StreamCaster MIMO Radio User Manual

Notice

Silvus Technologies reserves the right to make changes to its products or discontinue any of its products or offerings without notice.

Silvus Technologies warrants the performance of its products to the specifications applicable at the time of sale in accordance with Silvus Technologies' standard warranty.

Revision History

Version	Date	Changes
1.0	September, 2012	Original
1.1	October 9, 2012	Minor Fixes
2.0	January 9, 2012	Updated for StreamScape 2.0
2.1	March 15, 2012	Updated Sensitivity Values. Added cable pinouts
2.2	May 23, 2013	Updated cable pinouts section
2.3	June 5, 2013	Added Tri-Color LED info
3.0	July 1, 2013	Updated for StreamScape 3.0
3.1	July 23, 2013	Minor Fixes
3.2	September 3, 2013	Added Link Characteristics
3.3	January 17, 2014	Updated Throughput in Tables 6 and 7
3.4	February 24, 2014	Updated through release SS3vb9.17
3.5	April 1, 2014	Updated to include SC3822
3.6	August 18, 2014	Updated for SS3.11.2.5
3.7	August 20, 2014	Added Safety Disclaimer
3.7.1	September 13, 2014	Updated FCC Clause
3.8	October 23, 2014	Added 10MHz data, added 3822 mechanicals, etc.
3.8.1	October 28, 2014	Added EXT PA related information
3.8.2	November 24, 2014	Added EXT PA Connector Diagram
3.9	March 17, 2015	Updated for SS3.11.3.13
3.10	March 23, 2015	Added SC3822 USB/GPIO Connector Diagram
3.11	May 11, 2015	Updated 5V GPS Voltage for Newer Revs
3.11.1	June 2, 2015	Updated FCC clause to include SC3822
3.12	September 10, 2015	Updated for SS3.12 – Added VLAN, USB, and Spectrum Scan support
3.12.1	February 17, 2016	Corrected 3822 Voltage Range in Table 5
3.12.2	April 28, 2016	Added SC4200
3.12.3	August 18, 2016	Added SC4210 to Section 11 FCC Notes
3.12.4	September 15, 2016	Added Custom Frequency Plan instructions
3.12.5	October 7, 2016	Updated Section 12 FCC Notice

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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:

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

In which D = safe working distance (meters)

PT = transmitter or combiner power output (watts)

GR = antenna gain ratio = anti log (gain dBi ÷10)

w = power density (watts/square meter)

The RF power density value is determined by reference to 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 Silvus use, a maximum power density limit of 1w/m² is to be applied when calculating minimum safe working distances.

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

To be safe:

a) 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.

b) 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.

Antenna			Transmitter Power				
Type	Gain (dBi)	Gain Ratio (GR)	1W	2W	4W	10W	30W
Omni	3	2	0.4	0.6	0.8	1.3	2.2
Sector	20	100	2.9	4	5.6	9	15.5
Parabolic Dish	35	3162	16	22.5	32	50	87
			Minimum Safe Distance (Meters)				

Table 1 Safe Working Distances

1.2   Maximum RF Power Density Limits

The RF Radiation Power Density limit figure recommended by Silvus is based upon guideline levels published in:

a. IEEE standard C95.1 1999 - IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

b. Guidelines for Limiting Exposure to Time-varying Electric, Magnetic & Electromagnetic Fields (up to 300 GHz) published in 1998 by the Secretariat of the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Both documents define guideline RF power density limits for "Controlled" and "Uncontrolled" environments. An uncontrolled environment is defined as one in which the person subjected to the RF radiation may be unaware of and has no control over the radiation energy received. The uncontrolled environment conditions can arise, even in the best regulated operations and for this reason the limits defined for the uncontrolled environment have been assumed for the RF Central recommended limit.

Documents a) and b) also show the RF power density guidelines to be frequency dependent. Different power density / frequency characteristics are presented in the two documents. To avoid complexity and to avoid areas of uncertainty, Silvus recommends the use of a single power density limit across the frequency range 100 kHz to 300 GHz. The 1w/m² power density limit we recommend satisfies the most stringent of the guidelines published to date.

Footnote: The IICNIRP document may be freely downloaded from the internet at www.icnirp.de/documents/emfgdl.pdf (PDF file).

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 quick start user guide contains all essential information for the user to configure the StreamCaster radio and to also run an iperf network test.

3.   StreamCaster Network

Each StreamCaster MIMO radio has a fixed static IP address in the 172.20.xx.yy network. 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 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

SC4200:

Figure 1 StreamCaster 4200 Ruggedized Enclosure

1 RF channels 1-2 connectors [TNC Female]

2 Power Switch [2-Position Rotating]

3 Power (Optional, 9-20V), Ethernet, and Serial Port connector [Hirose LF10WBRB-12PD]

4 Bi-Color Status LED (See Section 11.1 for Troubleshooting Information)

- 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 – Radio has recovered from a bad state and has reverted to factory default settings.

5 Push-to-Talk (PTT) Connector [Hirose LF07WBR-6P 12PD]

6 USB/GPIO connector [Hirose LF10WBRB-12SD]

SC3822:

Figure 2 StreamCaster 3822 Ruggedized Enclosure

1 RF channels 1-2 connectors [SMA Female]

2 USB/GPIO connector [Hirose LF10WBRB-12SD]

3 Tri-Color Status LED (See Section 11.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up

- Orange – 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 – Radio has recovered from a bad state and has reverted to factory default settings.

4 Power (9-32 VDC), Ethernet, and Serial Port connector [Hirose LF10WBRB-12PD]

SC3500/SC3800:

Figure 3 StreamCaster 3500/3800 Ruggedized Enclosure

1 RF channels 1-4 connectors [TNC Female]

2 Ethernet connector [Mighty-Mouse 801-010-07NF7-10SA]

3 Power (9-20 VDC) and Serial Port connector [Mighty-Mouse 801-010-07NF7-10PA]

4 Tri-Color Status LED (See Section 11.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Orange – 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 – Radio has recovered from a bad state and has reverted to factory default settings

5 Power Switch

SC3500/SC3800 with EXT Connector (PA Faceplate Option):

Figure 4 StreamCaster 3500/3800 Ruggedized Enclosure

1 RF channels 1-4 connectors [TNC Female]

2 EXT PA Connector [Mighty-Mouse 801-010-07NF7-25SA]

3 Ethernet connector [Mighty-Mouse 801-010-07NF7-10SA]

4 Power (9-20 VDC) and Serial Port connector [Mighty-Mouse 801-010-07NF7-10PA]

5 Power Switch

6 Tri-Color Status LED (See Section 11.1 for Troubleshooting Information)

- Red – Radio is in the process of booting up
- Orange – 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 – Radio has recovered from a bad state and has reverted to factory default settings

4.1 Connector Pinouts

4.1.1 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	NC
7	100-Base T ETH0 M2P	NC
8	100-Base T ETH0 M1P	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N	NC

Table 2 SC4200 Power/Ethernet/Serial Connector Pinout

SC4200 RS-232 and PS/2 (GPS) Pinout			
RS-232	PS/2 (GPS)	Signal	Switchcraft Pinout
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 3 SC4200 Serial and GPS Pinout

SC4200 USB/GPIO Connector Pinout	
Enclosure USB/GPIO (LF10WBRB-12PD)	Signal
1	USB1_GND
2	USB1_D-
3	USB1_VBUS
4	USB2_VBUS
5	GPIO1 (PA Enable 3.3V)
6	USB2_D+
7	USB2_D-
8	RESERVED (Do Not Connect)
9	GND
10	USB1_Sense
11	USB1_D+
12	USB2_GND

Table 4 SC4200 USB/GPIO Connector Pinout (USB1 is USB 2.0 OTG, USB2 is USB 2.0 Host Mode Only)

SC4200 PTT Connector	
Enclosure PTT Connector (Hirose LF07WBR-6P)	Signal
1	RESERVED (Do Not Connect)
2	RESERVED (Do Not Connect)
3	AUDIO_GND
4	PTT
5	SPEAKER_OUT
6	MIC_IN

Table 5 SC4200 PTT Connector Pinout
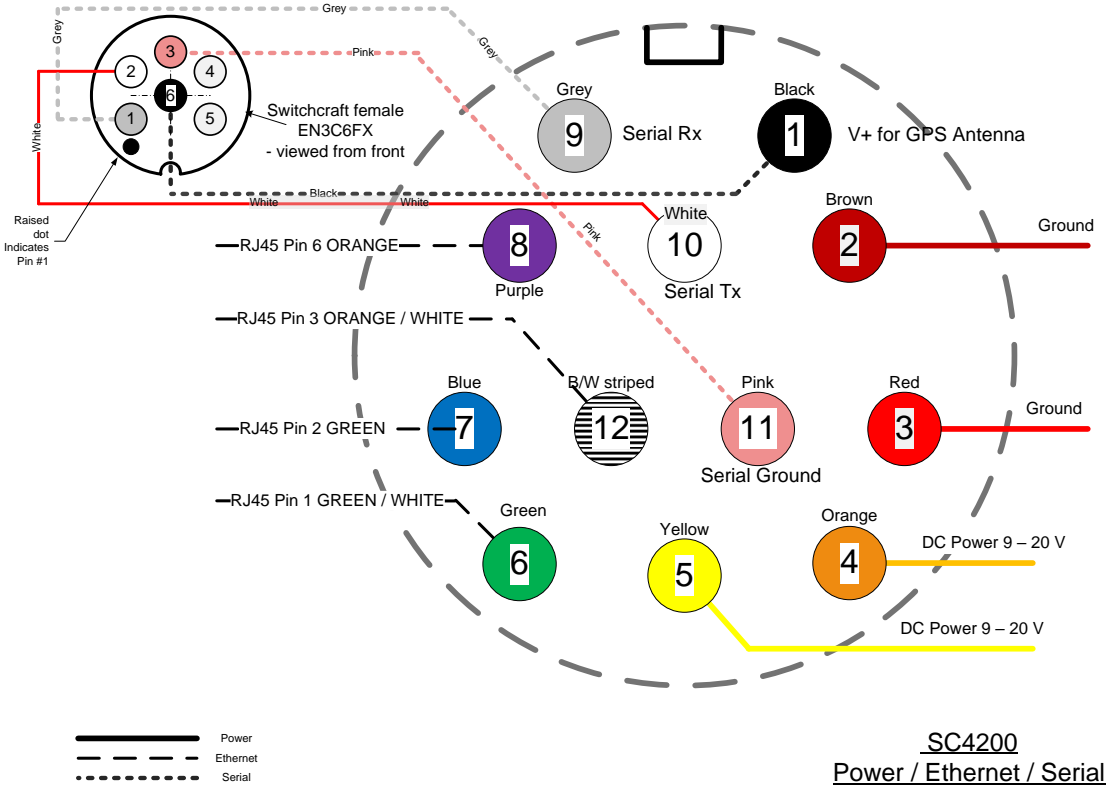
Figure 5 SC4200 Power (Optional)/Serial/Ethernet Pinout Diagram (Cable Side)
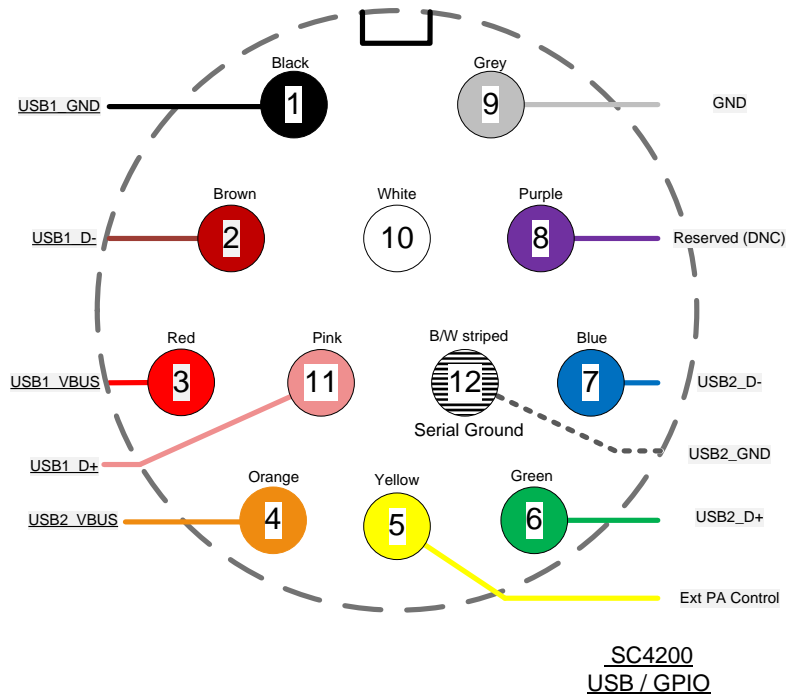
Figure 6 SC4200 USB/GPIO Pinout Diagram (Cable Side)
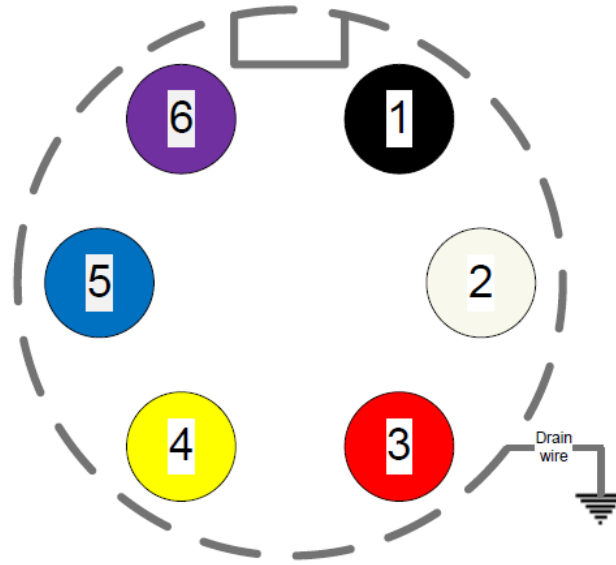
Female - PTT

LF07WBP-6S (CIRCULAR CONN)

Figure 7 SC4200 PTT Pinout Diagram (Cable Side)

4.1.2   SC3822 Pinouts

SC3822 Power/Ethernet/Serial Connector Pinout		
Enclosure PWR/COMM (LF10WBRB-12PD)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	3.3V (5V on Rev. D Digital and Newer)	NC
2	GND IN	2
3	GND IN	2
4	VCC IN	1
5	VCC IN	1
6	100-Base T ETH0 M2N	NC
7	100-Base T ETH0 M2P	NC
8	100-Base T ETH0 M1P	NC
9	RS232_RXD	NC
10	RS232_TXD	NC
11	RS232_GND	NC
12	100-Base T ETH0 M1N	NC

Table 6 SC3822 Power/Ethernet/Serial Connector Pinout

SC3822 RS-232 and PS/2 (GPS) Pinout			
RS-232	**PS/2 (GPS)**	**Signal**	**Switchcraft Pinout**
3	4	TxD	2
2	5	RxD	1
NC	NC	NC	4
NC	2	3.3V (5V on Rev. D Digital and Newer)	6
NC	NC	NC	5
5	1	Ground	3

Table 7 SC3822 Serial and GPS Pinout

SC3822 USB/GPIO Connector Pinout	
Enclosure USB/GPIO (LF10WBRB-12PD)	**Signal**
1	USB_GND
2	USB_D-
3	USB_5V
4	NC
5	GPIO1 (PA Enable 3.3V)
6	GPIO2
7	GPIO3
8	3.3V
9	GND
10	USB_Sense
11	USB_D+
12	GPIO4

Table 8 SC3822 USB/GPIO Connector Pinout

SC3822 Extension Port Pinout		
Pin #	**Signal**	**Notes**
1-6	VCC_IN	9V - 32V. These pins are directly wired to the VCC_IN on FPC 1.
7-10	GPIO1 – GPIO4	These GPIOs are directly wired to the GPIOs on FPC connector 2.
11-19	Reserved for Testing	Do Not Connect
20	CPU Reset (3.3V)	Wired to PS_SRST_EXT signal on FPC 1
21-54	Reserved for Testing	Do Not Connect
55	GND	
56	ETH1_MX4N	
57	ETH1_MX4P	
58	ETH1_MX3N	
59	ETH1_MX3P	
60	ETH1_MX2N	Second Gigabit Ethernet Interface
61	ETH1_MX2P	
62	ETH1_MX1N	
63	ETH1_MX1P	
64	GND	
65-68	Reserved for Testing	Do Not Connect

