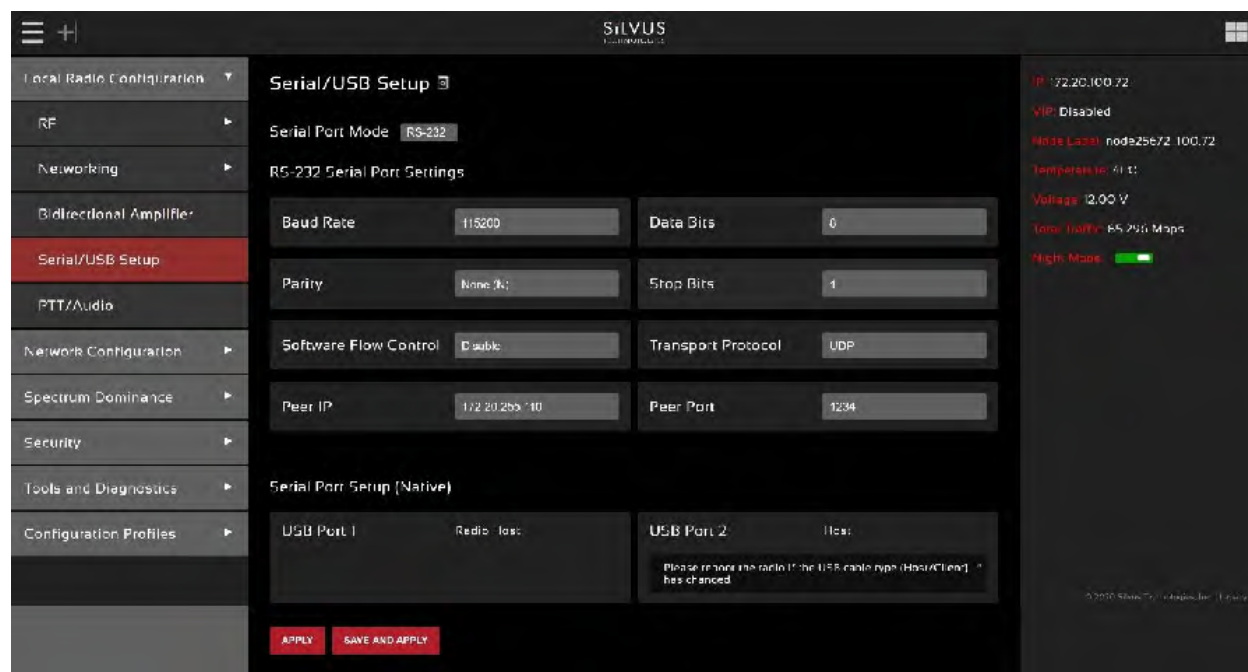


Figure 39 Serial/USB Setup Page

Serial Port Setup:

Each StreamCaster is equipped with one user configurable serial port. A special power cable and null modem cable are required for access to the radio's serial port. A brief description of each parameter is given below.

- **Serial Port Mode:** The user can select one of four available modes for the serial port: *GPS*, *RS232*, *Debug*, and *Disabled*.

- **GPS:** In GPS mode, an external serial GPS module can be connected to and powered from the serial port of the radio. A `gpsd` service daemon running on the node will make the GPS information available to any user on the network from TCP/IP port 2947. For more information on `gpsd` please see: <http://catb.org/gpsd/>

In addition, GPS information can be pushed to the radio via the Ethernet or pulled by the radio from a remote device. If using a remote device to obtain GPS, set the GPS mode to remote, the GPS Server IP to the IP address of the remote device, and the Port. The radio will try to connect via TCP to server on local subnet. It will expect data in GPSd format. If GPS information is pushed to the radio via Ethernet, the radio will listen on specified port and expect GPS data as NMEA Formatted UDP packets.

- **RS-232:** The RS-232 mode provides a wireless serial connection between any two serial devices connected to StreamCaster radios on the network. In this mode, the user must configure the RS-232 protocol parameters shown in **Figure 39 Serial/USB Setup Page** above. The transport protocol for the serial data can be set as either TCP or UDP. For data that is sensitive to latency such as command and control data, UDP is recommended. For data that cannot tolerate any data loss, such as telemetry data, TCP is recommended.
 - The Peer IP should be the IP address of the radio on the other end of the RS-232 communication.
 - The Peer IP can be the native or virtual IP address but must be consistent at both ends.
 - Baud rate must match the baud rate of data being sent from the device.
 - Note – An additional ‘null modem’ cable may be needed at either end, depending upon whether connected device is acting as a terminal or as a control (DTE or DCE)
- **Debug:** The debug mode is used to gain terminal access to the StreamCaster radio and is available for debug or interface purposes (API commands). The user’s terminal client should be set to a baud rate of 115200 for console access to the radio.
- **Disabled:** This mode completely disables the serial terminal of the radio.
- **Serial Server:** This will have the same parameter inputs as the RS-232, but will not have a peer IP or transport protocol. This is because you are not trying to connect to just one peer IP. The transport protocol is automatically configured for TCP. On the client side of this connection, ethernet will be used and so the serial port is not configured. It is recommended to configure the serial port as GPS or disabled.

- **Apply:** Apply the new values but does not save them to flash.
- **Save and Apply:** Save the new values to flash and apply.

USB Status (3822/4200/4400):

The USB port on the 3822/4200/4400 can auto-detect whether the connected device is a USB host or client device. The USB cable should not be unplugged while the radio is running.

5.1.5 PTT (push-to-talk) (not available on SL4200)

The screenshot displays the Silvus StreamCaster 4000 series MIMO Radio configuration interface, specifically the "Push-to-Talk (PTT) & Audio" settings page. The interface is dark-themed with a sidebar on the left containing navigation options: Local Radio Configuration, RF, Networking, Bidirectional Amplifier, Serial/USB Setup, PTT/Audio (highlighted), Network Configuration, Spectrum Dominance, Security, Tools and Diagnostics, Configuration Profiles, and Misc Settings.

The main content area is titled "Push-to-Talk (PTT) & Audio". At the top, there is a "PTT Status" toggle switch, which is currently turned on (green). Below this, the "Push-to-Talk Voice Groups" section displays a grid of 15 PTT groups, each with a name (PTT Group 1 through PTT Group 15) and a status indicator (Active or Inactive). PTT Group 1 is currently Active, while all other groups are Inactive.

The "PTT/Audio Settings" section contains various configuration options:

- Mic Type:** Set to "CONDENSER".
- Audio Encoder Type:** Set to "Variable Rate Codec".
- Audio Codec Rate:** A slider set to 10 kbps.
- Mic Volume:** A slider set to 50.
- Beep Volume:** A slider set to 100.
- PTT Aggregation Delay:** A slider set to 100. A note below states: "Lower values will have lower latency and higher values will have higher efficiency. Measured in milliseconds."
- Dual PTT/COS:** Set to "Disable".

A warning message is displayed below the Beep Volume slider: "When PTT button is pressed during an incoming call, a warning beep will be played. This will control the volume of the beep as a percent (50) of the speaker volume above. Pressing the PTT button while in this state will terminate the incoming call."

The "PTT HQ Link Notifications" section shows a "monitored" status and a "Refresh" button. Below this, there is a bar chart showing link quality over time, with values 1038 and 1038 displayed. The "Notification Volume" is set to 100, and the "Repeat notifications when no link to HQ" checkbox is checked.

At the bottom of the settings section, there are two buttons: "APPLY" and "SAVE & APPLY".

The right sidebar displays system information: IP: 192.168.1.105, VSW: Disabled, Power Label: Conference Room, Temperature: 30°C, Voltage: 1.80 V, and Night Mode: (indicated by a green bar).

Figure 40 Push-to-Talk (PTT) & Audio Page

The PTT page can be used to configure talk groups (Multicast Groups) and speaker/mic settings for PTT enabled radios. Radios will only communicate with other radios that are subscribed to the same 'Multicast Group'. Radios can be active in multiple talk groups. PTT will always send its multicast traffic using MANET Multicast method. PTT traffic will use port 1234.

Multicast Group – Input the IP address of the multicast group. Radios will only communicate to radios within the same group. There are three different modes to select which dictate how a radio behaves within a group:

- **Active:** Radio may send and receive PTT audio on this group.
- **Inactive:** Group is disabled, no PTT audio will be sent or received.
- **Monitor:** Radio may listen to PTT audio from other users on this group, but may not talk.

Mic Type – Supported MIC types are Moving Coil or Condenser. The input amplification is adjusted based on the Mic Type chosen on this page

Mic Bias Voltage – Options are 90% (3V) or 65% (2.15V).

Audio Encoder Type – Default option is 'Variable Rate Code (OPUS)'. 'G.722 (high quality)' and 'G.711' are also supported for backwards compatibility

Speaker Volume – Moving slider adjusts the gain on the speaker

Mic Volume – Moving slider adjusts the gain on the microphone

Beep Volume + PTT Override – When the PTT button is pressed while another user is speaking, a warning beep will be played. This setting controls the volume of the Beep as a percent (%) of the speaker volume above. Pressing the PTT button three times (and holding on the third) within 1s will allow a user to override the channel and speak.

PTT Aggregation Delay – Lower values will have lower latency and higher values will have higher efficiency. Measured in milliseconds.

Dual PTT/COS – This allows Dual PTT functionality for some mic handsets to talk on two talk groups at the same time. COS is to allow ROIP functionality.

PTT HQ Link Notifications – When the PTT button is pressed twice within 1s, an audio notification will read out the SNR level to the user-specified HQ node. If the level transitions option is enabled, the notification will be played automatically when the SNR crosses the specified thresholds. The SNR thresholds can be set by first choosing the number of levels desired, and then moving the sliders accordingly.

5.2 StreamScape Network Configuration

Silvus' StreamScape Network Management Utility was designed to monitor the status of a Silvus mesh network in real-time. The graphical interface network map, shown in **Figure 41 Silvus StreamScape Network Topology Page**, allows users to quickly and effortlessly view the network topology and observe key parameters of the network. For ease of use, the Silvus StreamScape utility is designed to be accessible from a Firefox or Chrome web browser.