Table 9 SC3822 Extension Port Pinout
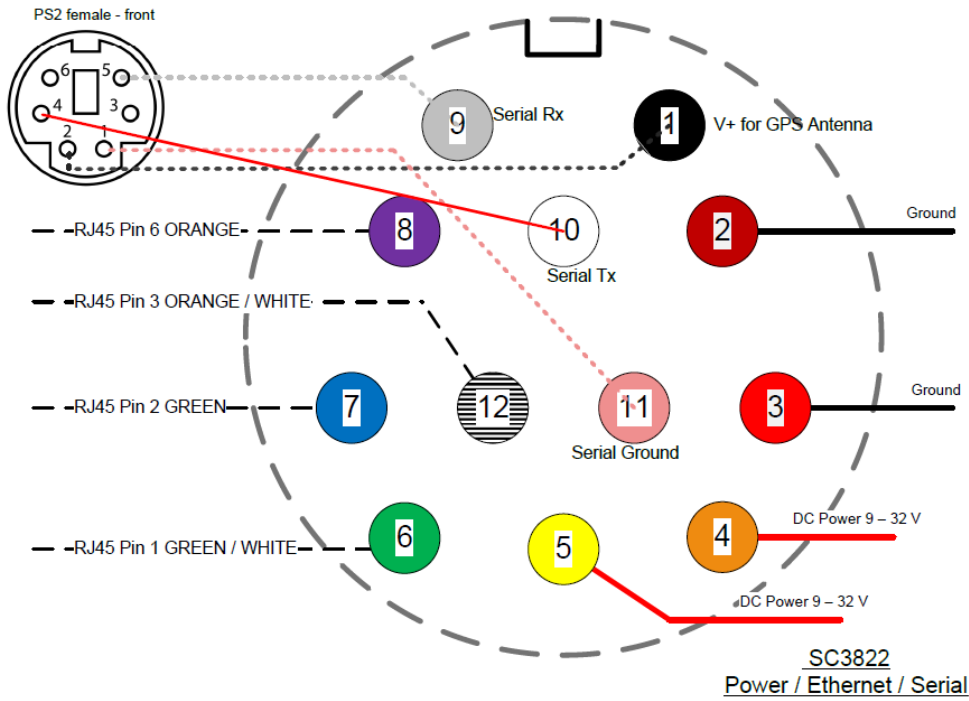
Figure 8 SC3822 Power/Serial/Ethernet Pinout Diagram (Cable Side)
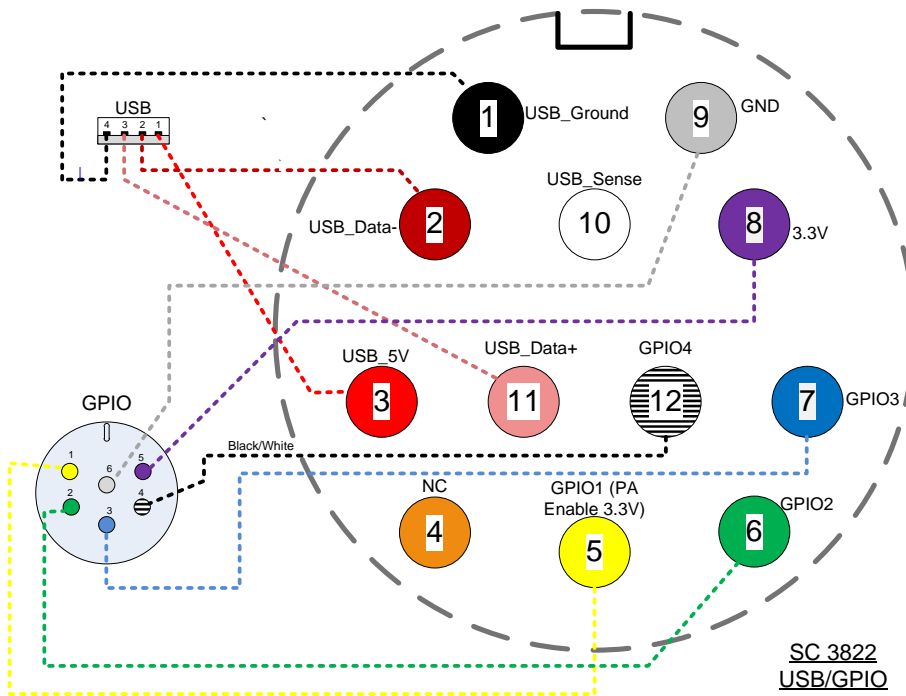
Figure 9 SC3822 USB/GPIO Pinout Diagram (Cable Side)

4.1.3 SC3500/SC3800 Pinouts

SC3500/3800 Power Connector Pinout		
Enclosure Pinout (801-010-07NF7-10PA)	**Signal**	**Switchcraft Pinout (EN3C2F16X)**
1	12V Power Return	2
2	12V Power Return	2
3	12V Power	1
4	12V Power	1
5	TxD	For Serial Comm.
6	RxD	For Serial Comm.
7	RTS	For Serial Comm.
8	CTS	For Serial Comm.
9	Ground	For Serial Comm.
10	3.3V (5V on Rev. E Digital and Newer)	3.3VDC for GPS

Table 10 SC3500/SC3800 Power Connector Pinout

SC3500/3800 Ethernet Connector Pinout		
Enclosure Pinout (801-010-07NF7-10SA)	**Signal**	**RJ45 Pinout**
1	WHT/BLU	5
2	WHT/BRN	7
3	BRN	8
4	ORG	2
5	WHT/GRN	3
6	WHT/ORG	1
7	BLU	4
8	GRN	6
9	NC	NC
10	NC	NC

Table 11 SC3500/SC3800 Ethernet Connector Pinout

SC3500/3800 EXT Connector Pinout (PA Faceplate Option Only)	
Enclosure Pinout (801-010-07NF7-25SA)	Signal
1	PA On (+3.3V)
2	Ground
3	NC
4	NC
5	NC

Table 12 SC3500/SC3800 EXT Connector Pinout

SC3500/3800 RS-232 and PS/2 (GPS) Pinout			
RS-232	PS/2 (GPS)	Signal	Switchcraft Pinout
3	4	TxD	2
2	5	RxD	1
7	NC	RTS	4
NC	2	3.3V (5V on Rev. E Digital and Newer)	6
8	NC	CTS	5
5	1	Ground	3
NA	NA	LED Ground	NA
NA	NA	Green	NA
NA	NA	Red	NA

Table 13 SC3500/SC3800 Serial and GPS Pinout
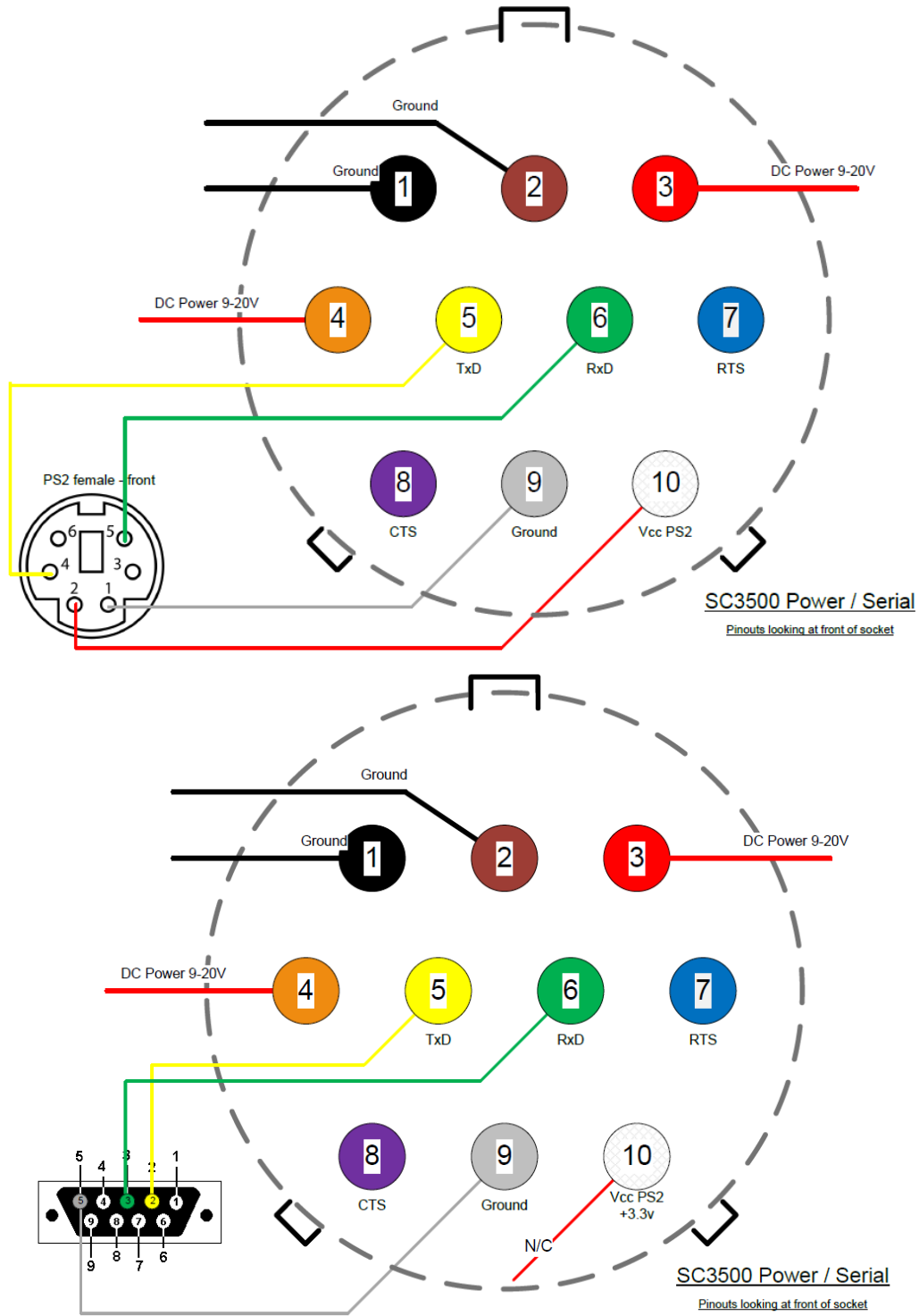
Figure 10 SC3500/SC3800 Power/Serial Pinout Diagram (Cable Side) for GPS (Top) and RS-232 (Bottom)
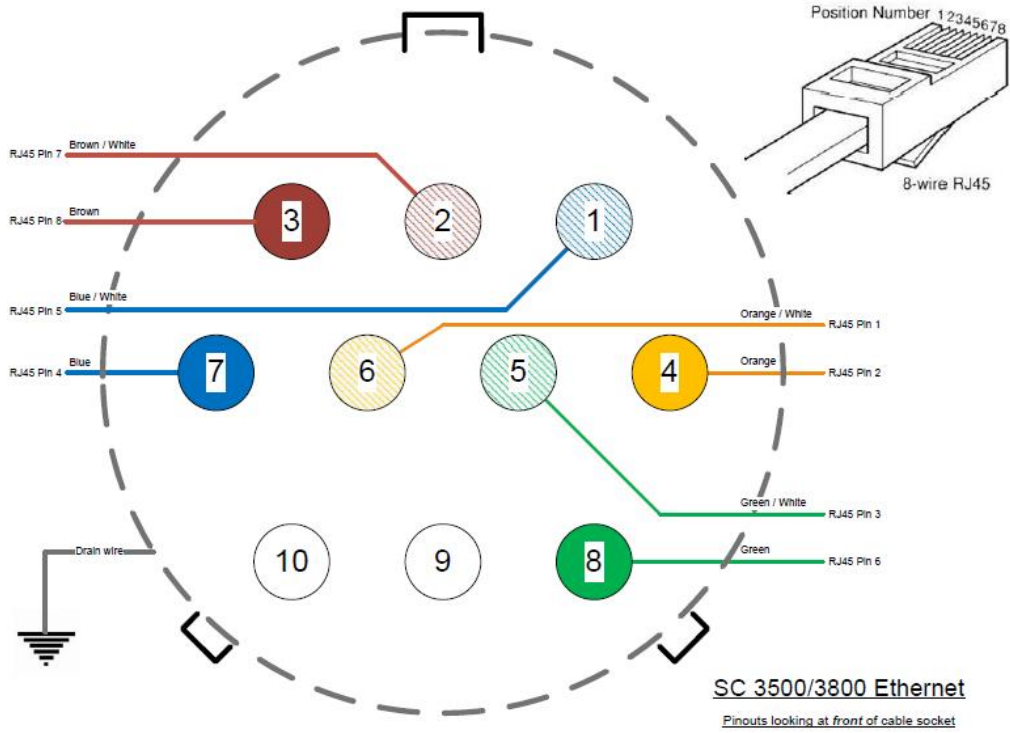
Figure 11 SC3500/SC3800 Ethernet Pinout Diagram (Cable Side)
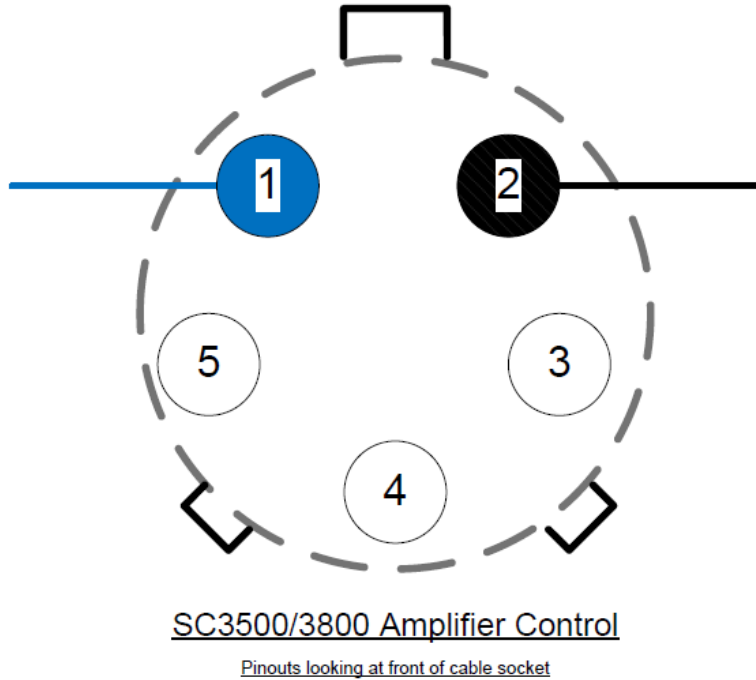
Figure 12 SC3500/SC3800 EXT Pinout Diagram (Cable Side)

4.2   Mechanical and Operating Specifications

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** .... 15 oz.
- **Color** .... Black Anodized
- **Mounting** .... 4-Hole Mounting Patterns (Through-Hole)

Power

- **Voltage** .... 9 – 20 VDC
- **Power Consumption** .... 4.8 W – 24 W
- **Battery Life** .... Up to 12 Hours (6.8Ah MBITR Battery)
- **Power Options** .... Twist-Lock Battery <u>or</u> Front Panel

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 Circular Connector (Front Panel)
- **Status Indicator** .... Bi-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

SC3822:

Environmental

	Standard Temperature	Extended Temperature
• **Operating Temp.**	-40° - +55° C	-40° - +65° C
• **IP Rating (Ingress Protection)**	IP-67 (Dust / Immersion in water up to 1m)*	

*Must have all connectors mated and use IP67 or better cables/antennas

Mechanical – Chassis

	Standard	Extended Temperature
• **Dimensions**	4.4" x 3.4" x 1.3"	4.4" x 3.4" x 2.0"
• **Weight**	1.0 Pounds	1.2 Pounds
• **Color**	a. Black anodized	
	b. FED-STD-595B-34094 (green 383)	
• **Mounting**	4-hole mounting patterns (Through-hole)	

1.3"
4.4"
3.4"
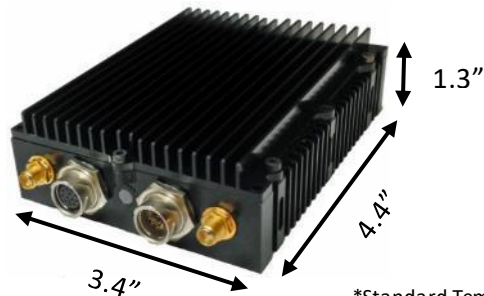
*Standard Temperature enclosure shown. Extended Temp has height of 2".

Connectors
• **RF**	SMA (f) (2 each)
• **Data / Control**	Ethernet (Gigabit for OEM, 100 Base-T for Enclosed), RS232, USB
• **Power**	Hirose LF Series Circular Connector (Front Panel)
	Samtec QSH (Expansion)

Controls and Indicators
• **Status Indicator**	Tri-Color LED

Power Requirements
• **Voltage**	9 – 32 VDC
• **Consumption**	6W – 16W (Duty Cycle and Frequency Dependent)

Mechanical – OEM Board Stack
• **Dimensions**	3.3" x 2.9" x 0.5" L x W x H
• **Weight**	3 oz
• **RF Connector**	SMP (m)

SC3500/SC3800:

Environmental

	Standard	**Extended Temperature**
• **Operating Temp.**	-40° - +55° C	-40° - +65° C
• **IP Rating (Ingress Protection)**	IP-67 (Dust / Immersion in water up to 1m)*	

*Must have all connectors mated and use IP67 or better cables/antennas

Mechanical – Chassis

	Standard	**Extended Temperature**
• **Dimensions**	3.25" x 5.75" x 4"	4.5" x 5.75" x 4"
• **Weight**	3.7 Pounds	4.0 Pounds
• **Color**	c. FED-STD-595B-34094 (green 383)	
	d. Black anodized	
	e. CARC (Chemical Agent Resistant Coating)	
• **Mounting**	4-hole mounting patterns (non-penetrating) located on both rear and bottom sides	

Extended Temperature Variant

Standard Temperature Variant

4.50
3.25
5.75

ANT1 ANT2 ANT3 ANT4   SiLVUS TECHNOLOGIES

ON
OFF   STATUS   PWR   ETH
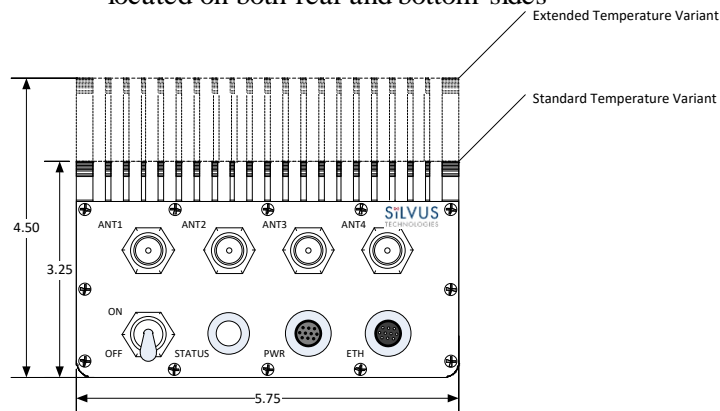
Connectors

• **RF**	TNC (f) (4 each)
• **Data / Control**	Ethernet cable, Mighty-Mouse 801 Heavy-Duty, Double-Start 10
• **Power**	Mighty-Mouse 801 Heavy-Duty, Double-Start 10 conductor (m) (RS232 / GPS Support)

Controls and Indicators

• **Power**	On / Off Toggle with detent
• **Status Indicator**	Tri-Color LED

Power Requirements

• **Voltage**	9 – 20 VDC
• **Consumption**	12W – 22.5W (Duty Cycle and Frequency Dependent)

Mechanical – OEM Board Stack

• **Dimensions**	1.9" x 5.25" x 2.9" H x L x W
• **Weight**	8 oz
• **RF Connector**	SMP (m)
• **Data Connector**	Harwin M80 8-pin (m), (RS232/GPS optional)
• **Power Connector**	Harwin M80 8-pin

4.2.1   SC3822 Enclosure Mechanical Drawing
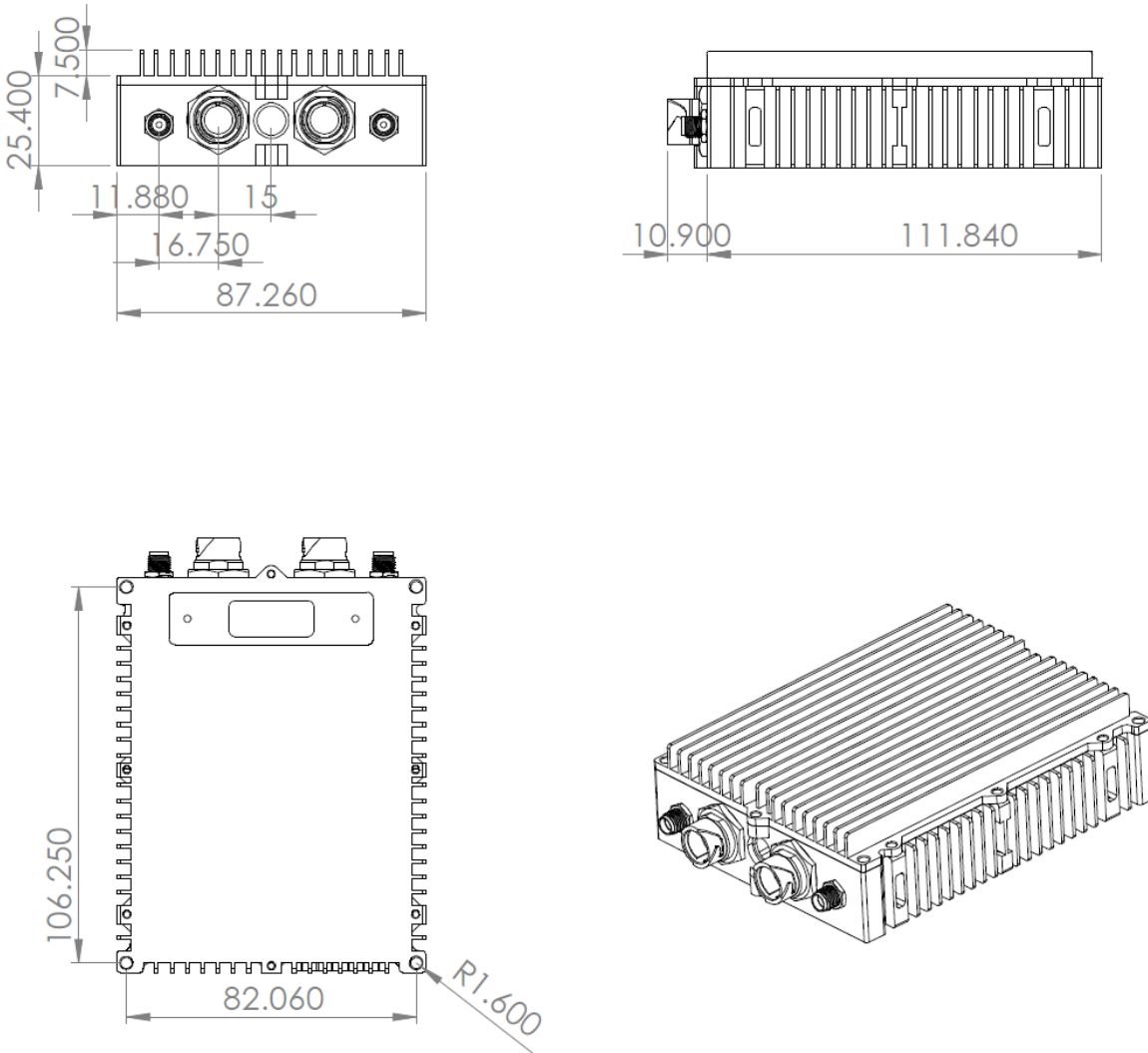
Figure 13 SC3822 Mechanical Drawing (top) and Mounting Pattern (bottom)

4.2.2   SC3500/SC3800 Phase II Enclosure Mounting Pattern

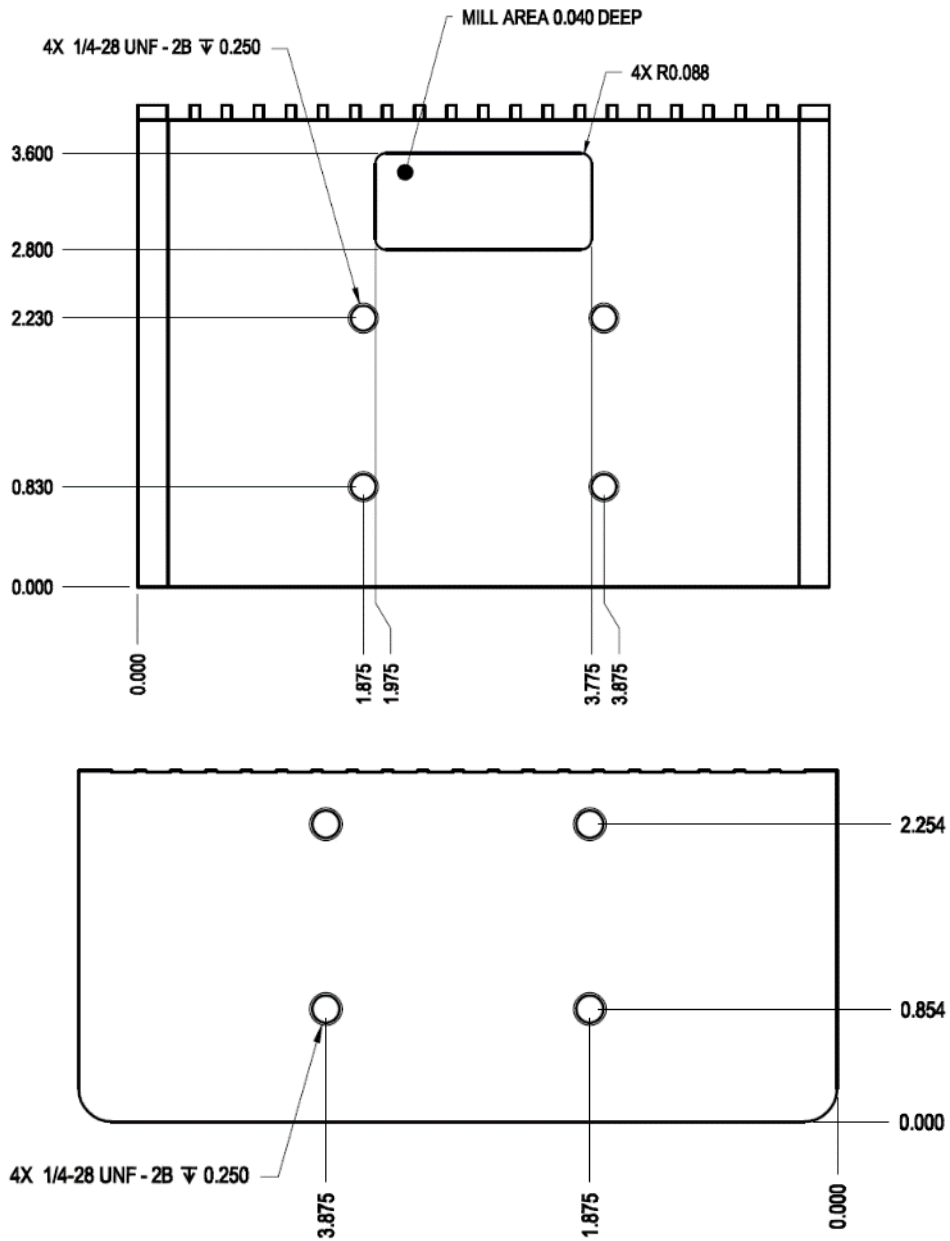**Figure 14 SC3500/SC3800 Phase II Enclosure Mounting Pattern for Back of Enclosure (top) and Bottom of Enclosure (bottom)**

4.2.3 SC3500/ SC3800 Phase III Enclosure Mounting Pattern
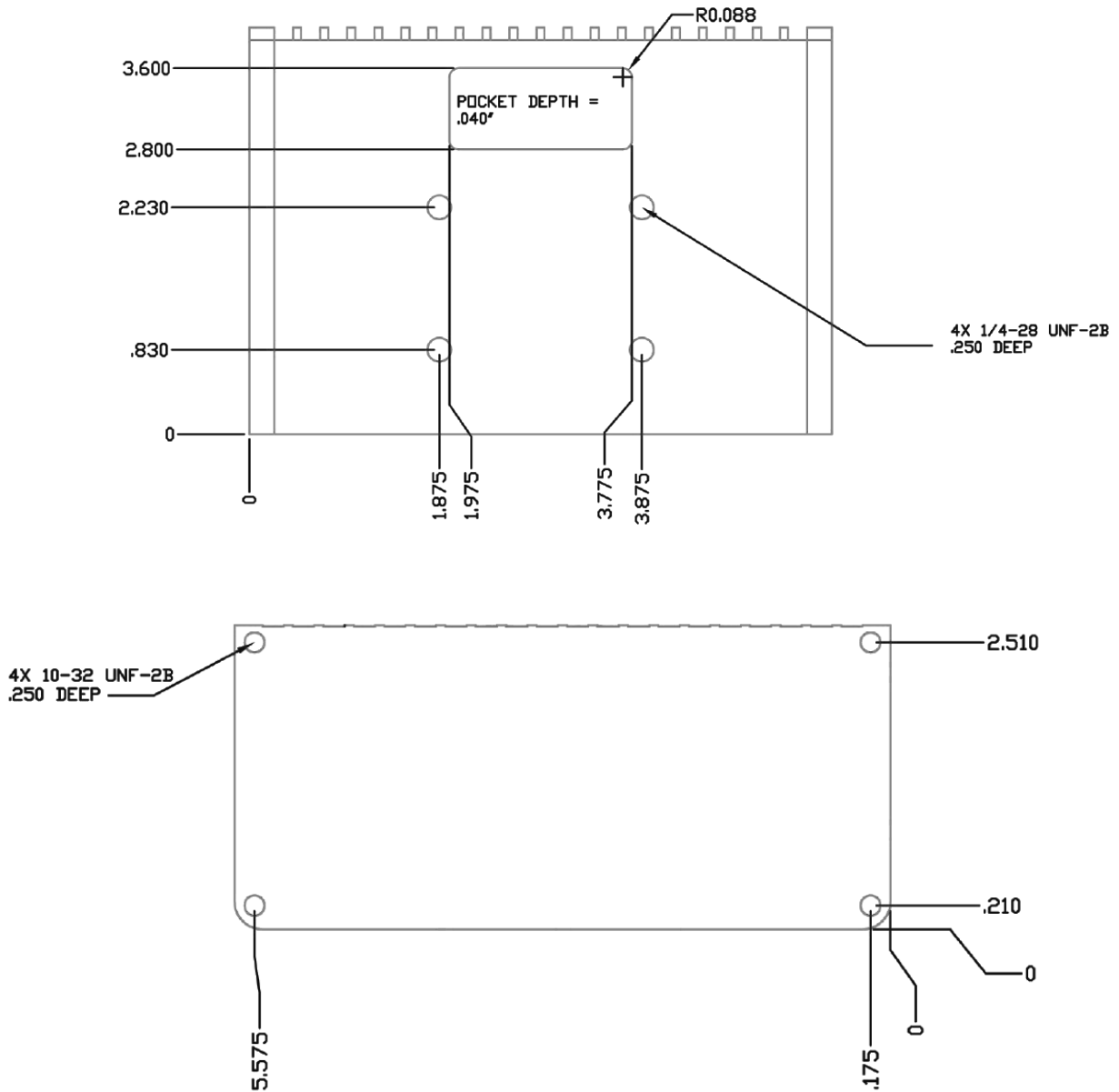

Figure 15 SC3500/SC3800 Phase III Enclosure Mounting Pattern for Back of Enclosure (top) and Bottom of Enclosure (bottom)