5.2.1 Network Topology

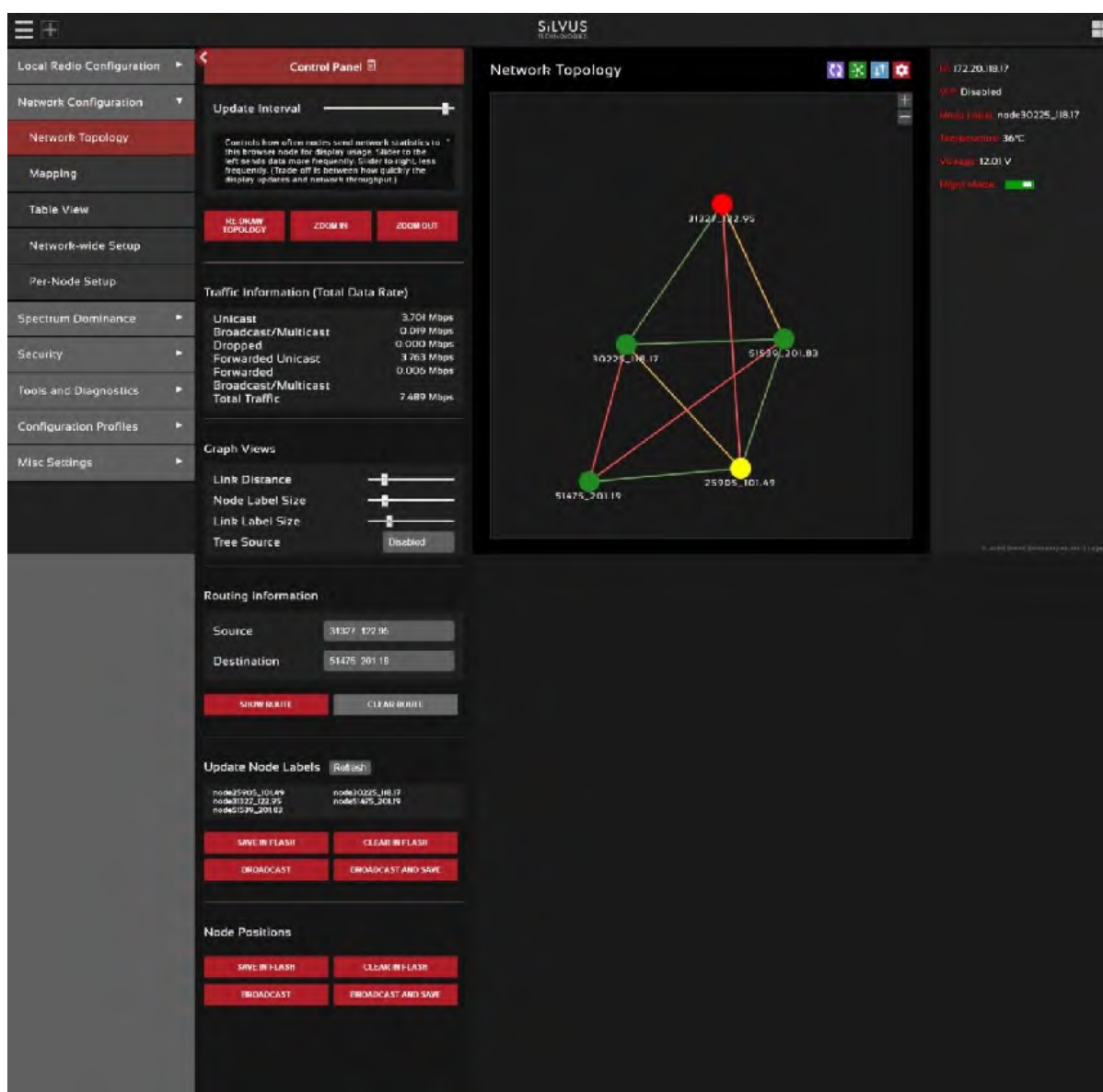


Figure 41 Silvus StreamScape Network Topology Page

The network topology provides the user with real-time visual feedback of the network. Users will be able to determine several network characteristics at a glance with the following features:

- **Color Coded Link Health** – Color coding of each link in the network allows the user to quickly identify the weak links within a network. A link between two nodes will transition from green to yellow to red as the link weakens while also displaying the SNR of the link. This can be seen in **Figure 42 Example Network Topology**.
- **Route Health** – The Silvus StreamScape Utility will alert the user when too many packets are being routed through a single node. In such cases, a node will change from green to yellow to red as the packet queue increases (see '31327_122.95' and '25905_101.49' in **Figure 42 Example Network Topology**). This will allow the user to recognize the issue and configure the network accordingly. Table below also shows the values for each scenario.

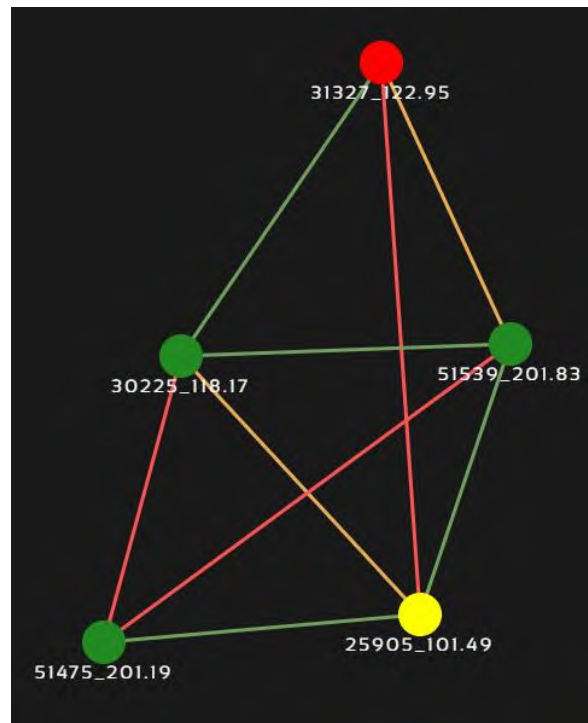


Figure 42 Example Network Topology

	Green	Orange	Red
Link	>20dB	10-20dB	<10dB
Node	<10 Packets in Queue	10-100 Packets in Queue	>100 Packets in Queue

Table 25 Color Coding for Links and Nodes

- **Individual Node Characteristics** – By double clicking on any node in the network, users can view key operating characteristics of the node. **Figure 43 Individual Node Characteristics** shows an example of this for 'node25905'. The characteristics shown are:

- **Node ID:** The unique node ID assigned to each node at time of manufacture. This cannot be changed.
- **IP:** IP address of the node.
- **MAC:** MAC address of the node.
- **Connections:** Number of direct connections to node. Each directly connected node is listed in the following format:

<Node Name> <RX SNR> <TX MCS> <Variable GI Mode><Pkts in TX Queue> <Num. of Spatial Streams><UDP User Throughput (Mbps)>

<Air Time %><Data Rate (Mbps)><Loss Rate %><RSSI Ch1> <RSSI Ch2> <RSSI Ch3> <RSSI Ch4>

Notes:

- The 'Air Time' specifies the percentage of time the radio is transmitting.
- Data rate shown is actual user data rate in Mbps.
- MCS or NSS of N/A signifies that no data has been sent to that radio yet.
- **Frequency:** RF center frequency of the node.
- **Bandwidth:** RF bandwidth of the node.
- **Noise Level:** Received noise level of the node.
- **Interference:** Approximate in-band interference level.
- **TX Power:** Total target transmit power of node.
- **TX Power (Actual):** Actual transmit power of node. This value may differ from the target transmit due to temperature variation or inability to transmit a clean signal with the selected MCS at the target power.
- **Fragmentation Threshold:** Chosen fragmentation threshold.
- **Virtual IP:** Secondary IP address of node (0 if none set).
- **MCS Mode:** Transmit MCS of node.
- **Variable GI mode:** The variable GI mode setting for this node.
- **Link Distance:** Link distance setting of node.
- **Burst Time:** Burst time setting of node.

- **Routing Beacon Period:** Routing Beacon Period setting of node.
- **Routing Beacon MCS:** This is the MCS setting that the routing beacons will use.
- **RTS Retries:** RTS Retry setting of radio.
- **Contention Window Minimum:** Low Priority Contention Window Minimum setting of node.
- **Maximum Ground Speed:** Maximum Ground Speed setting of node.
- **Queue Size:** Number of packets currently waiting to be transmitted.
- **Total Air Time:** Total percentage of air time being used by this radio.
- **Total Data Rate:** Total data rate in Mbps being transmitted from this radio.
- **Input Unicast Rate:** Total data rate pushed into the radio as Unicast
- **Input Broadcast/Multicast Rate:** Total data pushed into the radio as Multicast
- **Input Dropped Rate:** Total data rate dropped by the radio
- **Forwarded Unicast Rate:** Total data rate forwarded by the radio as Unicast
- **Forwarded Broadcast/Multicast Rate:** Total data rate forwarded by the radio as Multicast
- **Last Updated:** Duration that has passed in seconds since last update.

29505_101.49

Node ID: 29505 IP: 172.20.101.19 MAC: 02:03:0C:00:00:81

Connections: 4

Node	SNR (dB)	MCS	Variable GI Mode	Queue Size	RTS	UDP Live Throughput (Mbps)	Air Time (%)	Low Data Rate (Mbps)	Loss Rate (%)	Received Signal Power (dBm)			
										1	2	3	4
80025_118.57	20	4	Extended (32)	Auto	0	1	5.44	0.00	0.00	-78	-79	N/A	N/A
81827_132.95	13	0	Regular (auto)	0	1	1.21	0.00	0.00	0.00	-86	-85	N/A	N/A
01460_201.14	20	0	Regular (auto)	0	1	1.14	0.00	0.00	0.00	-71	-71	N/A	N/A
81539_101.43	31	12	Regular (auto)	0	2	12.65	1.41	0.022	0.00	-67	-65	N/A	N/A

Frequency: 2385 MHz

Bandwidth: 5 MHz

Noise Level: -98 dBm

Interference: 3 dB

TX power: 0 dBm

TX power (Actual): 0 dBm

Fragmentation Threshold: 1600 bytes

Virtual IP: 10.10.10.25

MCS Mode: Extended Auto - GI

Variable GI mode: Extended (32)

Link Distance: 5000 meters

Burst Time: 50 ms

Routing Beacon Period: 100 ms

Routing Beacon MCS: 0

RTS Retries: 1

Contention Window Minimum: 4

Maximum Ground Speed: 10 mph

Queue Size: 0

Total Air Time: 4.02 %

Total Data Rate: 0.108 Mbps

Input Unicast Rate: 0.002 Mbps

Input Broadcast/Multicast Rate: 0.008 Mbps

Input Dropped Rate: 0.000 Mbps

Forward Unicast Rate: 0.000 Mbps

Forward Broadcast/Multicast Rate: 0.002 Mbps

Last Updated: 2s

SHOW CONNECTED DEVICES

Figure 43 Individual Node Characteristics

- **Link Characteristics** – By double clicking the mouse on any link in the network, users can view key operating characteristics of that link. **Figure 44 Link Characteristics** shows an example of this for the link between ‘node30225’ and ‘node51539’. The characteristics shown are:
 - **SNR:** The SNR of the link in each direction.
 - **MCS:** The MCS used to transfer data in each direction.
 - **Variable GI Mode:** The variable GI mode used for the transmitting node.
 - **UDP User Throughput:** The estimated UDP User Throughput available for each direction of the link. This is estimated based on the current MCS used for transmission.
 - **Queue Size:** Number of packets in TX Queue in each direction.
 - **NSS:** Number of Spatial Streams in each direction.
 - **Air Time:** Percentage of air time used in each direction
 - **Data Rate:** Data rate in each direction
 - **Data Loss Rate:** Percentage of data lost during transmission
 - **Received Signal Powers:** Received signal power for each antenna in each direction.