4.3   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), Suite B
- **Tuning Step Size**   1 KHz
- **Data Rates**   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 Beam Forming
- **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 Dual Band Optional
- **Onboard Storage**   Up to 128 GB*

Frequency Band Options

Band (Freq. Code)	Frequency Range	Band (Freq. Code)	Frequency Range
UHF (042)*	400-450	Low C Band (455)*	4400-4700
ISM 900 (091)*	902-928	Federal C (470)*	4400-5000
L Band (137)	1350-1390	High C Band (485)*	4700-5000
Broadcast A (209)	1980-2200	5.2GHz ISM (520)*	5150-5250
Broadcast B (206)	2025-2110	5.8GHz ISM (580)*	5725-5875
Federal S (225)	2200-2300		
Low S Band (230)	2200-2400		
High S Band (240)	2300-2500		
2.4GHz ISM (245)	2400-2500		

(All bands listed in MHz)

<u>Note:</u> If band of interest is not listed, please contact a sales representative

Footnote: (*) in development

SC4200 PTT Specifications

- **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

4.4 SC3822 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 128/256 Optional (FIPS 140-2)
- **Frequency Stability** — 1 PPM over temp -40° - +85° C
- **Tuning Step Size** — 1 KHz
- **Data Rates** — 85 Mbps UDP & 70 Mbps TCP
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, RX Eigen Beam Forming
- **No. of Spatial Streams** — 1-2
- **No. of Antennas** — 2
- **Total Power Output** — 10mW – 500mW (variable)

Performance

- **Latency** — 7 ms average
- **Sensitivity** — Varies with MCS index
  Maximum = -99 dBm (5MHz BW, MCS0)

Frequency Band Specifics

<u>Please note,</u> this table reflects standard frequency bands available, additional bands are frequently added as demands dictate. If your band of interest is not listed, please contact your sales person. (All bands listed in MHz)

Low Band		High Band	
UHF	400-450 *	**C-1 Band**	4400-4700
ISM 900	902-928 *	**C-2 Band**	4700-5000
L Band	1350-1390	**C-3 Band**	5727-5852
Broadcast A	1980-2200	**UNII-1 Band**	5150-5250
Broadcast B	2025-2110		
Federal 'S'	2200-2300*		
ISM2400	2400-2483*		
Federal 'S' +			
2.4GHZ ISM	2200-2500		

Footnote: (*) in development

4.5   SC3500 Specifications

General

- **Radio Type** — MIMO Coded-OFDM
- **Subcarrier Modulation** — BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth** — 5, 10 & 20 MHz
- **Encryption** — DES Standard, AES 128/256 Optional
- **Frequency Stability** — 1 PPM over temp -40° - +85° C
- **Tuning Step Size** — 1 KHz
- **Data Rates** — 85 Mbps UDP & 70 Mbps TCP
- **Error Correction** — 1/2, 2/3, 3/4, 5/6
- **Antenna Processing** — Spatial Multiplexing, Space-Time Coding, Eigen Beam Forming
- **No. of Spatial Streams** — 1-4
- **No. of Antennas** — 4
- **Total Power Output** — 10mW – 1W (variable)

Performance

- **Latency** — 7 ms average
- **Sensitivity** — Varies with MCS index
  Maximum = -102 dBm (5 MHz BW, MCS 0)

Frequency Band Specifics

	S Band	C Band
Frequency Code '245540' **2.385 – 2.490 GHz** **4.960 – 5.875 GHz**	2.400 – 2.500 GHz	4.940 – 5.875 GHz
Frequency Code '245551'	2.400 – 2.500 GHz	5.150 – 5.875 GHz
Frequency Code '243578'	2.417 – 2.457 GHz	5.735 – 5.840 GHz

4.6   SC3800 Specifications

General

- **Radio Type**   MIMO Coded-OFDM
- **Subcarrier Modulation**   BPSK, QPSK, 16-QAM, 64-QAM
- **Channel Bandwidth**   5, 10 & 20 MHz (1.25*, 2.5*)
- **Encryption**   DES Standard, AES 128/256 Optional
- **Frequency Stability**   1 PPM over temp -40° - +85° C
- **Tuning Step Size**   1 KHz
- **Data Rates**   85 Mbps UDP & 70 Mbps TCP
- **Error Correction**   1/2, 2/3, 3/4, 5/6
- **Antenna Processing**   Spatial Multiplexing, Space-Time Coding, RX Eigen Beam Forming
- **No. of Spatial Streams**   1-4
- **No. of Antennas**   4
- **Total Power Output**   10 mW – 1 W (variable)

Performance

- **Latency**   7 ms average
- **Sensitivity**   Varies with MCS index
  Maximum = -102 dBm (5MHz BW, MCS 0)

Frequency Band Specifics

Please note, this table reflects standard frequency bands available, additional bands are frequently added as demands dictate. If your band of interest is not listed, please contact your sales person. (All bands listed in MHz)

Low Band		High Band	
UHF	400-450 *	**C-1 Band**	4400-4700
ISM 900	902-928 *	**C-2 Band**	4700-5000
L Band	1350-1390	**C-3 Band**	5727-5852
Broadcast A	1980-2200	**UNII-1 Band**	5150-5250
Broadcast B	2025-2110		
Federal 'S'	2200-2300*		
ISM 2400	2400-2483*		
Federal 'S' +			
2.4GHZ ISM	2200-2500		

Footnote: (*) in development

5.   Web Interface

5.1   Getting Started

Connect a laptop to the StreamCaster radio using the supplied Ethernet cable and turn on the radio. Users can type "ping <IPaddress>" 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 be directed to the Basic Configuration page. (See **Figure 16**)

5.1.1   Basic Configuration

Figure 16 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. Please see Section 7 for "Custom Frequency Plan" access and installation instructions.

- **Bandwidth**: This defines the RF bandwidth of the signal.

- **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.

- **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.

- **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 and can be up to 2 watts total.

- **Wired Backbone Gateway**: This setting pertains to wired backbone functionality (See Section 6: Wired Backbone). For normal operation, set Wired Backbone Gateway to enable. If multiple radios will be connected to a wired backbone, only one radio should be enabled as a Wired Backbone Gateway and all others on the wireline should be disabled.

- **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.

- **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.
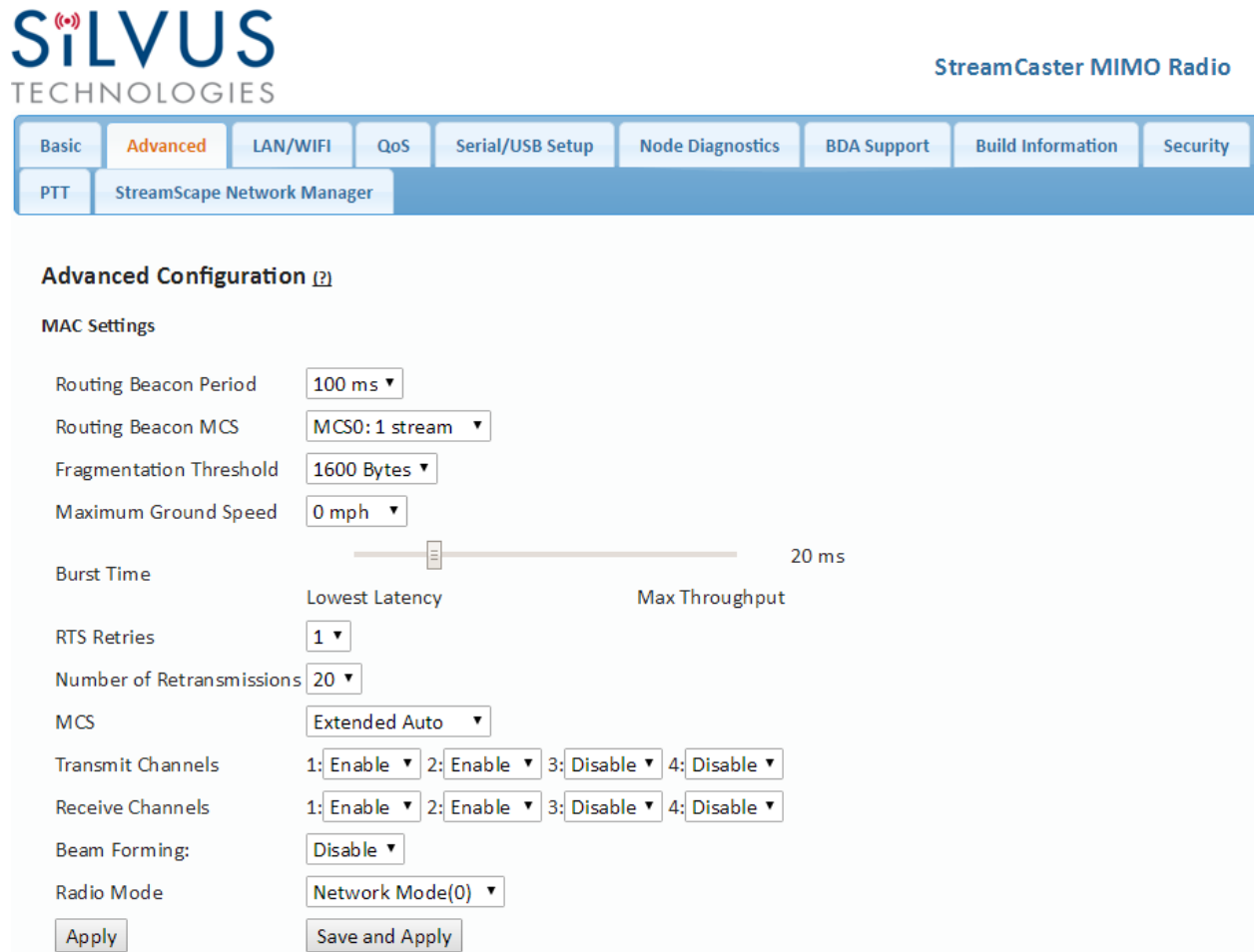
5.1.2   Advanced Configuration

Figure 17 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.

- **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).

- **Maximum Ground Speed**: 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. The throughput values shown in **Table 14** and **Table 16** assume the minimum burst time.

- **RTS Retries:** A node wishing to send data initiates the process by sending a request to send message (RTS). The destination node replies with a clear to send (CTS) message. Any other node that receives the RTS or CTS message will refrain from sending data for a given time. In larger networks, there is a higher probability of collisions occurring when an RTS is sent out. This field defines the number of retries before a packet is dropped. A lower value will result in faster handoffs in mobile situations.

- **Number of Retransmissions:** Allows the user to define the number of times a lost packet is retransmitted before being dropped. Default value is 20.

- **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 14** and **Table 16** below show the estimated UDP data rate and sensitivity for each MCS. This table assumes a 20MHz bandwidth, 1000 meter link distance and 1600 byte fragmentation threshold.

- **Transmit Channels:** Allows user to Enable or Disable each channel on the radio for TX.

- **Receiver Channels:** Allows user to Enable or Disable each channel on the radio for RX.

- **Beamforming (SC4200 Only):** Enable or disable TX Beamforming (Up to 40% increase in range when enabled)

- **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 1000m, 10ms burst time and 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 that are not currently supported.

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC3500/SC3800 Sensitivity	SC3822 Sensitivity
1	0	BPSK 1/2	1.625	1.03	-102	-99
1	1	QPSK 1/2	3.25	2.06	-100	-97
1	2	QPSK 3/4	4.875	3.09	-97	-94
1	3	16-QAM 1/2	6.5	4.12	-95	-92
1	4	16-QAM 3/4	9.75	6.18	-92	-89
1	5	64 QAM 2/3	13	8.25	-87	-84
1	6	64 QAM 3/4	14.625	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	6.5	4.12	-97	-94
2	10	QPSK 3/4	9.75	6.18	-94	-91
2	11	16-QAM 1/2	13	8.25	-91	-89
2	12	16-QAM 3/4	19.5	12.38	-88	-85
2	13	64 QAM 2/3	26	16.21	-84	-81
2	14	64 QAM 3/4	29.25	17.62	-82	-79
2	15	64 QAM 5/6	32.5	18.94	-77	-74

Table 14 MCS vs. Sensitivity Chart (5MHz Bandwidth)

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC3500/SC3800 Sensitivity	SC3822 Sensitivity
1	0	BPSK 1/2	3.25	2.48	-99	-96
1	1	QPSK 1/2	6.5	4.96	-97	-94
1	2	QPSK 3/4	9.75	7.40	-94	-91
1	3	16-QAM 1/2	13	9.90	-92	-89
1	4	16-QAM 3/4	19.5	14.80	-89	-86
1	5	64 QAM 2/3	26	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	6.5	4.96	-97	-94
2	9	QPSK 1/2	13	9.90	-94	-91
2	10	QPSK 3/4	19.5	14.80	-91	-88
2	11	16-QAM 1/2	26	19.90	-89	-86
2	12	16-QAM 3/4	39	29.90	-85	-82
2	13	64 QAM 2/3	52	39.70	-81	-79
2	14	64 QAM 3/4	58.5	43.50	-79	-77
2	15	64 QAM 5/6	65	48.1	-74	-75

Table 15 MCS vs. Sensitivity Chart (10MHz Bandwidth)

NSS	MCS	Coding Rate	PHY Throughput (Mbps)	UDP User Throughput (Mbps)	SC3500/SC3800 Sensitivity	SC3822 Sensitivity
1	0	BPSK 1/2	6.5	4.92	-96	-93
1	1	QPSK 1/2	13	9.82	-94	-91
1	2	QPSK 3/4	19.5	14.73	-91	-88
1	3	16-QAM 1/2	26	19.65	-89	-86
1	4	16-QAM 3/4	39	29.47	-86	-83
1	5	64 QAM 2/3	52	39.29	-82	-79
1	6	64 QAM 3/4	58.5	44.20	-80	-77
1	7	64 QAM 5/6	65	47.45	-78	-75
2	8	BPSK 1/2	13	9.82	-94	-91
2	9	QPSK 1/2	26	19.65	-91	-88
2	10	QPSK 3/4	39	29.47	-88	-85
2	11	16-QAM 1/2	52	39.29	-86	-83
2	12	16-QAM 3/4	78	57.04	-82	-79
2	13	64 QAM 2/3	104	75.00	-79	-76
2	14	64 QAM 3/4	117	75.00 (85.00 for SC3822)	-77	-74
2	15	64 QAM 5/6	130	75.00 (85.00 for SC3822)	-75	-72

Table 16 MCS vs. Sensitivity Chart (20MHz Bandwidth)

5.1.3   LAN/WIFI Configuration

Figure 18 LAN/WIFI Configuration Page

Network Settings:

- **Virtual IP**: Enable or Disable the Secondary IP address for the radio.

- **Virtual IP 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. Please note that the secondary IP address should NOT be on the 172.20.xx.xx subnet.

- **Virtual Netmask**: Netmask for the Secondary IP address, e.g. 255.255.255.0.

- **Gateway:** 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. 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.

VLAN Settings (License Enabled Feature):

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. 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 arry 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.

WiFi Settings (License Enabled Feature – SC3822 Only):

Note: Use of this feature requires a Silvus USB-WiFi adapter. The WiFi settings will only display if the USB WiFi license is loaded, and the WiFi dongle is attached to the radio's USB port before it is powered on.

- **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.

- **DHCP**: When enabled, the USB-Wifi adapter will assign IP addresses to connected devices. Note that when the AP is set to 'Bridge' mode, the DHCP will be delivered to the entire mesh. Users should be careful to make sure there is only one DHCP server connected into the mesh network to avoid any conflicts. When DHCP is enabled, the DHCP parameters must be set.

- **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.

- **Port Forwarding (NAT Mode Only)**: When in NAT mode, devices on the larger mesh will not be able to locate devices connected to the wireless adapter. This can be overcome by mapping port forwarding for specific data streams.

- **Apply**: Applies the new values but does not save them to flash.

- **Save and Apply**: Save the new values to flash and apply.

5.1.4 Quality of Service (QoS)

Figure 19 Quality of Service (QoS) Configuration Page

Quality of Service Port Classification:

The Quality of Service configuration page allows the user to make a distinction between low and high priority traffic transmitted through each radio. High priority traffic will always jump to the front of the queue and bypass any awaiting low priority traffic. In instances where the link cannot support the amount of data trying to be transmitted, low priority traffic may be completely shelved in order to ensure that the high priority traffic gets through.

To specify Low/High 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 Low Priority.

Quality of Service 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.

End-to-End Automatic Repeat request (Beta Feature – License Enabled)

The End-to-End ARQ feature provides packet re-ordering capability to the radio. This feature is useful in applications that are sensitive to out of order packets (i.e. video applications where the decoder does not have the ability to re-order packets).
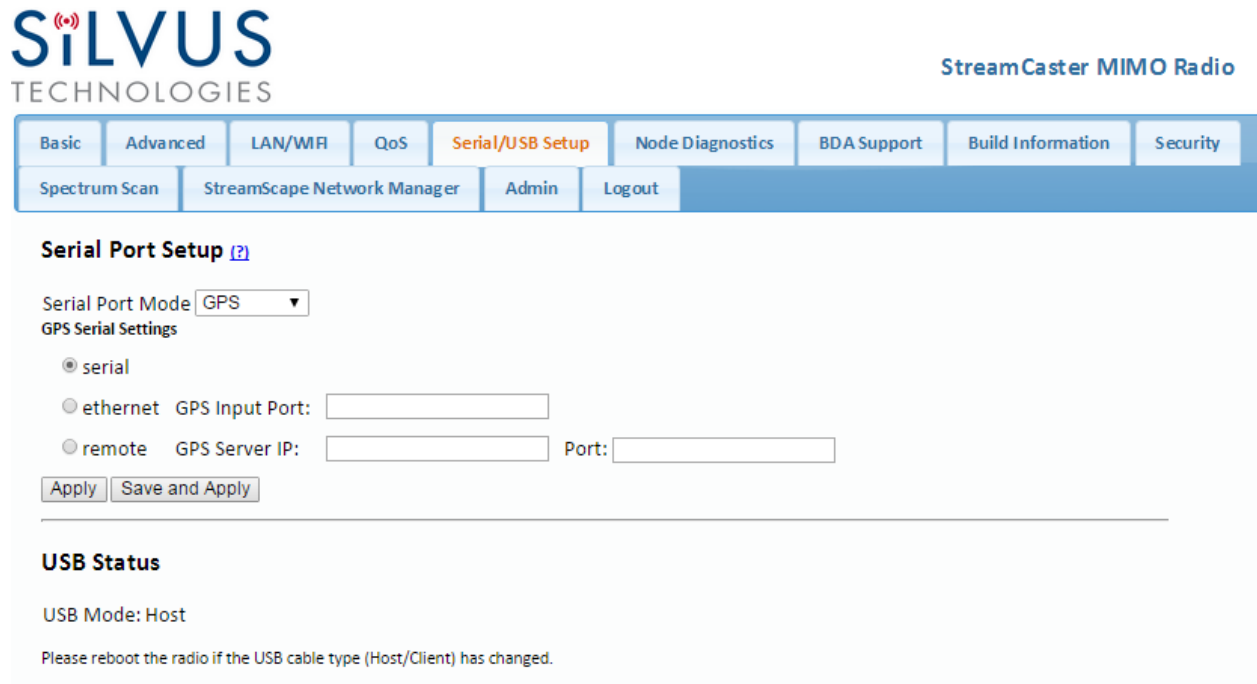
To enable packet reordering, specify the port number of the subject data in the same format as the QoS ports on the source and destination radio. The settings should match on both radios and do not need to be set on any relays.

Retransmissions Disabled – Only packet re-ordering with no end-to-end retransmissions if packets are lost. The receiver timeout is the length of time the receiver waits for out-of-order packets before giving up and delivering the data it has in its buffer. This is similar in concept to the jitter buffer in common video decoders (e.g. VLC). The worst case end-to-end delay will be incremented by the receiver timeout value.

Retransmissions Enabled – Packet re-ordering and end-to-end retransmissions enabled in case of packet loss. The retransmission timeout is the time the transmitter will wait before re-sending a lost packet. The worst case end-to-end delay will be incremented by the retransmission timeout value.

Determining Timeout Value – Both receiver timeout and retransmission timeout should be set to roughly 3 times the end-to-end latency. The end-to-end latency can be found by disabling e2e and doing a ping between the transmitter and receiver.

5.1.5 Serial/USB Setup

Figure 20 Serial/USB Setup Configuration 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*.

    o **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 port or pulled by the radio from a remote device such as an SC-IOM. If using an SC-IOM to obtain GPS, set the GPS mode to remote, the GPS Server IP to the IP address of the SC-IOM, and the Port to 2947.

o **RS-232**: The RS-232 mode provides a wireless serial connection between any two serial devices connected to StreamCaster nodes on the network. In this mode, the user must configure the RS-232 protocol parameters shown in **Figure 20** 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 can be the native or virtual IP address, but must be same at both ends.
- Baud rate must match the baud rate of data being sent.
- 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)

o **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.

o **Disabled**: This mode completely disables the serial terminal of the radio.

- **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):

The USB port on the 3822/4200 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.

5.1.6   Node Diagnostics

Figure 21 Node Diagnostics Configuration Page

The Node Diagnostics page allows the user to specify an IP and Port number for Temperature and RSSI (Receiver Signal Strength Indication) reports to be delivered to. This is useful for users that intend to feed this information into some other platform for analysis and recording. Section 7 gives more information on the format of streaming reports.

Temperature Thresholds:

In addition to receiving temperature reports, this page can be used to set minimum and maximum temperature thresholds for the radio. The StreamCaster™ family of radios is equipped with on board temperature sensors which are monitored to prevent overheating. Once a radio reaches the maximum temperature threshold, the radio will begin to reduce its transmission time until the temperature falls below the minimum temperature threshold. By default, the min and max values are 75C and 85C respectively.

LED Configuration:

This setting allows the user to disable or enable the LED on the faceplate of the radio.

Voltage Monitor:

Radios built on or after Jan 1, 2015 have the ability to monitor the input voltage, displayed here.

5.1.7   BDA Support

Figure 22 BDA (Bi-Directional Amplifier) Support 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.

- **Auto Noise Estimation:** When enabled, the radio can automatically estimate the noise in the channel, including any amplification due to the external amplifier. It is preferred that this remain disabled and the LNA gain values be manually input further below, but if the LNA gain values are not known, this can be used instead.

- **PA Mode**: Either set to "No PA" when there is no amplifier present or "Basic Mode" when using an external amplifier.

Basic Settings:

- **PA Gains for Channels 1-4**: Enter the gain (dB) for the power amplifier connected to each channel of the radio.

- **LNA Gains for Channels 1-4**: Enter the gain (dB) for the LNA connected to each channel of the radio.

- **Maximum PA Output Power Per Channel (dBm)**: Enter the maximum output power for each PA.

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

- **Save and Apply**: Save the new values to flash and apply.

5.1.8   Build Information

Figure 23 Build Information

The 'Build Information' page provides information about the hardware and firmware loaded onto the radio.

5.1.9   Security

The Security section of StreamScape allows users to enable/disable encryption, upgrade radios, and load license files for enabling features such as AES encryption.

Encryption:

Figure 24 Security (Encryption)

- **Encryption**: Enable or disable AES encryption.

- **Encryption Key**: Set an encryption key if encryption is enabled.

- **Encryption Profile**: Choose between AES, DES and CCM encryption. Note that the SC3500 and SC3800 currently only support AES and DES encryption.

- **HTTP Secure (HTTPS):** Enable or disable HTTPS access to StreamScape.

- **Login Authentication:** Enabling this will require the user to input login credentials before accessing the Security section of StreamScape.

Admin:

Figure 25 Security (Admin)

This tab can be used to set or change the administrator password (SC3822 only).
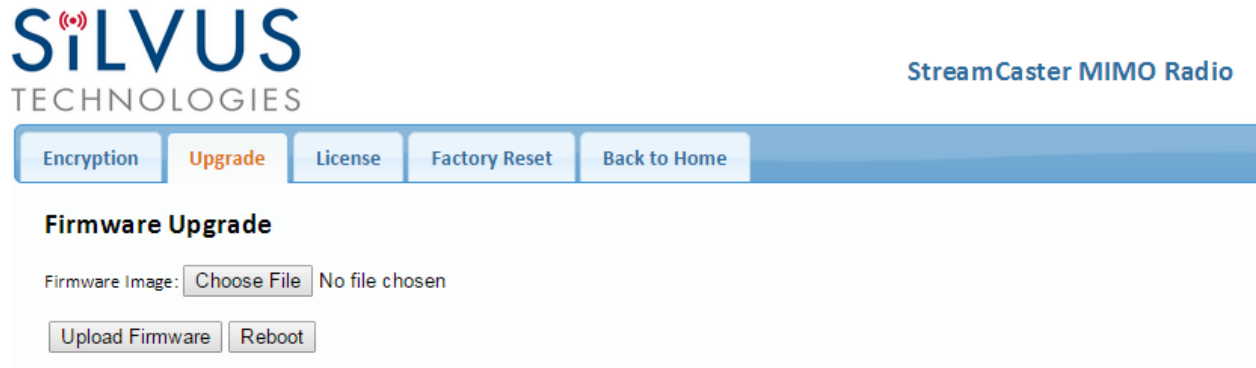
Upgrade:

Figure 26 Security (Upgrade)

The firmware can be upgraded by simply choosing the upgrade image from your desktop and uploading it to the radio. This field can be used to upgrade the radio root file system, linux kernel, or uboot. The upgrade system accepts the root file system image for upgrade or a tar file containing up to 3 files (uboot, kernel, rootfs) for upgrade. A radio reboot will be required after update before the changes take effect.
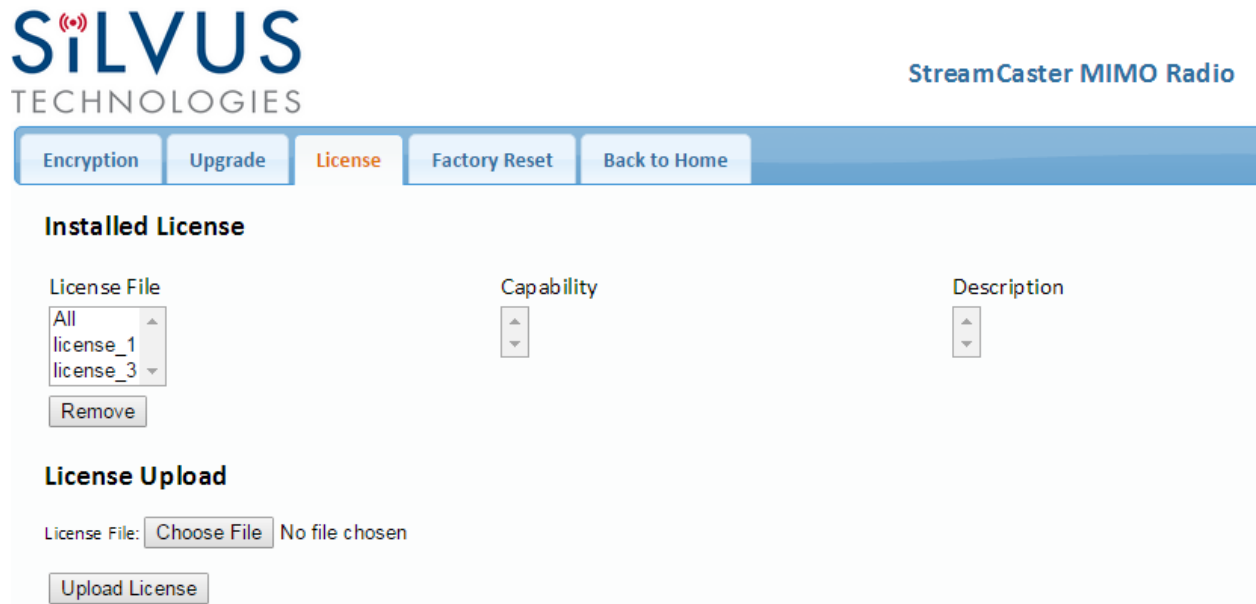
License:

Figure 27 Security (License)

Features such as encryption levels and frequency ranges can be enabled by license keys obtained from Silvus. New license keys can be uploaded to the radio on this page.
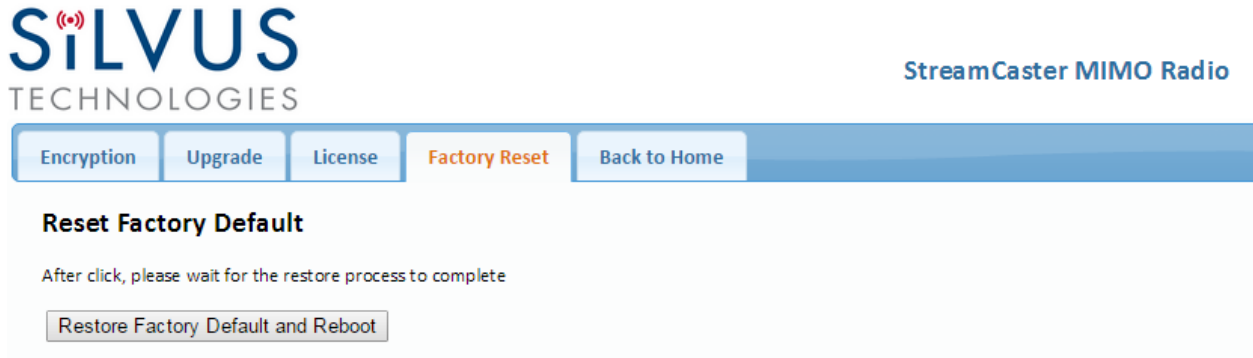
Factory Reset:

Figure 28 Security (Factory Reset)

This page allows the user to restore the settings in the radio to the factory default settings.

5.1.10   PTT (SC4200 Only)

Figure 29 PTT (Push-to-Talk)

The PTT page can be used to configure talk groups (Multicast Groups) and speaker/mic settings for PTT enabled radios. Radios can only communicate with other radios that are subscribed to the same 'Multicast Group'. Currently a radio is permitted to be active in only one Multicast Group.

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 G.722 (high quality). G.711 is also supported for backwards compatibility with the SC-IOM

Speaker Volume – Moving slider adjusts the gain on the speaker

Mic Volume – Moving slider adjust the gain on the microphone

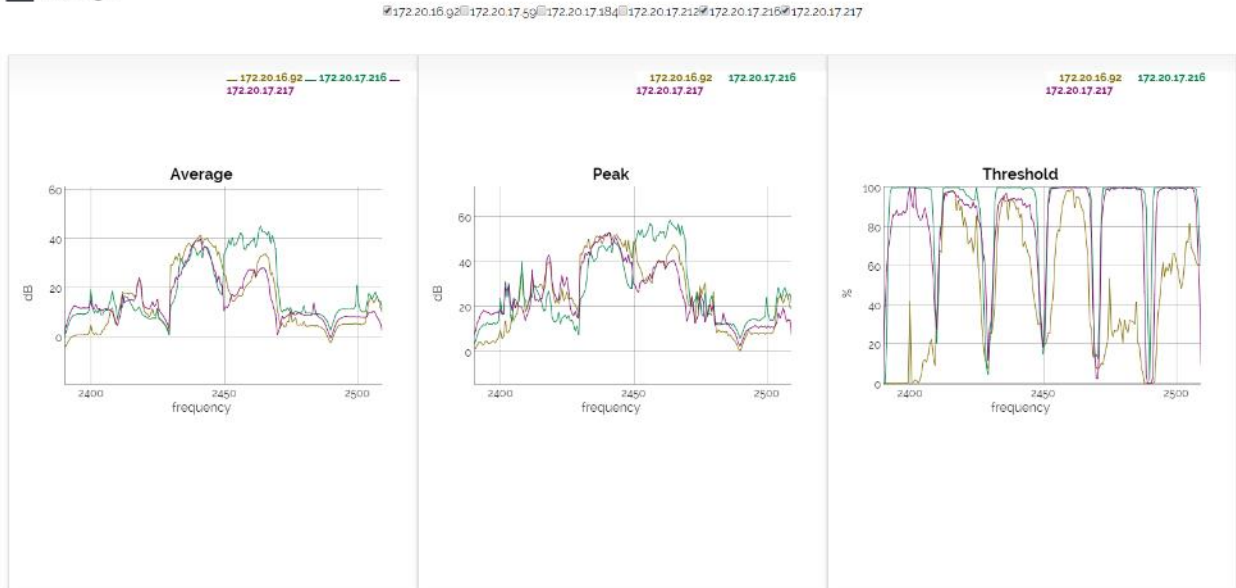# 5.1.11   Spectrum Scan (Beta Feature – License Enabled)

Figure 30 Spectrum Scan Results

The spectrum scan feature turns a Silvus network of radios into a distributed spectrum analyzer. When a scan is initiated, each selected radio in the network will go offline, perform a scan of the requested range, and report back. **Figure 30 Spectrum Scan** above shows the results from a scan of a network of 6 radios. The checkboxes at the top allow users to show or hide plots from specific radios. The three plots provided are:

Average – Displays the average power over the time duration specified in the settings.