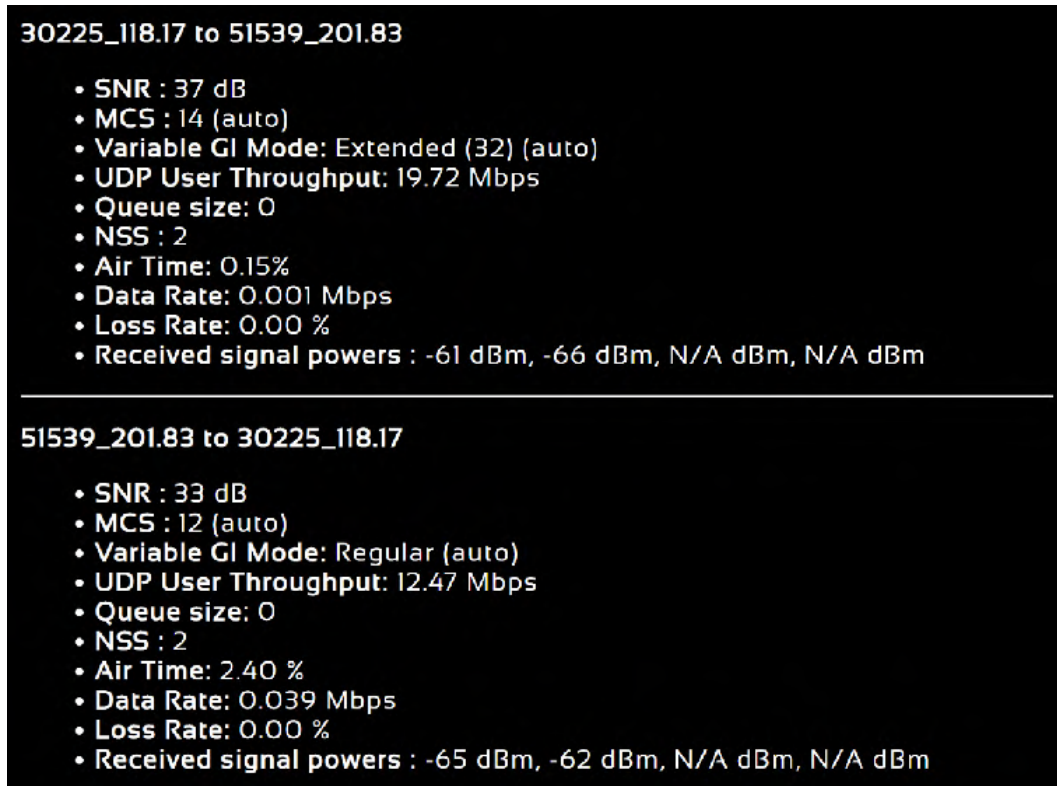


Figure 44 Link Characteristics

5.2.1.1 Control Panel

To open the control panel left-click on the red settings icon (■) at the top right of the graphic, and the control panel will populate on the left-hand side.

- **Update Interval** – Controls how often nodes send network statistics to this browser node for display usage. Move the slider to the left sends data more frequently. Move the slider to right, less frequently. (Trade-off is between how quickly the display updates and network throughput required to send the updates.)
- **Traffic Information** – The traffic information is shown in table form in the control panel as well. It contains all the current network traffic information of the entire network.

Traffic Information (Total Data Rate)	
Unicast	2.953 Mbps
Broadcast/Multicast	0.013 Mbps
Dropped	0.000 Mbps
Forwarded Unicast	3.492 Mbps
Forwarded Broadcast/Multicast	0.009 Mbps
Total Traffic	6.467 Mbps

Figure 45 Traffic Information

- **Graph Views** – The graph views section allows you to edit the graph to the preference of the network administrator. You can extend the distance between nodes by dragging the link distance bar to the right. Sliding the node label size or link label size to the right will use a larger font for the labels of the node or link respectively. Tree source is suggested for dense networks when the structure of the network is not immediately apparent from the regular view (tree source disabled). By selecting a specific node to be the tree source, the network topology will show you how each radio is routed to that node. Tree source views will only display the link colors and not the SNR.

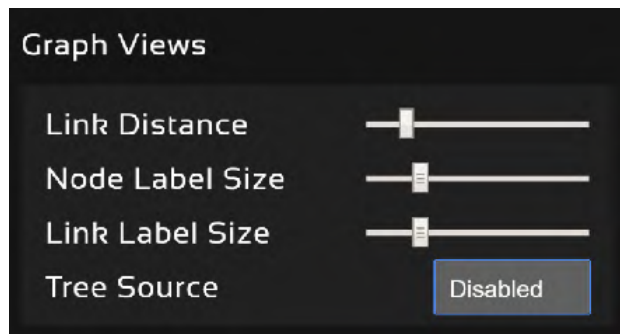


Figure 46 Graph Views

- Routing Information** – The user can view the routing path between any 2 nodes within a network by simply specifying the source and destination node in the Control Panel. The path will turn bold as shown in **Figure 47 Routing Path** for the path from ‘node31327’ to ‘node51475’. In the control panel section it will also list the routing path used between these two nodes, and the routing path available link capacity in UDP.

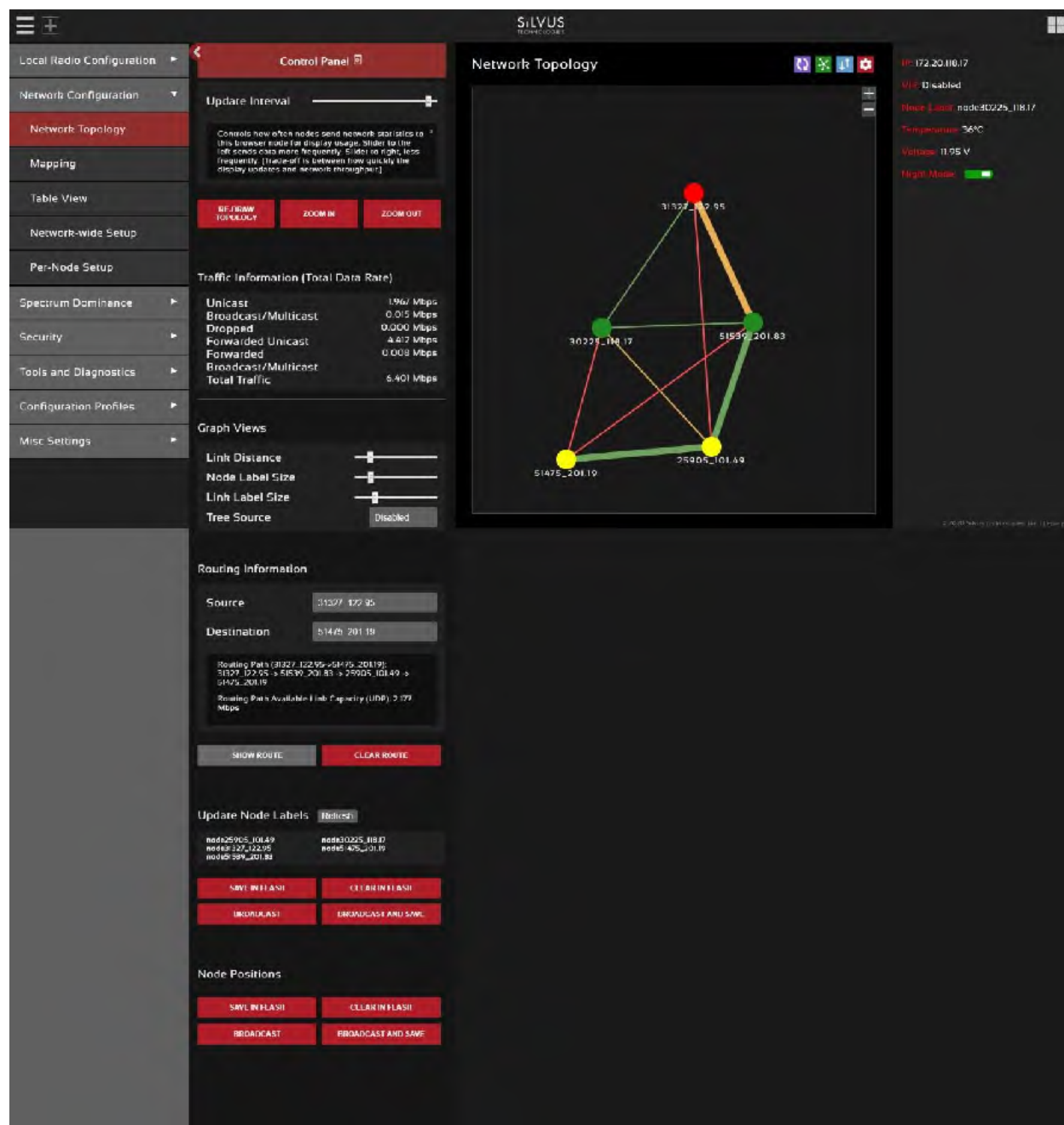


Figure 47 Routing Path

- **Update Node Labels** – Naming each node in the network is as simple as double-clicking on the node name and typing in a new name in the update node label section of the control panel as shown in **Figure 48 Custom Node Naming**. Once this is done, the user will need to hit enter to keep the node name. Otherwise it will change back to what it was. This feature enables quick identification of nodes in the field and is especially useful in mission critical situations with many mobile assets. The user can click on the ‘Save Labels in Flash’ button to store the node names to the radio’s flash memory. This will store the names on the radio even after the radio is powered off. The saved labels can also be cleared back to the defaults by clicking ‘Clear Labels in Flash’. The node labels set in one radio can also be broadcasted to other radios in the network by clicking the ‘Broadcast Node Labels’ button.

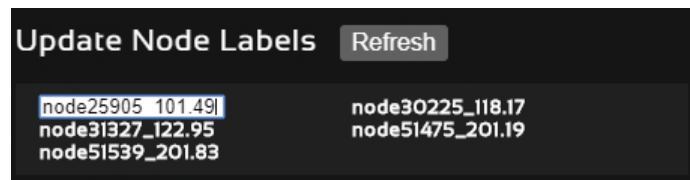


Figure 48 Custom Node Naming

- **Node Position** – You can customize the node positions in the network topology page by click and dragging the node dot. If you would like to save the custom node positions, you can save these positions to the flash memory on the radio. You can also broadcast and save these node positioning to all other radios on the network.

5.2.1.2 Send Traffic Between Nodes

Users can send test traffic across radios within a network using the built-in iPerf feature. This feature can be accessed by clicking the blue arrow icon (■) on the top right of the graphic. If you hover over the icon the title “Send traffic between nodes” will appear. This will pull out the menu where users can specify UDP/TCP data, source/destination, port, time to send, and datagram size as seen below in **Figure 49 iPerf Function within GUI**.

- **Source:** Radio that sends data (Client)
- **Destination:** Radio that is listening (Server)
- **Destination port:** Port number for the data transfer
- **Time to Send (TTS):** Amount of time user wants to send data
- **Bandwidth (BW) to Send:** Data rate to send, in Mbps
- **Datagram Size:** Size of the datagram
- **Effective Bandwidth:** The actual network load.

- **Jitter:** The variation in delays in the received packet.
- **Lost/Total Datagrams:** The amount of packets lost vs total packets sent

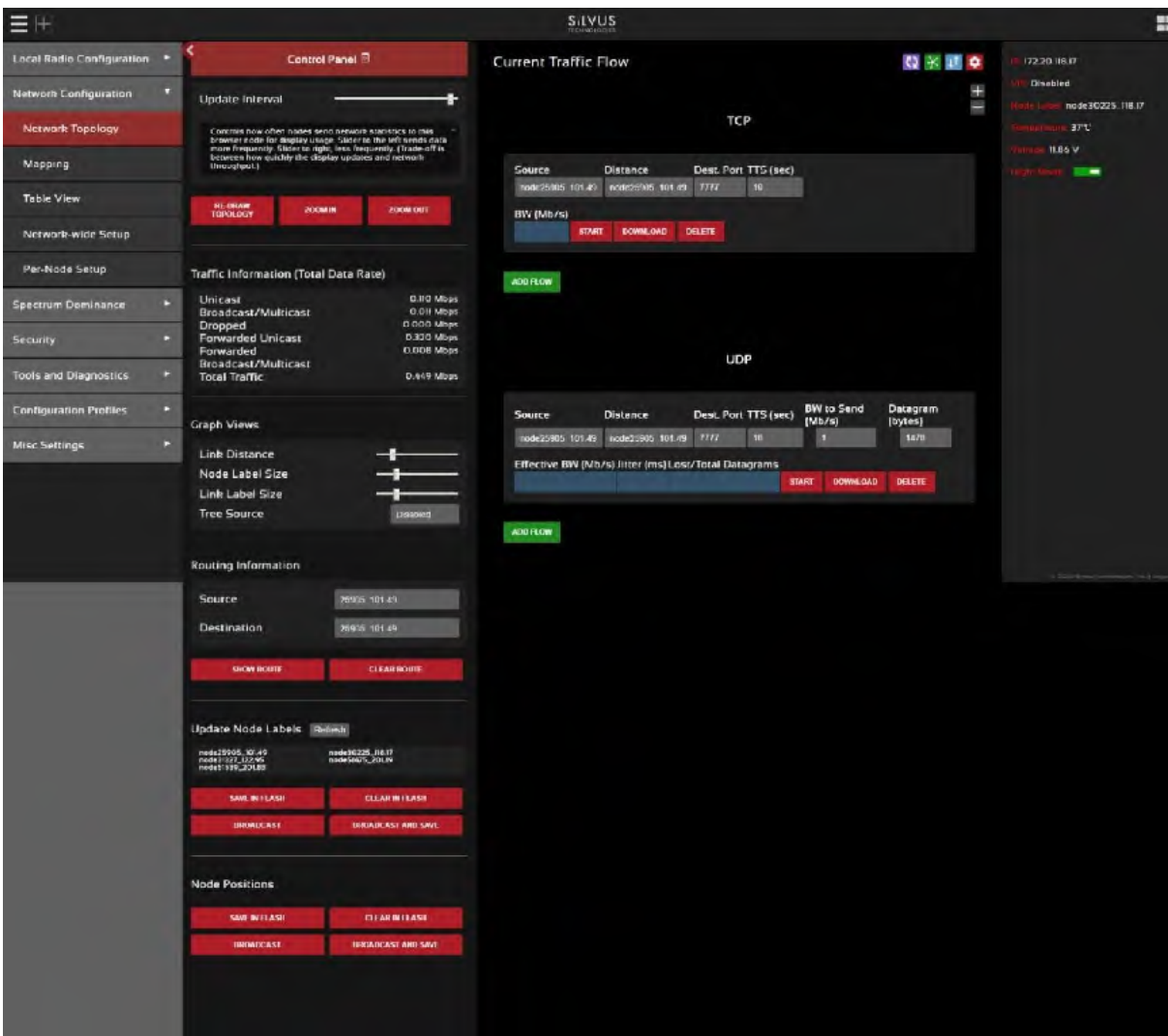


Figure 49 iPerf Function within GUI

You can add multiple iPerf sessions to run at the same time by click on the green “ADD FLOW” button. You can start and stop each session individually and download the results of the iPerf test by clicking on the download button after the iPerf test is complete.

5.2.2 Mapping

The Mapping page provides an easy-to-use method of tracking the location of nodes in real time. Nodes with GPS modules attached will be tracked on the map as shown in **Figure 50 Mapping Page**.

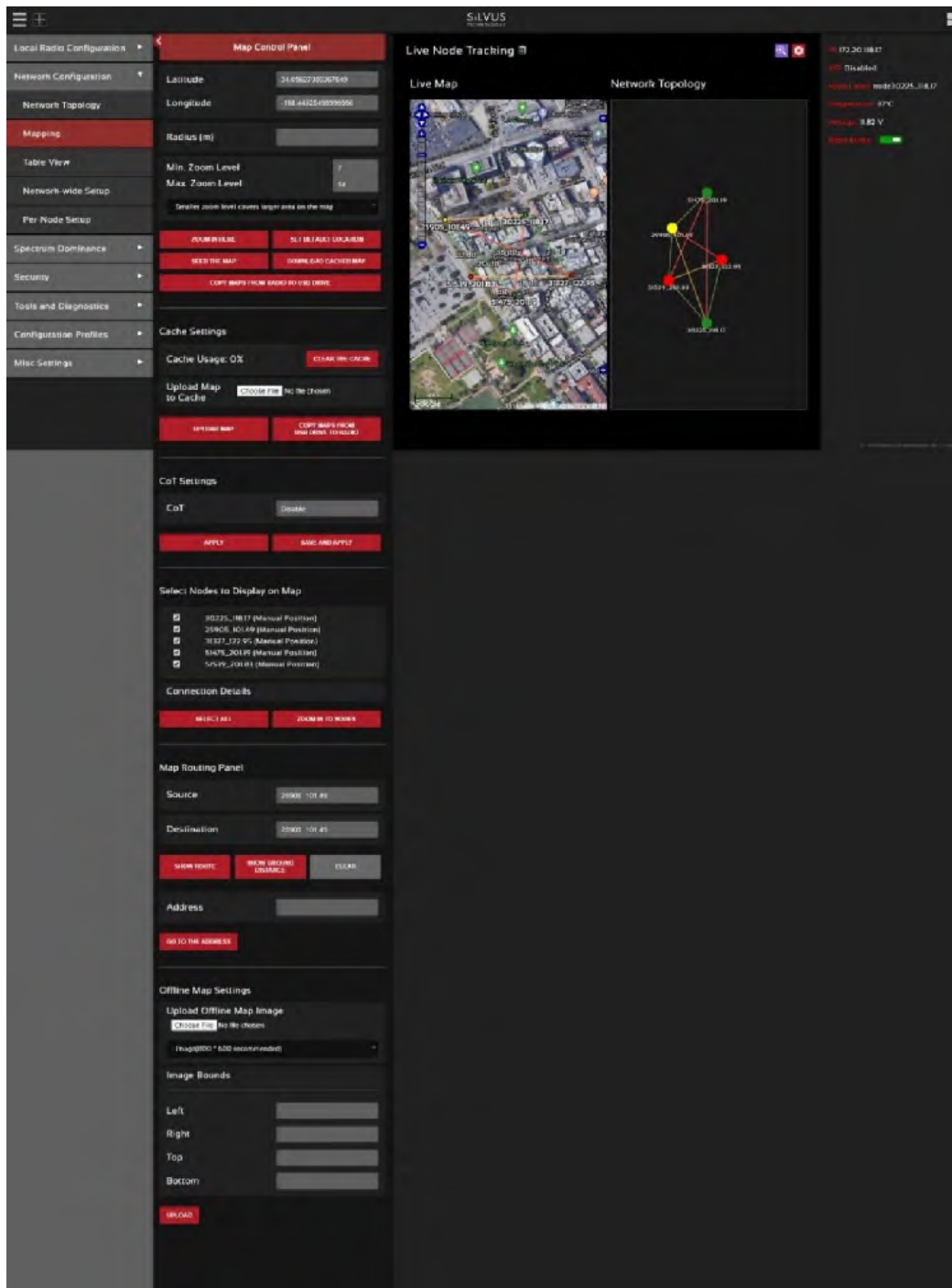


Figure 50 Mapping Page

For convenience, a small copy of the network topology is displayed on the right-hand side of the page. This allows users to clearly view the network characteristics in instances where nodes are physically close to one another and difficult to distinguish on the map overlay.

5.2.2.1 Map Options

There are 3 map options currently available in the Map Overlay view. The default map is OpenStreet Maps. OpenStreet Maps Silvus can be saved to the radio's internal memory for offline use. For instructions to Download OpenStreet Maps into the radio, see section Downloading Maps. OpenStreet Maps Silvus is a version of OpenStreet maps which is hosted on Silvus' servers in case of an interruption in service with OpenStreet Maps. The Silvus maps is currently only guaranteed to cover the United States. However it should have some international maps as well.