Peak – Displays the peak power seen at any point during the scan for each frequency. This is the equivalent of the 'Max Hold' feature on common spectrum analyzers.

Threshold – Displays the duty cycle of interference stronger than the user specified 'Threshold' power. In the example above, the threshold was set to 5dB. The plot is showing the percentage of time that the measured power is more than 5dB above the radio's noise floor.

Settings:

Figure 31 Spectrum Scan Settings

Clicking the settings button at the top left of the window will show the settings pane as shown in **Figure 31 Spectrum Scan Settings** The node list shows the list of nodes currently connected into the mesh network. Any nodes selected will be used as part of the spectrum scan. Nodes that are unchecked will resume normal operation. Note that an unchecked node will continue transmitting in the frequency channel it is operating in and its transmission will show up in the scan results of scanning radios.

Mode – Set to Spectrum Scan or Zero Span. Spectrum Scan mode provides plots of signal strength over frequency. Zero Span provides a plot of power over time in a 20MHz Bandwidth (see **Figure 33 Zero Span Results** below.

Spectrum Scan Mode:

    Center Frequency – Specify the center frequency of the scan.

    Span – Specify the span of the scan, centered on the center frequency. (e.g. Center freq of 2450MHz and span of 100MHz will scan 2400-2500MHz). A large span will take longer to complete.

    Antenna Mask – Choose which antenna on the radio to use for scanning. If there are 2 antenna radios in the network antenna 1 or 2 must be chosen.

    Resolution Bandwidth – Specify the RBW for the scan. A smaller RBW will provide a more detailed plot, but will take longer to complete the scan. 625KHz is a good balance between scan detail and time of scan.

Threshold – Specify the threshold for measurement of the duty cycle of interference.

Duration – Duration of each scan. A longer duration will provide better accuracy but will take longer to complete.

Zero Span Mode:

Figure 32 Zero Span Settings

In the Zero Span mode, the radio will provide a plot of the power measured in a 20MHz bandwidth across time. Zero Span can only be conducted on one radio in the network at a time. Other radios in the network will continue to operate and transmit so a zero span scan should not be conducted within the same frequency that the mesh network is operating in.

Center Frequency – Specify the center frequency of the scan.

Sampling Rate – Set the sampling rate of the scan. (0.3Msps recommended)

Antenna Mask – Choose which antenna on the radio to use for scanning. If there are 2 antenna radios in the network antenna 1 or 2 must be chosen.

Duration – Duration of each scan. A longer duration will provide better accuracy but will take longer to complete.

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Spectrum scanning

≡ Settings

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Figure 33 Zero Span Results

5.1.12 Admin Settings

Figure 34 Admin Settings

The Admin Settings page provides the option of password protecting access to Streamscape. To enable, simply set the Login Authentication to Enable and provide a password. If a password had previously been set, the old password must also be provided in order to change the password. Once Login Authentication is enabled, access to streamscape will require the admin username and password as shown in **Figure 35 Login**

Figure 35 Login
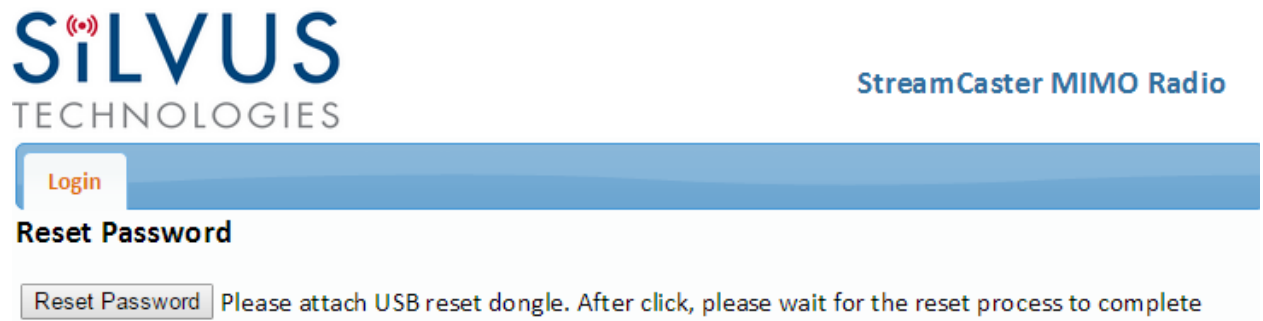
Reset Password:

Figure 36 Reset Password

If a user forgets the password, they can reset the password using a USB flash drive and a password reset key provided by Silvus. Note that since the SC3500 and SC3800 do not have USB ports, you will not be able to set a password for the interface.

5.2   StreamScape Network Manager

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 1, allows users to quickly and effortlessly view the network topology and configure 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.
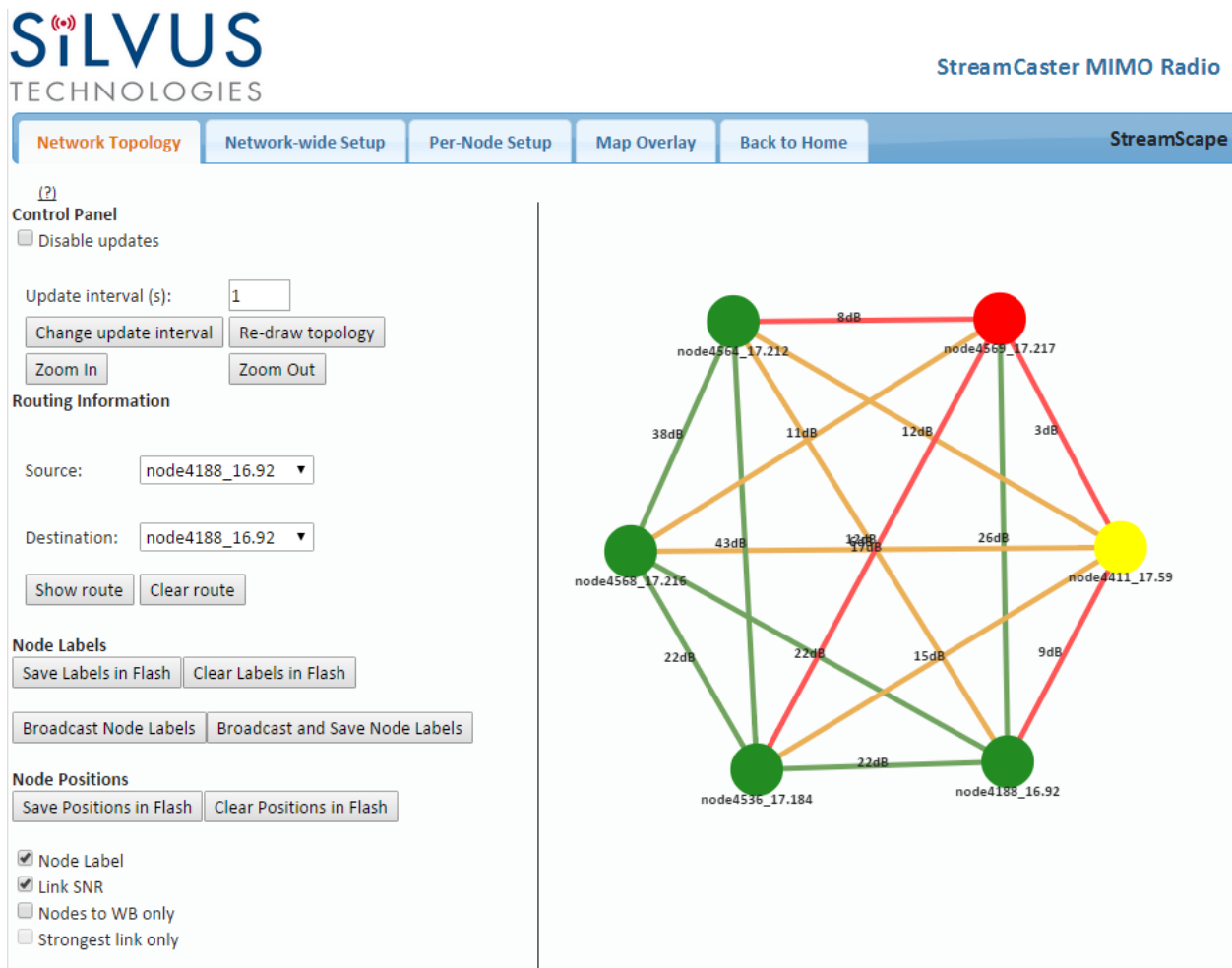
5.2.1   Network Topology

Figure 37 Silvus StreamScape Network Manager

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 38**.

- **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 'node4411' and 'node4569'in **Figure 38**). This will allow the user to recognize the issue and rearrange the network accordingly.
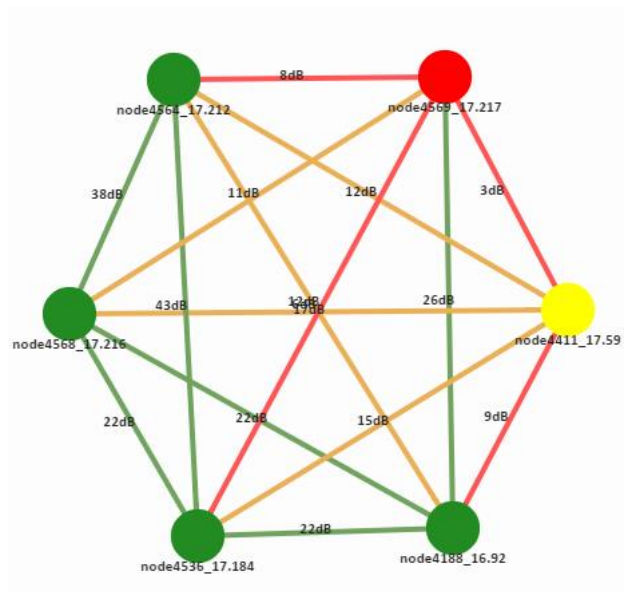

Figure 38 Example Network Topology

- **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 on the left hand side. The path will turn bold as shown in **Figure 39** for the path from 'node4411' to 'node4569'.
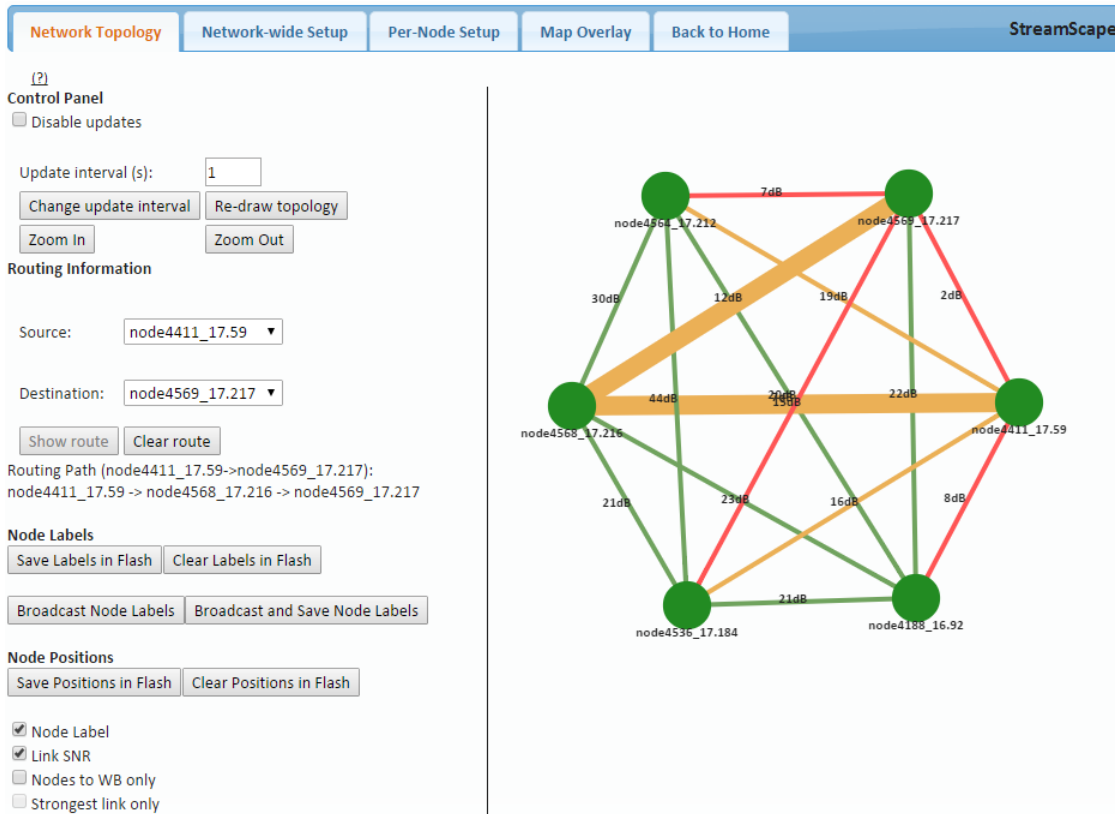
Figure 39 Routing Path

- **Custom Node Naming** – Naming each node in the network is as simple as double-clicking on the node name and typing in a new name as shown in **Figure 40**. 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 in the left pane 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 40 Custom Node Naming

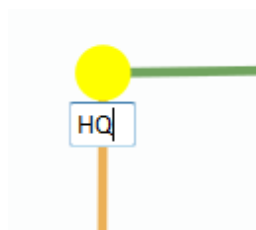- **Individual Node Characteristics** – By simply rolling the mouse over any node in the network, users can view key operating characteristics of the node. **Figure 41** shows an example of this for 'node4568'. The characteristics shown are:

  o **Node ID**: The unique node ID assigned to each node at time of manufacture. This cannot be changed.

  o **IP**: IP address of the node.

  o **Connections**: Number of direct connections to node. Each directly connected node is listed in the following format:
  <Node Name> <RX SNR> <TX MCS> <Pkts in TX Queue> <Num. of Spatial Streams> <Air Time %><Data Rate (Mbps)><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.

  o **Frequency:** RF center frequency of the node.

  o **Bandwidth:** RF bandwidth of the node.

  o **Noise Level:** Received noise level of the node.

  o **Interference:** Approximate in-band interference level.

  o **TX Power:** Total target transmit power of node.

  o **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.

  o **Fragmentation Threshold:** Chosen fragmentation threshold.

  o **Virtual IP:** Secondary IP address of node (0 if none set).

  o **MCS Mode:** Transmit MCS of node.

  o **Link Distance:** Link distance setting of node.

  o **Burst Time:** Burst time setting of node.

  o **Routing Beacon Period:** Routing Beacon Period setting of node.

o **RTS Retries:** RTS Retry setting of radio.

o **Number of Retransmissions:** Num. Retransmission setting of radio.

o **Contention Window Minimum:** Low Priority Contention Window Minimum setting of node.

o **Maximum Ground Speed:** Maximum Ground Speed setting of node.

o **Queue Size:** Number of packets currently waiting to be transmitted.

o **Total Air Time:** Total percentage of air time being used by this radio.

o **Total Data Rate:** Total data rate in Mbps being transmitted from this radio.

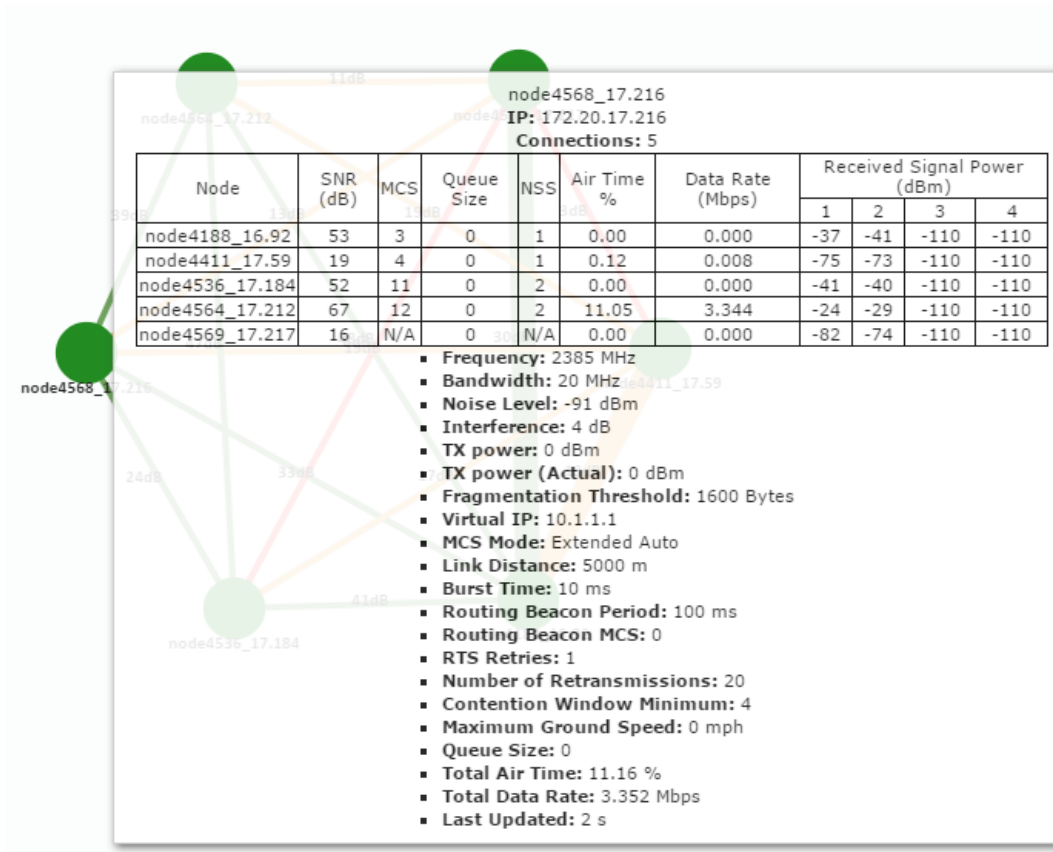o **Last Updated:** Duration that has passed in seconds since last update.

Figure 41 Individual Node Characteristics

- **Link Characteristics –** By simply rolling the mouse over any link in the network, users can view key operating characteristics of that link. **Figure 42 Link Characteristics** shows an example of this for the link between 'node4568' and 'node4564'. The characteristics shown are:

  o **SNR**: The SNR of the link in each direction.

  o **MCS**: The MCS used to transfer data in each direction.

  o **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.

  o **Queue Size:** Number of packets in TX Queue in each direction.

  o **NSS:** Number of Spatial Streams in each direction.

  o **Air Time:** Percentage of air time used in each direction

  o **Data Rate:** Data rate in each direction

  o **Received Signal Powers:** Received signal power for each antenna in each direction.
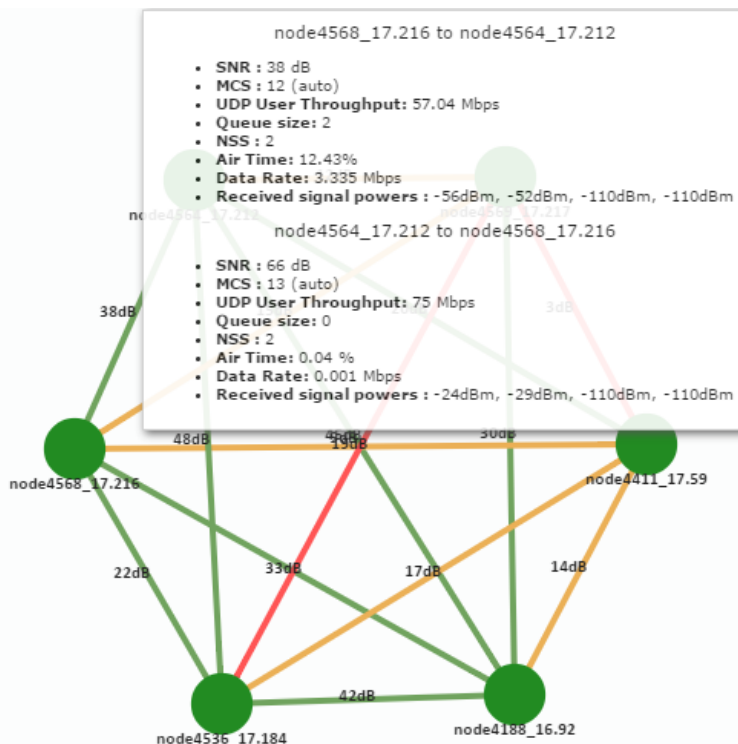
Figure 42 Link Characteristics

5.2.2 Network-wide Setup and Multicast

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.

Figure 43 Network-wide Setup

5.2.2.1   Multicast

The Network Wide Setup page is also used to configure up to 5 multicast streams. By default, all multicast/broadcast flows will be sent to all radios. This configuration is only necessary if a user wishes to send multicast streams to a subset of radios on the network. The configuration string format is as follows:

Multicast_ip_address, receiver_id1, receiver_id2, ... , receiver_idN

Multicast_ip_address is the multicast group address and receiver_idN are the node ids of the radios that need to receive the multicast stream. If no receivers are indicated, multicast will be sent to all radios. If there is only one receiver id = -1, the multicast stream will not be put on the air and discarded at the transmitter. This allows a quick way for the user to turn off a multicast stream from anywhere on the network.

Some Multicast 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 received by all radios:

224.50.50.51,

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

5.2.3   Per-Node Setup

The per-node setup can be used to modify key parameters of individual nodes within the network. As shown in **Figure 44**, 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.

In addition, this page can be used to upgrade a radio's firmware by simply choosing the upgrade image from your desktop and uploading it to the radio. This field can be used to upgrade the radio root file system, linux kernel, or uboot. The upgrade system accepts the root file system image for upgrade or a tar file containing up to 3 files (uboot, kernel, rootfs) for upgrade. A radio reboot will be required after update before the changes take effect.

Figure 44 Per-Node Setup

5.2.4   Map Overlay

The Map Overlay page provides an easy to use method of tracking the location of nodes in real-time. Nodes with GPS modules attached will be placed on the map as shown in **Figure 45**.
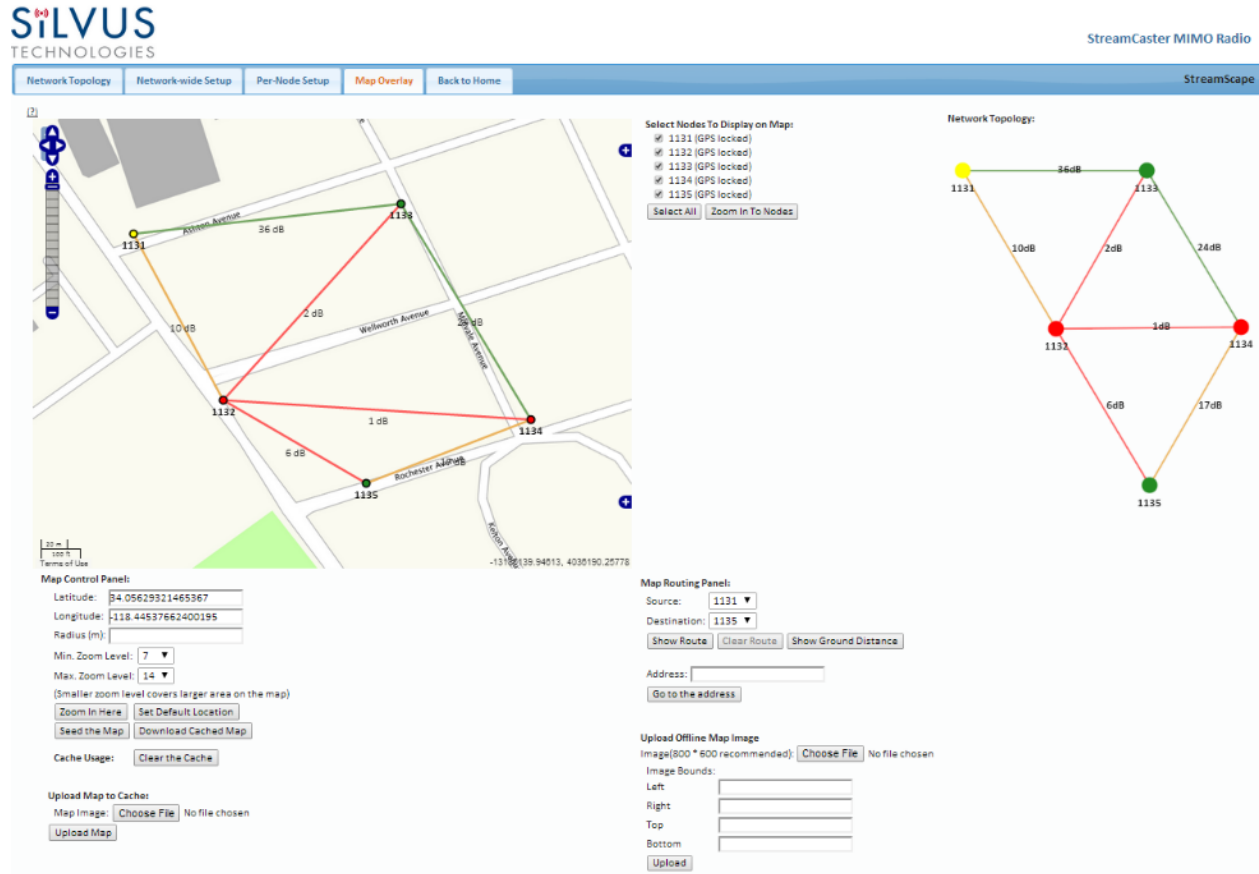
Figure 45 Map Overlay

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.

5.2.4.1   Map Options

There are 4 map options currently available in the Map Overlay view. The default map is OpenStreet Maps. OpenStreet Maps and 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 5.2.4.2. OpenStreet Maps Silvus is a version of OpensStreet maps which is hosted on Silvus' servers in case of an interruption in service with OpenStreet Maps. The Silvus maps currently only cover the United States.

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 46 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.

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 47 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.

5.2.4.2   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 advanced tab.

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.

5.2.4.3   Manual GPS for Nodes without GPS Module
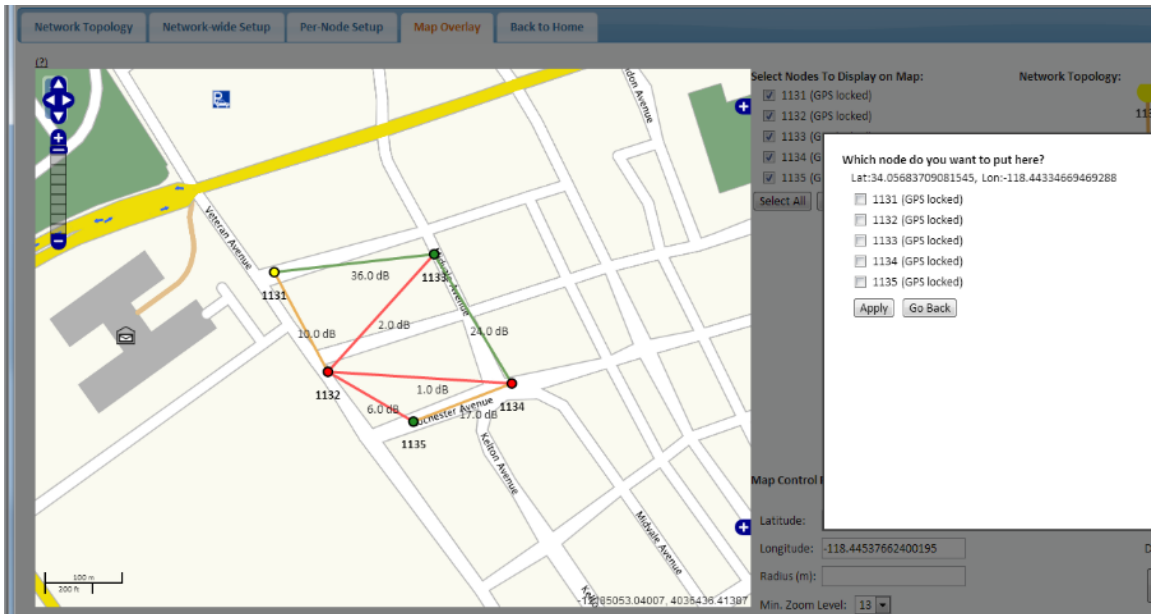

Figure 48 Placing Nodes on the Map

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.

6.   Wired Backbone

Wired Backbone extends the StreamCaster mesh functionality over LAN (Ethernet) and WAN (Internet) links. This feature is transparent to end-users - they do not have to re-configure their devices in any manner to use this feature.

The StreamCaster routing protocol will automatically detect and route data on wired links to preserve air bandwidth.

6.1   LAN Backbone

The LAN backbone feature allows more than one radio to be connected to a LAN.

6.1.1   Implementation

One of these radios must be configured as a "gateway" radio. This radio then begins listening promiscuously on its ethernet interface to "register" all devices on the LAN as being connected to the gateway radio. At the same time it auto-detects other non-gateway radios connected to the LAN and establishes "wired" links to them. StreamScape Web GUI will show LAN links with SNR of 150 dB to differentiate from wireless links.

The non-gateway radios do not register any devices, they merely act as relays. The gateway radio will forward traffic originating from the LAN, destined for a device attached to a wireless radio, to the non-gateway radio that is closest to the destination. Similarly, any traffic originating from a device attached to a remote wireless radio, destined to a device on the LAN will be forwarded by non-gateway radios to the gateway radio. The gateway radio will then send it to the device.

Currently we support data rates of up to 65 Mbps on the LAN without encryption. Since all LAN traffic goes via the gateway radio, this is the upper limit of all traffic that can enter or go out of the LAN from/to devices connected to wireless radios. Of course, this limit does not affect the throughput between two devices connected directly to the LAN backbone.

6.1.2   Use Case

Consider the following scenario. A business wants to do video monitoring of its grounds. High speed LAN hookups are available only in the HQ building. They want to use the StreamCaster radios on towers to provide complete coverage of the grounds. All video feeds are sent back and displayed at the HQ. To conserve air bandwidth and possible interference to other users, we want

video data to go through the high speed LAN backbone as much as possible. The below diagram shows the scenario.