In Addition to OpenStreet Maps, Google Maps and Google Satellite are also available. This can be changed by clicking the '+' symbol at the top right of the map:

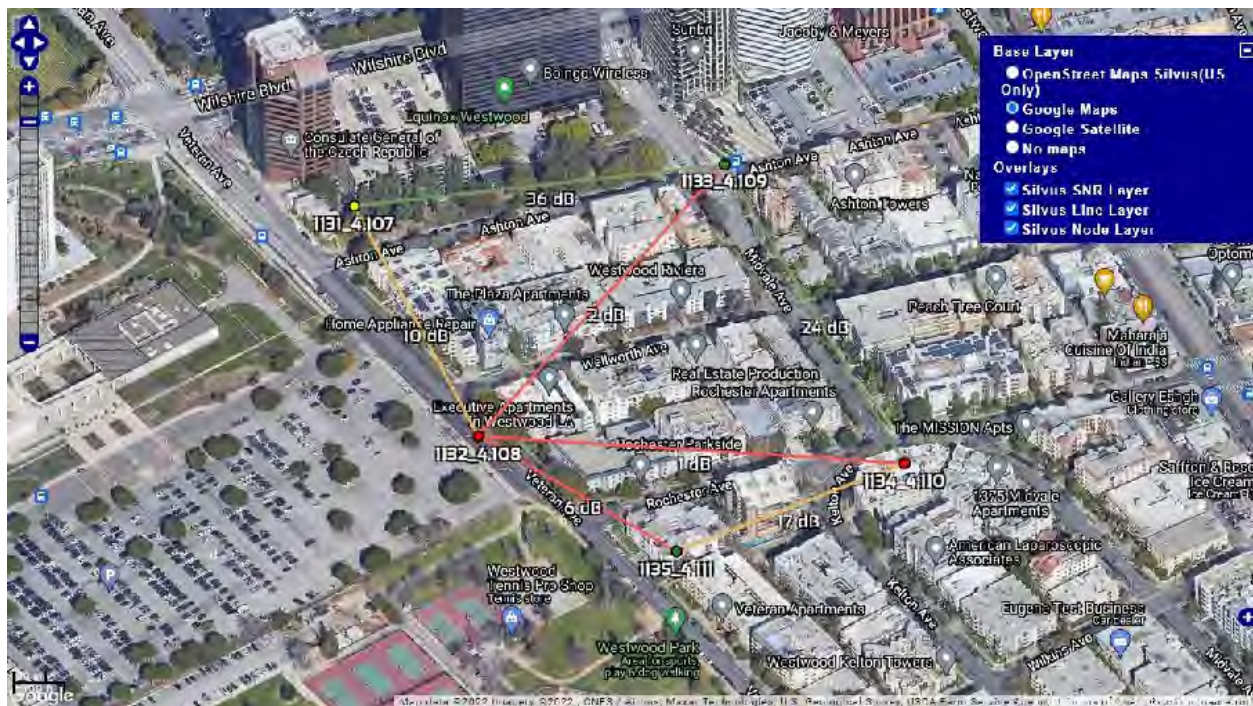


Figure 51 Google Maps

Note that Google Maps and Google Satellite require an active internet connection on the viewing computer. These maps cannot be saved for offline use.

5.2.2.2 Map Control Panel

To open the Map Control Panel, please select the red settings icon (■) on the top right of the page. This will populate the map control panel on the left side of the map overlay.

Lat/Long coordinates:

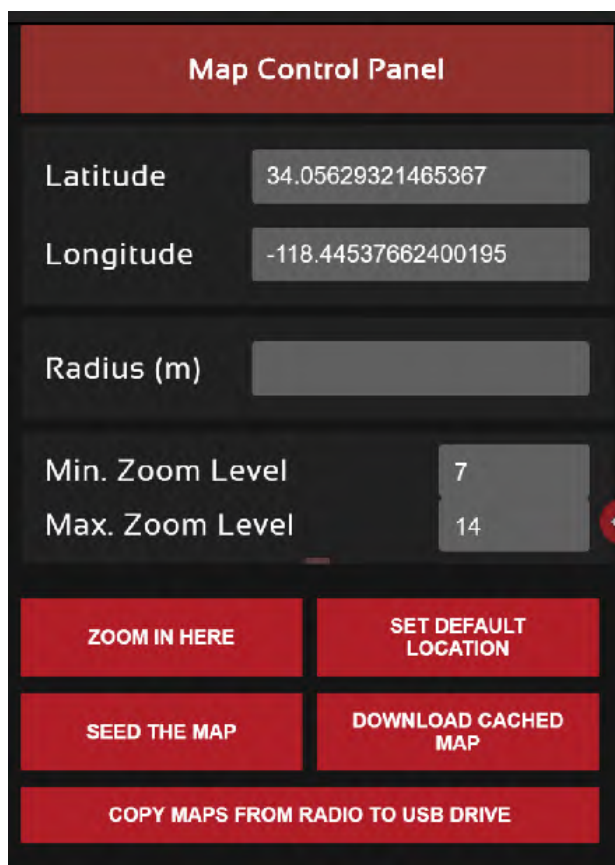
The image shows a 'Map Control Panel' with a dark background and red accents. At the top is a red header bar with the title 'Map Control Panel' in white. Below this are several input fields: 'Latitude' with the value '34.05629321465367', 'Longitude' with the value '-118.44537662400195', and 'Radius (m)' which is currently empty. Below these are two more input fields for 'Min. Zoom Level' (value '7') and 'Max. Zoom Level' (value '14'). At the bottom of the panel are five red buttons with white text: 'ZOOM IN HERE', 'SET DEFAULT LOCATION', 'SEED THE MAP', 'DOWNLOAD CACHED MAP', and 'COPY MAPS FROM RADIO TO USB DRIVE'.

Figure 52 Map Control Panel (Lat/Long coordinates)

The first section of the Map Control Panel will allow you to input a lat/long coordinate. After entering the lat/long coordinates you can have the map overlay zoom to these coordinates.

The 'Zoom in Here' function does not consider the radius parameter. It will simply zoom to that location. The 'Radius' is used when you want to cache (Seed) the map. The radio will download the map area based on the coordinates and radius as well as the zoom levels specified.

The zoom level corresponds to the different zoom levels available on the map (from 0-14). This is used to determine what zoom levels of the map you want to 'Seed' Zoom in Here.

Set Default Location – This is referring to setting the default location of a radio when that radio doesn't have GPS lock. You can do this by right clicking on the map in the location that you want to place the radio, and that will pop-up a menu where you can choose which radio to set there. That radio will default to that location when no GPS data is present. If the radio gets a GPS lock, it will use the real GPS data instead.

Seed the Map – This is when you download or cache the map. This function allows you to store map imagery into the radio for offline use. You can only cache the 'OpenStreet Maps' option. To download map imagery, you should set the lat/long of the center point, input a desired radius, specify desired zoom levels, then click 'Seed the Map'. This will then download the map imagery within those parameters. Note that the radio needs to have access to the internet for this function to work.

Download Cached Map – allows you to download all map imagery stored in the radio into a file that can then be uploaded to another radio.

Copy Maps from Radio to USB Drive – This will copy all of the stored maps in the radio to a file on a USB drive which can then be plugged into another radio and uploaded. This is so you don't need to repeat the caching steps each time.

Cache Settings:

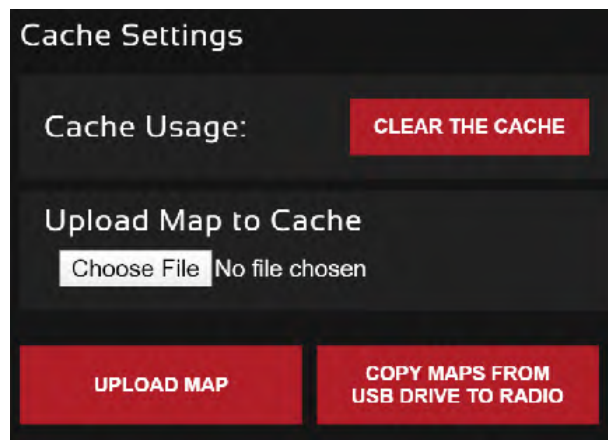


Figure 53 Map Control Panel (Cache Settings)

This section of the Map Control Panel allows you to clear any cached map data, and upload maps saved previously.

Cursor on Target:

CoT Settings

CoT Enable

CoT IP Address/Port: /

Time to Live:

CoT Message Interval (s):

CoT Current Date (UTC): / /
☒ Set As Current Date/Time

CoT Current Time (UTC): : :

CoT Stale Time (s):

CoT Type:

APPLY SAVE AND APPLY

Figure 54 Cursor on Target Settings

Cursor on Target is an exchange standard that is used to share information about targets. This is a messaging format often used in blue force tracking applications such as ATAK. CoT is a multicast type of traffic that will follow the multicast method configured on the default setting under Multicast tab.

- **CoT:** Enable/disable cursor on target
- **CoT IP Address/Port:** IP address/port for the communication to establish
- **Time to Live:** Each time the data packets pass through a router, it will decrement this number. Once it reaches 0, the data packets will no longer continue.
- **CoT Message Interval (Seconds):** How often to send CoT messages
- **CoT Current Date (UTC):** Time stamp of the date. If *Set AS Current Date/Time* is selected, it will be set as the current time displayed on your computer
- **CoT Current Time (UTC):** Time stamp of the time

- **CoT Stale Time (Seconds):** Data outside of this time window becomes invalid
- **CoT Type:** The event type of the target

Select Nodes to Display on Map:

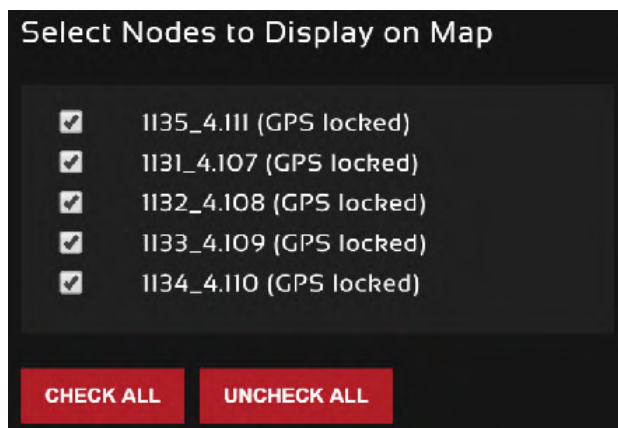


Figure 55 Map Control Panel (Nodes to Display on Map)

In the next section of the map control panel, you select or deselect nodes to be displayed on the map. This could be beneficial if you were trying to track locations of specific radios and wanted to zoom into their location.

Map Routing Panel:

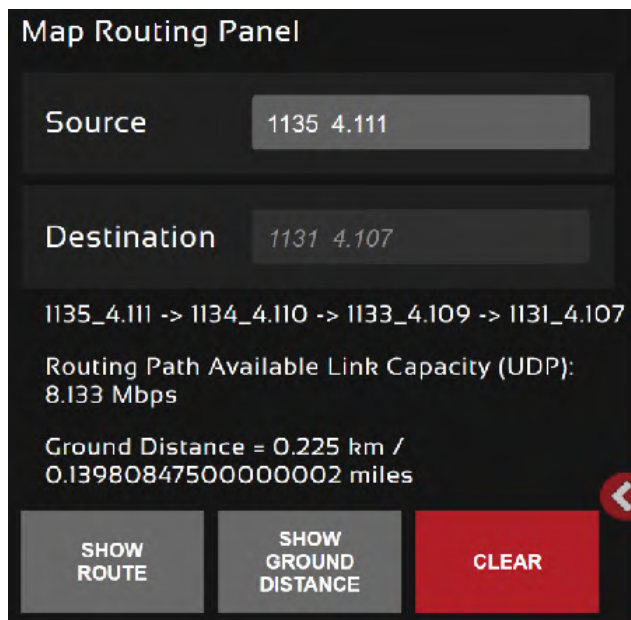


Figure 56 Map Control Panel (map routing panel)

The Map Routing Panel shows you the route path from one radio to another on the map. It also lists the link capacity between the two radios, and the ground distance.

Address:

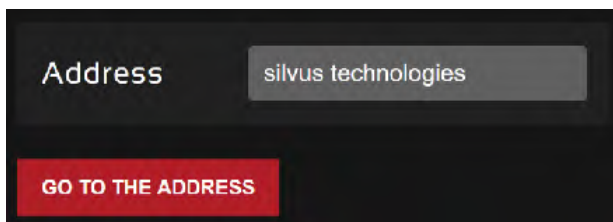


Figure 57 Map Control Panel (address)

The address function can help you zoom the map to a specific address without knowing the lat/long coordinates. This can be a useful tool and can also search for locations by just the name of it.

Offline Map Image:

In addition to the preset map options, the user can also upload a custom image or blueprint in place of the map.

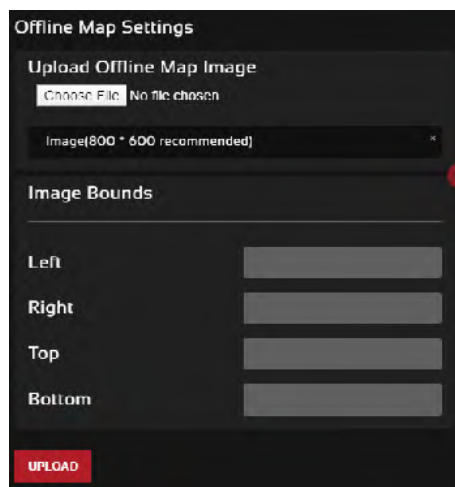


Figure 58 Offline Map Image

To upload a custom image (800 x 600 pixels recommended), first choose the file from your desktop. You will then need to provide the image bounds. These bounds will be the latitude of the left and right bounds of the image and longitude of the top and bottom bounds of the image. Once entered, click upload and there will now be a 4th option when clicking the '+' at the top left of the map overlay.

5.2.2.3 Downloading Maps

An internet connection is required to obtain map data; however, users can cache map data on a node beforehand. For map caching follow these steps:

1. Attach the radio to a laptop and open the Networking/LAN settings.
2. Set the Virtual IP address, netmask, and gateway to values appropriate for your local network. Your local network should be able to access the internet.
3. Attach the radio to your local network and open the Map Overlay tab.
4. Input the address of the location you wish to download
5. You now have two options for caching map data:
 - a. Zoom/pan around the area you are interested in at the zoom level you will be using. This will automatically cache the map data at this zoom level.
 - b. Fill in the radius field (in meters), set the Min/Max zoom levels and click on 'Seed the Map'. This is a beta feature and will attempt to cache the entire area for all appropriate zoom levels. Users should be careful in using this feature since it may take some time and will use up the radio's available memory. For reference, a radius of ~3000m will use approximately 5 percent of the total memory.

5.2.2.4 Manual GPS for Nodes without GPS Module

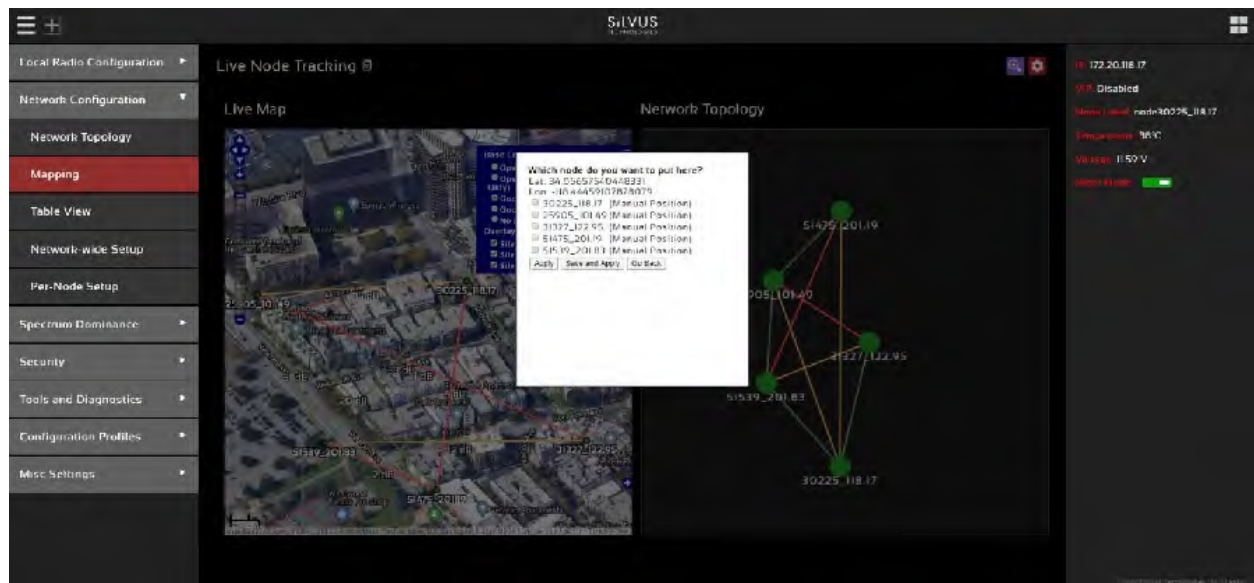


Figure 59 Manually Placing Nodes on the Map

If there are nodes within the mesh that do not have a GPS module connected or are located in an area with no GPS connectivity, the user can easily place the node on the map by right clicking on the desired location on the map and choosing which node to place there. These values will be ignored if GPS coordinates are available via a GPS module.

5.2.3 Table View

The screenshot displays the Silvus StreamCaster 4000 series MIMO Radio User Manual interface. The main content area is titled 'Table View' and contains two sections: 'Statistics' and 'Settings'.

Statistics Section:

- Filters:** Noise Level (dBm), Queue Size, Total Data Rate (Mbps), Input Unicast Rate (Mbps), Input Dropped Rate (Mbps), Forward Broadcast/Multicast Rate (Mbps), Interference (dB), Total Air Time (s), Highest SNR (dB), Input Unicast Rate (Mbps), Input Broadcast/Multicast Rate (Mbps), Input Dropped Rate (Mbps), Forward Unicast Rate (Mbps), Forward Broadcast/Multicast Rate (Mbps).
- Buttons:** SELECT ALL, UNCHECK ALL, APPLY, CANCEL.
- Table:**

Node Label	Noise Level (dBm)	Interference (dB)	Queue Size	Total Air Time (s)	Total Data Rate (Mbps)	Highest SNR (dB)	Input Unicast Rate (Mbps)	Input Broadcast/Multicast Rate (Mbps)	Input Dropped Rate (Mbps)	Forward Unicast Rate (Mbps)	Forward Broadcast/Multicast Rate (Mbps)
25X05_10119	-55	-2	0	5.81	0.12	30	0.002	0.014	0.000	0.001	0.000
30005_10119	-57	-4	0	2.34	0.005	36	0.002	0.001	0.000	0.000	0.000
1022_10119	-45	-4	0	10.5	0.008	31	0.003	0.004	0.000	0.000	0.000
10475_20119	-46	-5	0	1.78	0.013	19	0.006	0.003	0.000	0.000	0.000
10595_20119	-49	-2	0	1.0	0.014	26	0.002	0.003	0.000	0.001	0.003
Nodes: 5				22.09	0.266		0.025	0.023	0.000	0.008	0.003

Settings Section:

- Filters:** Frequency (MHz), Tx Power (dBm), MCS, Burst Time (ms), Routing Beacon MCS, Contention Window Minimum, Bandwidth (MHz), Fragmentation Threshold (Bytes), Link Distance (m), Routing Beacon Period (ms), RTS Retries, Max Channel Speed (mph).
- Buttons:** SELECT ALL, UNCHECK ALL, APPLY, CANCEL.
- Table:**

Node Label	Frequency (MHz)	Bandwidth (MHz)	Tx Power (dBm)	Fragmentation Threshold (Bytes)	MCS	Link Distance (m)	Burst Time (ms)	Routing Beacon Period (ms)	Routing Beacon MCS	RTS Retries	Contention Window Minimum	Max Channel Speed (mph)	CI Mode
25X05_10119	2385	5	0	1600	Ext Auto	5000	50	100	0	1	5	10	Variable - 10/32
30005_10119	2385	5	0	1600	Ext Auto	5000	100	500	0	1	4	0	Variable - 10/32
1022_10119	2385	5	0	1600	Ext Auto	5000	20	100	0	1	4	0	Variable - 10/32
10475_20119	2385	5	0	1600	Ext Auto	5000	10	100	0	1	5	0	Fixed - 16
10595_20119	2385	5	0	1600	Ext Auto	5000	10	100	0	1	5	0	Variable - 10/32

Right Sidebar:

- IP: 172.20.108.17
- WiFi: Disabled
- StreamCaster: node 10595_10119
- PowerSource: NVC
- Current: 11.53 V
- Signal: Good

Figure 60 Table View

The table view tab shows all the statistics and setting profiles in table view. Users can select what is being displayed in the table view by clicking the blue filter icon (■) to the top right of each table. You can deselect or select various parameters in this filter selection to display in the table view.

5.2.4 Network-wide Setup

Using the network-wide setup users can configure key parameters of every node in the network with just one click. Users simply need to check off the parameters they wish to be updated across the network and click on *Apply* to apply but not write new values to flash or *Save and Apply* to apply and save values to flash. The *Broadcast Update Interval* field determines how often, in seconds, the new parameters will be broadcast to the entire network. A list of all nodes will appear on the right with a check box next to each node. This box will be checked off as each node receives the update.

Network-Wide Setup

Frequency (MHz): 2025

Bar Width: 5 MHz

TX Power: 100mW

Fragmentation Threshold: 100 Bytes

MCS Mode: FORTHWARD

CI Mode: 802.11n

Warning: Nodes with IP 172.20.0.255 and below do not support IEEE 802.11n. If you have such radios, it is recommended to stick to the 802.11n mode option's safety.