Towers 1-3 are equipped with IP cameras attached to StreamCaster radios 1-3. Radios 4-6 are mounted on three sides of the HQ building with their Ethernet interfaces connected to the high speed LAN. Tower 1 can only communicate wirelessly with radio 4, Tower 3 with radio 5 and Tower 2 with radio 6. Video from Tower 1 will flow wirelessly to radio 4, then via the LAN backbone to the HQ viewer which is also attached to the LAN backbone. Even though the radios 4-6 may communicate wirelessly, they will choose to do so via the LAN backbone.
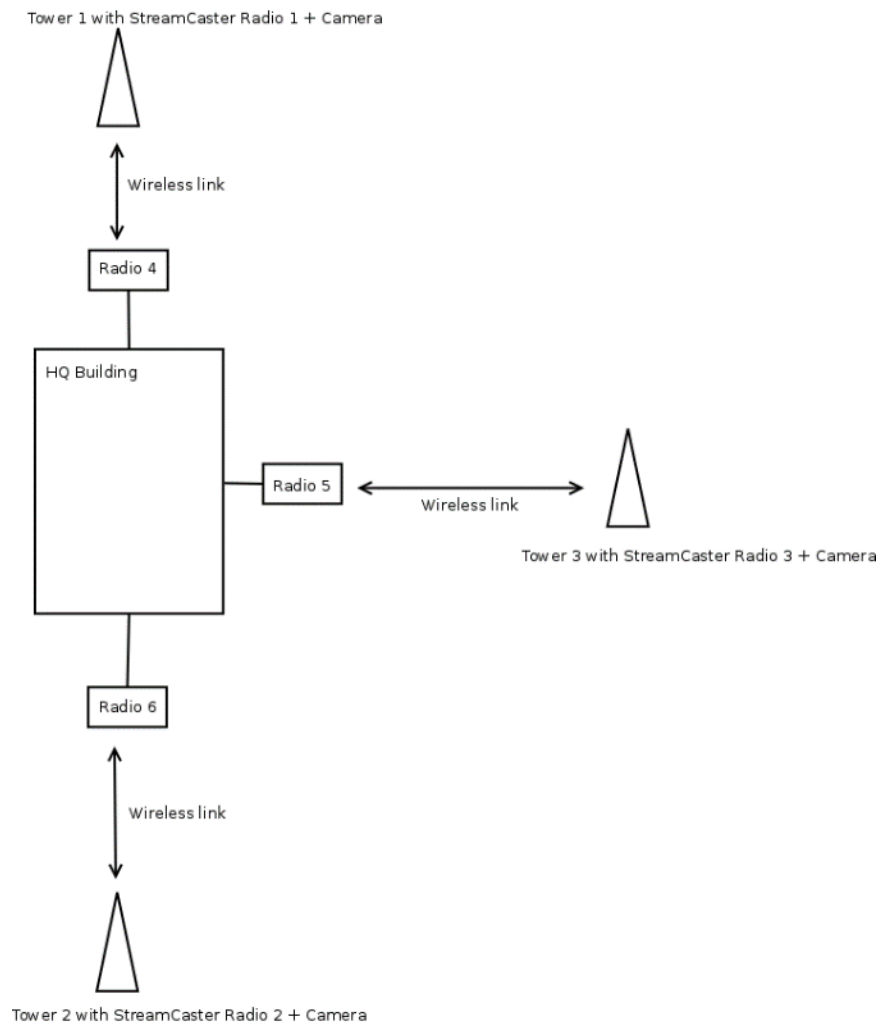

Figure 49 LAN Backbone Example

6.2   WAN Backbone with Roaming

The WAN backbone feature allows the wireless mesh network to extend over Internet links. Multiple geographically separate "sites" can be connected into one single layer 2 network as long as each site has an uplink to the Internet. The roaming feature allows mobile devices connected to StreamCaster radios to roam from one site to another without any network re-configuration.

6.2.1   Implementation

Each site wishing to become part of the wireless mesh needs to connect one StreamCaster radio to its LAN. Such a radio has to be configured to connect to a remote VPN server using the N2N protocol. Radios from multiple sites will be connected at layer 2 via the N2N VPN server creating a single broadcast domain for such nodes. By broadcasting routing packets in this domain, the nodes will auto-detect each other and establish WAN links. Such links will appear on the StreamScape GUI with a link SNR of 120 dB to differentiate from LAN links (150 dB) and wireless links.

The N2N VPN server will try to establish peer-to-peer links between the radios if it can. Under some cases (e.g. symmetric NATs), this is not possible, in which case traffic between the peers is relayed by the N2N server.

The N2N server can be hosted at any server with a public IP on the Internet. As a proof-of-concept, a server has been set up on Amazon Web Services. Currently we support up to 10 Mbps unencrypted between any two sites.

6.2.2   Use Case

Consider a military scenario where a platoon of soldiers begins its mission at an HQ, then breaks up into two groups. Each group has at least one soldier with an uplink to the Internet (provided by a 4G card). The HQ also has an uplink to the Internet. Every soldier and the HQ have a StreamCaster radio attached to their devices.

The soldiers in the two groups want seamless and transparent communication between 1) other soldiers in the same group 2) soldiers in the other group 3) back to HQ. Some lone soldiers (e.g. Soldier A with a StreamCaster radio) may break up from each group and move about on their own. As they get close to group 1, 2 or the HQ, they should be able to immediately establish communication and talk to all other soldiers in the network.

The StreamCaster radios connected to the uplinks in Group 1-2 and the HQ will automatically connect and form WAN links.

Note that the WAN and LAN backbone are complementary features. E.g. at the HQ, multiple radios can be connected to a LAN backbone so that any approaching soldier or group has a direct line of sight wireless connection to the HQ.
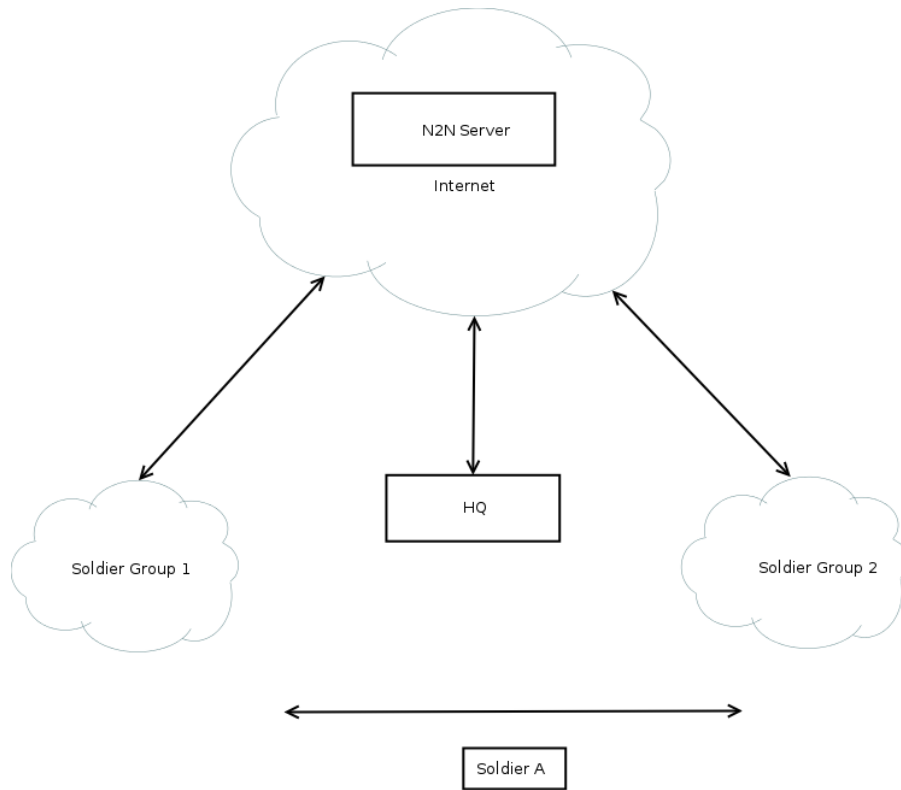
Figure 50 WAN Backbone Example

7.   Custom Frequency Plan

7.1   Accessing and Installing CFP

The hidden Custom Frequency Plan page can be accessed via http://<radio IP>/custom_freq.sh

The interface will allow an upload of a custom frequency plan file which should be in the following format:

```
{
    "type": "custom_frequency_plan",
    "name": "cfp_example",
    "description": "CFP Example",
    "frequencies": [
      "2412",
      "2417",
      "2422",
      "2427",
      "2432",
      "2437",
      "2442",
      "2447",
      "2452",
      "2457",
      "2462",
      "2467",
      "2472",
      "5745",
      "5765",
      "5785",
      "5805",
      "5825"
    ]
}
```

(Put the above format in a Text file. Name/description can be changed)

Custom Frequency Plan Text file example:
https://drive.google.com/file/d/0ByThlCSjgHe1TDMtZ2xDXzhEblE/view?usp=sharing

The numbers can be changed to the frequencies desired. The name of the text file does not matter in order to be utilized. After uploading the file, the web interface will be populated with the Custom Frequency Plan.

Note:
Once installed, the Custom Frequency Plan will be cross-checked with hardware capability and the licensed frequency range previously installed on the radio. The Custom Frequency Plan will only change what is displayed. It will not give new frequencies that are previously out of licensed range.

8.   Streaming Response

Some users may be interested in streaming specific information from the radio e.g. RSSI, noise floor, temperature, etc. After enabling the response they need using the above commands, the radio will transmit the desired information in the form of UDP packets to a specific IP address and port. The format of each report message will be in the type-length-value format as shown below:

TYPE LENGTH VALUE TYPE LENGTH VALUE …

- TYPE and LENGTH will be 16-bit unsigned integers in network-endian format.
- TYPE indicates the kind of information being transmitted. Pre-defined types are listed later in this document.
- LENGTH indicates the length of the VALUE field in bytes, including the terminating null byte.
- VALUE will be ASCII-encoded text terminated with a null byte ('\0').
- A single report will comprise of a set of type-length-value fields beginning with a "begin" report type. It will have a type which is specific to the type of report being generated, length of 1 byte and a value of an empty string (""). Note the empty string is still null terminated.
- Each report will end with an end of report which has type 1 (type = end of report, length = 1, value = "").
- The empty string listed above has a NULL character and has length 1. Any length number in the streaming report includes the NULL character
- A UDP packet may contain more than one report.
- The UDP packets have a maximum size of 1400 bytes.

8.1   RSSI and Noise Floor Reporting

The type/length/value for RSSI and noise floor reporting are listed in the following table:

Report Type	Data Type	Information
5009	Empty string ""	Begin of RSSI report
5010	Float	Revision number for RSSI report
5000	Integer	Raw signal power of first antenna, represented in half dBm steps.
5001	Integer	Raw signal power of second antenna represented in half dBm steps.
5002	Integer	Raw signal power of third antenna represented in half dBm steps.
5003	Integer	Raw signal power of fourth antenna represented in half dBm steps.
5004	Integer	Raw noise power represented in half dBm steps.
5005	32-bit integer	Sync signal power (from digital domain, see note below).
5006	32-bit integer	Sync noise power (from digital domain, see note below).
5007	16-bit integer	Node ID of the radio.
5008	32-bit integer	Report sequence number, increments for every report, resets after 9999.
1	Empty string ""	End of report.

Table 17 RSSI Reporting Format

Note:

The sync noise and power (types 5005, 5006) are special values obtained after packet processing in the digital domain. They cannot be directly compared to the raw signal and noise values. To obtain an SNR from these values the user needs to run the below formula on these values:

X = sync signal power;

Y = sync noise power;

$Z = (Y-X)/51$

$SNR\_mw = (X – 12 * Z)/(64 * Z)$

$SNR\_db = 10 * \log(SNR\_mw)/\log(10)$

SNR_db is the SNR in dB and it is averaged across all antennae.

The SNR obtained above is more accurate when the real SNR goes below 10 dB. Above 10 dB, the SNR obtained from the raw signal and noise values are more accurate.

Below is an example of the RSSI report:

Report Type	Length	Information
5009	1	""
5010	4	"1.0"
5008	5	"2333"
5000	5	"-43"
5001	5	"-31"
5002	5	"-28"
5003	5	"-66"
5004	5	"-190"
5005	8	"8604568"
5006	8	"8861322"
5007	5	"1025"
1	1	""

Table 18 Sample RSSI Report

The corresponding raw UDP dump in hexadecimal format is attached below. For the purpose of easier reading, each byte is separated by a space, and each item is separated by a new line. The real streaming report is continuous without any spaces or newlines and is currently 109 bytes long.

13 ffffff91 0 1 0
13 ffffff92 0 4 31 2e 30 0
13 ffffff90 0 5 32 33 33 33 0
13 ffffff88 0 5 20 2d 34 33 0
13 ffffff89 0 5 20 2d 33 31 0
13 ffffff8a 0 5 20 2d 32 38 0
13 ffffff8b 0 5 20 2d 36 36 0
13 ffffff8c 0 5 2d 31 39 30 0
13 ffffff8d 0 a 20 20 38 36 30 34 35 36 38 0
13 ffffff8e 0 a 20 20 38 38 36 31 33 32 32 0
13 ffffff8f 0 5 31 30 32 35 0
0 1 0 1 0

8.2   Temperature Reporting

The type, length and value for temperature reporting are listed in the following table:

Report Type	Data Type	Data
8	Empty string ""	Begin of temperature report.
9	Float	Revision number for temperature report.
2	Integer	Current Temperature on the radio.
3	Integer	Maximum Temperature reached on the radio after last booting.
4	Integer	Overheat Count: number of times the radio temperature has exceeded temp_reporting_max_threshold.
1	Empty string ""	End of report

Table 19 Temperature Reporting Format

9.   Setting up an Iperf Test

9.1   Required Equipment

- Two laptops with jperf installed. It is beyond the scope of this manual to cover the installation and operation of these tools. The laptops must be on the same subnet but not necessarily the same subnet as the radios (172.20.xx.yy). It is not required for the user to set a secondary IP address on the radio to perform this test. It is recommended the iperf or jperf tests are first conducted between the laptops using an Ethernet switch or cross-over Ethernet cable between them to verify the laptops and iperf/jperf tools.

- Two or more StreamCaster radios properly configured.

9.2   Running Iperf Test

- Connect a laptop to one StreamCaster radio using the Ethernet cable.

- Connect the other laptop to another StreamCaster radio.

- Power up the radios and verify the radios are booted and connected wirelessly.

- At the receiver side type the following in a terminal

  o   iperf –s –u -i 1

- At the transmitter side type the following in a terminal

  o   iperf –c receiver_laptop_ip_address –u –i 1 –b 1M –t 60

10. Precautions and Recommendations

10.1 Saving the Radio Configuration

It is very important that the radio does not lose power during any configuration changes in which the user requests a "save and apply" operation. Partial saving of the configuration to the radio due to power interruption may disable the radio requiring reprogramming at the factory. Also, please wait for a "done" feedback at the web interface before proceeding to any other configuration changes.

11. Troubleshooting

11.1 LED Issues

- If flashing red LED is present, radio is in safe boot mode. Click save and apply to resume normal operation.

- If LED is orange and node won't connect to another node, click "restore factory defaults" on both radios to ensure all settings are reverted to factory settings.

11.2 Intermittent Link

- In a long range scenario if SNR is good but link drops unexpectedly check link distance parameter and make sure that the link distance is set the same on all radios and sufficiently large enough.

- Check interference levels as strong interference can result in an intermittent link.

12. FCC Notice (SC3500-243541, SC3822-245580 and SC4210-245-BB Only)

Silvus P/N:	SC3500; SC3822; SC4210
FCC Identifier:	N2S-SC3500; N2S-SC3822; N2S-SC42-245
Equipment Class:	Digital Transmission System
Maximum Power:	500mW for SC3500; 250mW for SC3822; 800mW for SC4210
Antennas:	3dBi Omni Antennas (AOV3T245515575) for SC3500 and SC3822; 2.15dBi Omni Antennas (AOV2S230515) for SC4210
Bandwidth:	20MHz for SC3500; 20MHz for SC3822; 10MHz for SC4210

This equipment has been tested and found to comply with the limits for a class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

* Reorient or relocate the receiving antenna.

* Increase the separation between the equipment and receiver.

* Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

* Consult the dealer or an experienced radio/TV technician for help.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate the equipment.

To satisfy RF exposure requirements, this device and its antennas must operate with a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.