Link Distance (meters): 5000

Maximum Channel Speed: 3 Mbps

Burst Time: 100 ms

Routing Beacon Period: 500 ms

Routing Beacon MCS: 0

RTS Threshold: 1

Contention Window Minimum (Low Priority): 4

Multicast Stream 1 Configuration:

Multicast Stream 2 Configuration:

Multicast Stream 3 Configuration:

Multicast Stream 4 Configuration:

Multicast Stream 5 Configuration:

Broadcast Update Interval (s): 1

CHECK ALL STOP UPDATE APPLY SAVE AND APPLY

Node List:

- 172.20.0.17
- 172.20.0.18
- 172.20.0.19
- 172.20.0.20
- 172.20.0.21
- 172.20.0.22
- 172.20.0.23
- 172.20.0.24
- 172.20.0.25
- 172.20.0.26
- 172.20.0.27
- 172.20.0.28
- 172.20.0.29
- 172.20.0.30
- 172.20.0.31
- 172.20.0.32
- 172.20.0.33
- 172.20.0.34
- 172.20.0.35
- 172.20.0.36
- 172.20.0.37
- 172.20.0.38
- 172.20.0.39
- 172.20.0.40
- 172.20.0.41
- 172.20.0.42
- 172.20.0.43
- 172.20.0.44
- 172.20.0.45
- 172.20.0.46
- 172.20.0.47
- 172.20.0.48
- 172.20.0.49
- 172.20.0.50
- 172.20.0.51
- 172.20.0.52
- 172.20.0.53
- 172.20.0.54
- 172.20.0.55
- 172.20.0.56
- 172.20.0.57
- 172.20.0.58
- 172.20.0.59
- 172.20.0.60
- 172.20.0.61
- 172.20.0.62
- 172.20.0.63
- 172.20.0.64
- 172.20.0.65
- 172.20.0.66
- 172.20.0.67
- 172.20.0.68
- 172.20.0.69
- 172.20.0.70
- 172.20.0.71
- 172.20.0.72
- 172.20.0.73
- 172.20.0.74
- 172.20.0.75
- 172.20.0.76
- 172.20.0.77
- 172.20.0.78
- 172.20.0.79
- 172.20.0.80
- 172.20.0.81
- 172.20.0.82
- 172.20.0.83
- 172.20.0.84
- 172.20.0.85
- 172.20.0.86
- 172.20.0.87
- 172.20.0.88
- 172.20.0.89
- 172.20.0.90
- 172.20.0.91
- 172.20.0.92
- 172.20.0.93
- 172.20.0.94
- 172.20.0.95
- 172.20.0.96
- 172.20.0.97
- 172.20.0.98
- 172.20.0.99
- 172.20.0.100

Figure 61 Network-wide Setup

5.2.5 Per-Node Setup

The per-node setup can be used to modify key parameters of individual nodes within the network. As shown in **Figure 62 Per-Node Setup**, users will see a list of all nodes available within the network. The directly connected node is listed first with the rest ordered lexically. From here, users can click on an individual node and modify its parameters. Any parameters changed from this interface can either be applied or saved and applied.

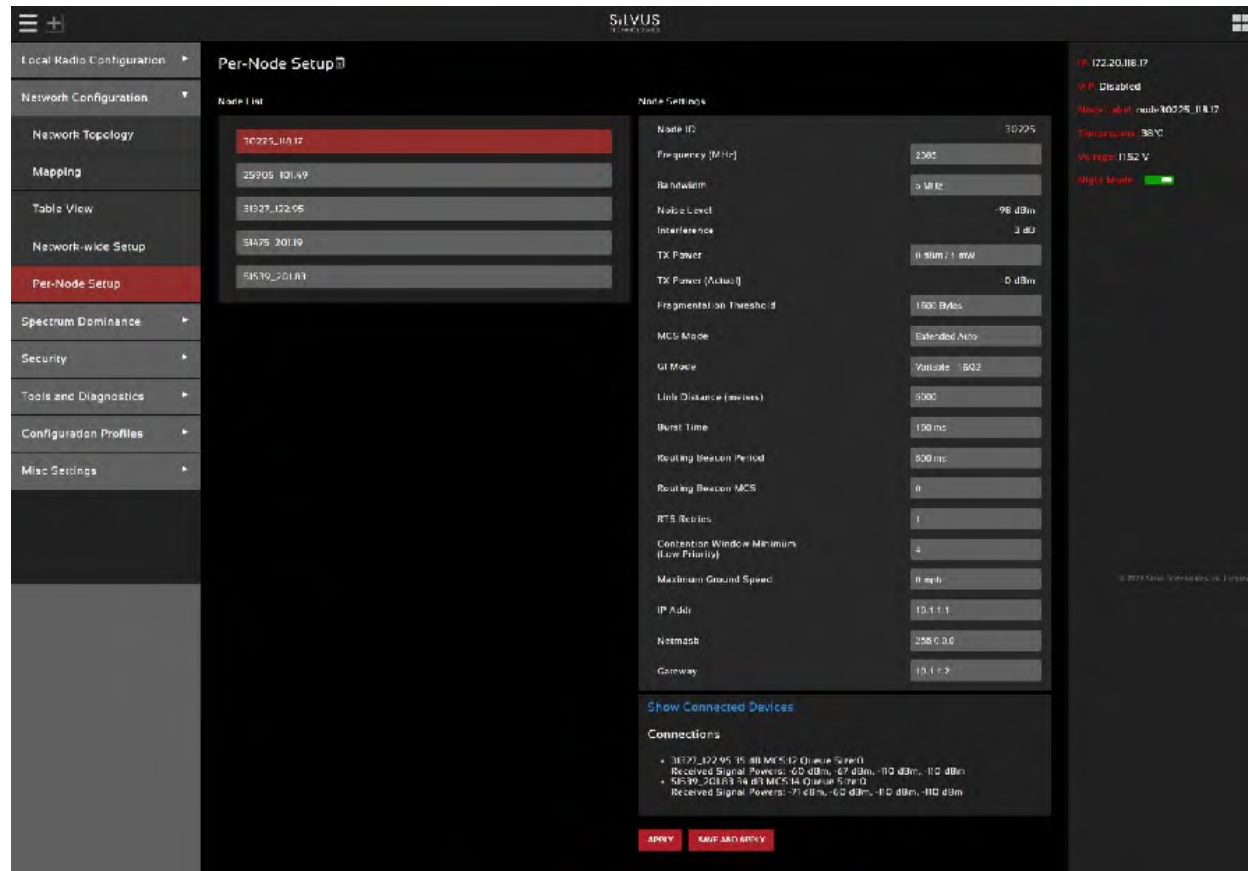


Figure 62 Per-Node Setup

5.2.6 SNMP (Simple Network Management Protocol)

The Silvus Streamscape SNMP service provides support for

- MIB-II (RFC 1213, Management Information Base for Network Management of TCP/IP-based internets). MIB-II provides access to standard properties of the system, interfaces, IPs, access, and others.
- DisMan (RFC 2981, Distributed Management) to enable event management and push notifications.
- Customizations to support specific properties of the Streamscape radios, described in SILVUS-MIB.txt. The Silvus OIDs are located in the .enterprise.silvus subtree (1.3.6.1.4.1.56320)

The SILVUS-MIB.txt can be downloaded from the radio with a standard http browser/downloader. The file is located in /SILVUS-MIB.txt.

(e.g `wget http://{RADIO}/SILVUS-MIB.txt -O ~/.snmp/mibs/SILVUS-MIB.txt`).

For snmp monitors and tools, load the MIB file in the corresponding folder and/or load the MIB module before accessing the radio.

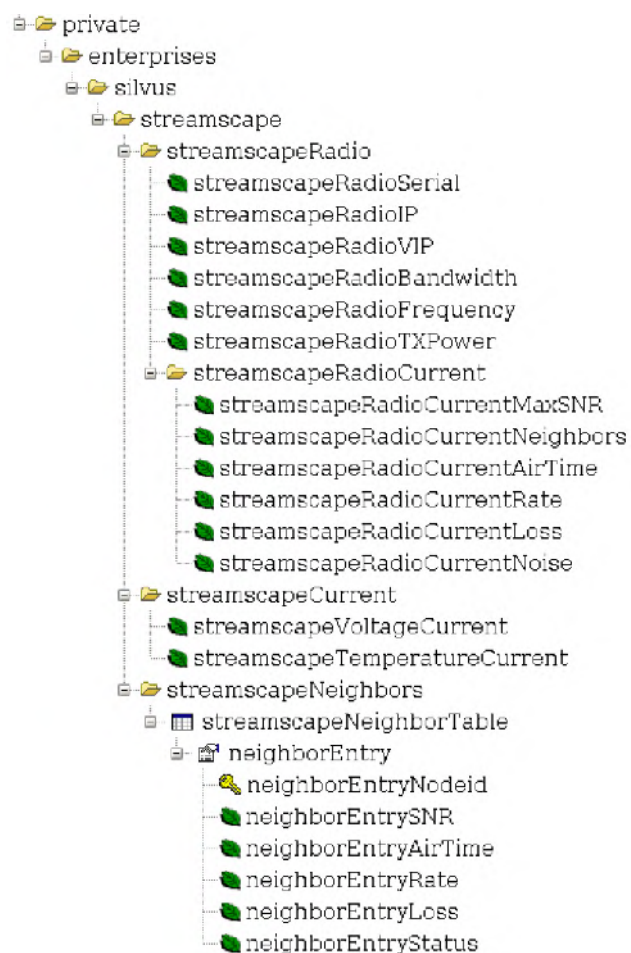


Figure 63 Silvus OID tree loaded into the iReasoning MIB Browser

Access:

The Streamscape snmp service (snmpd) starts automatically during the startup of the radio (unless disabled in the Web GUI). The snmp service is available on udp port 161.

The Streamscape snmp service supports snmp version 2 (v2c) and version 3 (v3).

To access the service use the following default credentials:

- for SNMP version 3: set user “silvus”, no password, no auth no priv
- for SNMP version 2: set community to “silvus”

Examples:

```

$ snmpwalk -m ALL -v3 -u silvus 172.20.11.3 silvus
SILVUS-MIB::streamscapeRadioSerial.0 = INTEGER: 2819
SILVUS-MIB::streamscapeRadioIP.0 = IpAddress: 172.20.11.3
  
```

```
SILVUS-MIB::streamscapeRadioVIP.0 = IPAddress: 192.168.50.113
SILVUS-MIB::streamscapeRadioBandwidth.0 = INTEGER: 20
SILVUS-MIB::streamscapeRadioFrequency.0 = INTEGER: 2280
SILVUS-MIB::streamscapeRadioTXPower.0 = INTEGER: 1
SILVUS-MIB::streamscapeRadioCurrentMaxSNR.0 = INTEGER: 50
SILVUS-MIB::streamscapeRadioCurrentNeighbors.0 = INTEGER: 2
SILVUS-MIB::streamscapeRadioCurrentAirTime.0 = INTEGER: 80
SILVUS-MIB::streamscapeRadioCurrentRate.0 = INTEGER: 79291648
SILVUS-MIB::streamscapeRadioCurrentLoss.0 = INTEGER: 2
SILVUS-MIB::streamscapeRadioCurrentNoise.0 = INTEGER: -100
SILVUS-MIB::streamscapeVoltageCurrent.0 = INTEGER: 11565
SILVUS-MIB::streamscapeTemperatureCurrent.0 = INTEGER: 46
SILVUS-MIB::neighborEntryNodeid.19499 = INTEGER: 19499
SILVUS-MIB::neighborEntryNodeid.30225 = INTEGER: 30225
SILVUS-MIB::neighborEntrySNR.19499 = INTEGER: 48
SILVUS-MIB::neighborEntrySNR.30225 = INTEGER: 52
SILVUS-MIB::neighborEntryAirTime.19499 = INTEGER: 62
SILVUS-MIB::neighborEntryAirTime.30225 = INTEGER: 0
SILVUS-MIB::neighborEntryRate.19499 = INTEGER: 64985984
SILVUS-MIB::neighborEntryRate.30225 = INTEGER: 0
SILVUS-MIB::neighborEntryLoss.19499 = INTEGER: 0
SILVUS-MIB::neighborEntryLoss.30225 = INTEGER: 0
SILVUS-MIB::neighborEntryStatus.19499 = INTEGER: up(1)
SILVUS-MIB::neighborEntryStatus.30225 = INTEGER: up(1)
```

```
$snmptable -m ALL -v 2c -c silvus 172.20.11.3 streamscapeneighborTable
SNMP table: SILVUS-MIB::streamscapeNeighborTable
```

nbNodeid	neighborEntrySNR	neighborEntryAirTime	neigEntryRate	nbEntryLoss	nbEntryStatus
19499	49	74	73357696	3	up
30225	54	0	0	0	up

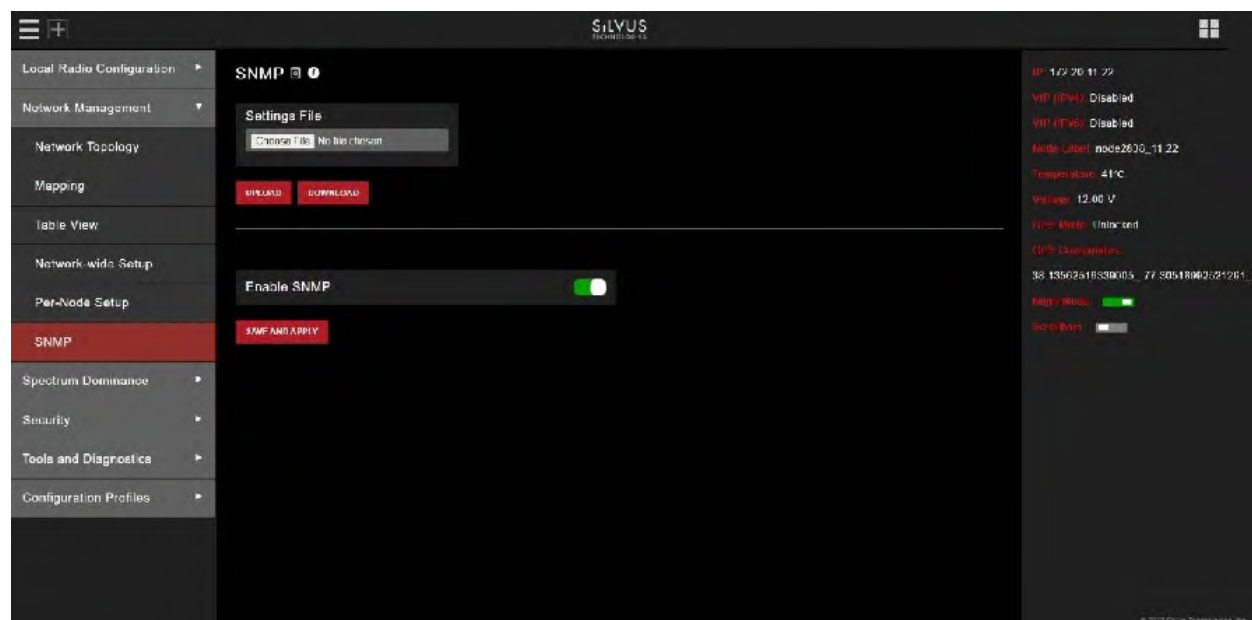


Figure 64 SNMP

Features available on this page include the below:

- SNMP service can be enabled/disabled on this page.
- Upload an extended SNMP configuration file
- Download the currently active extended SNMP configuration file.

Note: check [http://\[node\]/snmpHandler.py?action=log](http://[node]/snmpHandler.py?action=log) to see the snmpd.log for configuration warnings or errors

Extended configuration for access control and traps

The Streamscope SNMP service can be further configured by uploading a configuration file.

Configurations are needed for

- Adding new users and access groups
- Setting up user credentials and passwords (for SNMP v3)
- Setting up traps, trap sinks and notifications

The format of the configuration file follows the net-snmp configuration file (see <http://www.net-snmp.org/docs/man/snmpd.conf.html>)

Examples:

Traps for SNMP v3:

```
createUser myuser MD5 mypassword DES myotherpassword
authPrivEnable 1
trapsess v3 1 authPriv u myuser 192.168.1.2

notificationEvent neighborDownTrap LinkDown SILVUS-MIB::neighborEntryNodeid
monitor -r 5 -e neighborDownTrap "Link Down" SILVUS-MIB::neighborEntryStatus > 1

notificationEvent neighborUpTrap LinkUp SILVUS-MIB::neighborEntryNodeid
monitor -r 5 -e neighborUpTrap "Link Up" SILVUS-MIB::neighborEntryStatus 1

notificationEvent machineTooBusy "Machine Busy" HOST-RESOURCES-MIB::hrProcessorLoad > 60
monitor -r 5 -e temperatureHigh "Temp High" SILVUS-MIB::streamscapeTemperatureCurrent > 40
```

That example

- Adds a user "myuser" with MD5 and DES passwords
- Sets up the traps to be sent to the sink 192.168.1.2
- Sets up alarms for high system utilization, high temperature, and link up/down events

To receive SNMP v3 traps, it is necessary to set the correct user, with the correct passwords and engine ID on the trap receiver. For example in snmptrapd set

```
createUser -e 0x80001F888076AC0A51137A495A myuser MD5 mypassword DES myotherpassword
```

Each radio has its own engine ID. The engine ID can be obtained with

```
snmpwalk -m ALL -r 1 -t 1 -v 3 -u silvus [RADIO_IP]:161 1.3.6.1.6.3.10.2.1.1.0
```

Example for SNMP v2 traps to checks for low voltage, low SNR and high processor load - and sends it to a chosen sink:

```
monitor -r 5 lowVoltage SILVUS-MIB::streamscapeVoltageCurrent < 11
monitor -r 5 lowSNR SILVUS-MIB::neighborEntrySNR < 40
monitor -r 5 machineTooBusy HOST-RESOURCES-MIB::hrProcessorLoad > 50
trap2sink 172.20.2.2 silvus
```

For more details on monitoring/push see below link:

http://net-snmp.sourceforge.net/wiki/index.php/TUT:DisMan_Monitoring

Complete list of Silvus SNMP OIDs:

OID	Description and command to obtain the value
1.3.6.1.4.1.56320 enterprise.silvus	Registered enterprise OID for Silvus
1.3.6.1.4.1.56320.1 enterprise.silvus.streamscape	Subtree for StreamScape radios
1.3.6.1.4.1.56320.1.1 .streamscape.streamscapeRadio	Subtree for static radio properties
1.3.6.1.4.1.56320.1.1.1 .streamscapeRadio.streamscapeRadioSerial	Serial number of the radio
1.3.6.1.4.1.56320.1.1.2 .streamscapeRadio.streamscapeRadioIP	Primary IP address (of br0)
1.3.6.1.4.1.56320.1.1.3 .streamscapeRadio.streamscapeRadioVIP	virtual IP of the radio (if set)
1.3.6.1.4.1.56320.1.1.4 .streamscapeRadio.streamscapeRadioBandwidth	Bandwidth of the Radio (in MHz)
1.3.6.1.4.1.56320.1.1.5 .streamscapeRadio.streamscapeRadioFrequency	Radio frequency (in MHz)
1.3.6.1.4.1.56320.1.1.6 .streamscapeRadio.streamscapeRadioTXPower	Tx power in mW
1.3.6.1.4.1.56320.1.2 .streamscapeRadioCurrent	Subtree for current radio properties
1.3.6.1.4.1.56320.1.2.1 .streamscapeRadioCurrent.streamscapeRadioCurrentMaxSNR	Current Maximum SNR to a wireless neighbor; a value of -150 indicates that the node is not connected wirelessly
1.3.6.1.4.1.56320.1.2.2 .streamscapeRadioCurrent.streamscapeRadioCurrentNeighbors	Current Number of Active Neighbors of the Node (wired and wireless)
1.3.6.1.4.1.56320.1.2.3 .streamscapeRadioCurrent.streamscapeRadioCurrentAirTime	AirTime (in percent) of radio over the last second
1.3.6.1.4.1.56320.1.2.4 .streamscapeRadioCurrent.streamscapeRadioCurrentRate	current transmit data rate of radio over the last second
1.3.6.1.4.1.56320.1.2.5 streamscapeRadioCurrent.streamscapeRadioCurrentLoss	Number of transmitted packets lost from the radio over the last second
1.3.6.1.4.1.56320.1.2.6 .streamscapeRadioCurrent.streamscapeRadioCurrentNoise	Current Noise Level of the Node

1.3.6.1.4.1.56320.1.3 .streamscape.streamscapeCurrent	Subtree for current values (voltage, temperature)
1.3.6.1.4.1.56320.1.3.1 .streamscapeCurrent.streamscapeVoltageCurrent	Current voltage in mV
1.3.6.1.4.1.56320.1.3.2 .streamscapeCurrent.streamscapeTemperatureCurrent	Current CPU temperature in C
1.3.6.1.4.1.56320.1.5 .streamscape.streamscapeNeighbors	Subtree for neighbors table
1.3.6.1.4.1.56320.1.5.1 .streamscapeNeighbors.streamscapeNeighborTable	Structure (and OID) for the neighbor table
1.3.6.1.4.1.56320.1.5.1.1 .streamscapeNeighborTable.neighborEntry	Struct for a table row
1.3.6.1.4.1.56320.1.5.1.1.1 .neighborEntry.neighborEntryNodeid	Node id of the neighbor, this column is the index of the table
1.3.6.1.4.1.56320.1.5.1.1.1.2 .neighborEntry.neighborEntrySNR	SNR of local radio to the neighbor
1.3.6.1.4.1.56320.1.5.1.1.1.3 .neighborEntry.neighborEntryAirTime	Air time (in percent) of the transmission link to the neighbor within the last second
1.3.6.1.4.1.56320.1.5.1.1.1.4 .neighborEntry.neighborEntryRate	Data rate (in Byte) of the link to the neighbor within the last second
1.3.6.1.4.1.56320.1.5.1.1.1.5 .neighborEntry.neighborEntryLoss	Lost packets of the link to the neighbor within the last second
1.3.6.1.4.1.56320.1.5.1.1.1.6 .neighborEntry.neighborEntryStatus	The current operational state of the link (1=up, 2=down)

Table 26 Silvus SNMP OIDs