

LIVESHOT IP VIDEO CODEC

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I. INTRODUCTION

The Comrex LiveShot is a hardware video codec system designed for real-time video and audio transmission over IP networks, including the Internet. Some of the benefits of the LiveShot system are:

Quality - LiveShot uses a highly optimized version of H.264 video coding and AAC-ELD audio coding for the best possible quality.

Delay - LiveShot's video and audio processing is highly optimized to reduce delay. End-to-end delays of 200mS are possible on good networks.

Form Factor - LiveShot Rackmount is contained in a 1U Rackmount chassis. The Portable unit can clip to the back of a professional video camera.

Power - LiveShot Portable uses around 8 watts of power - low enough to share power with camera batteries.

I/O ports - LiveShot connects to cameras and switches via a wide array of A/V connections, including **HD-SDI**, analog **Composite** and **HDMI** ports.

Network connections - Both LiveShot Rackmount and Portable support Ethernet and LiveShot Portable supports two simultaneous wireless network connections over USB.

USB masts - LiveShot Portable utilizes a pair of innovative bendable USB goosenecks, providing durability as well as elevation and spacial diversity between modems.

Interface - LiveShot is controlled via an intuitive web page delivered from the internal web server. In the Portable, a built-in Wi-Fi access point can deliver the page to a laptop with wireless connectivity. Apps are also available to deliver this page to mobile devices.

A WORD ABOUT 3G/4G NETWORKS

Summary - Default coding is 2.2Mbps (or lower) up, 400Kbps (or lower) down. The default video encoders will throttle based on network performance. This works well with LTE or a pair of 3G modems.

Many users are excited to get started using LiveShot in 3G and 4G networks. Here's some advice and suggestions for use on these networks:

*The default mode (or “**sweet spot**”) for LiveShot delivers a video feed coded to 2Mbps, along with an audio feed coded to 48Kbps. With packetization overhead, this stream comes in around 2.2Mbps total. A lower quality stream is delivered in the direction to the Portable at around 400Kbps total. If network connections are constrained, the video encode rate will be reduced without interruption. These are only default modes, and lots of profiles exist to raise or lower these data rates depending on available networks.*

The default stream fits nicely within the upload path of one or two 4G LTE services. On GSM-based 3G services (or services marketed as “4G” but not LTE-based, like some HSPA+ networks) this speed will sometimes fit on a single modem, but may tend to be constricted automatically to below 1Mbps. For highest quality on these networks, it's advisable to “**pair up**” with two active wireless modems simultaneously.

In our experience, CDMA-based 3G services (e.g., Verizon and Sprint in the U.S.) have varying upload speeds in different areas. It's usually not possible to deliver the default coding mode on a single CDMA 3G modem, but often possible to use a pair.

Lower quality connections on a single CDMA 3G modem may be established by setting the connection profile to a lower setting.

QUICKSTART IN LOOPBACK

We'll dive into all the LiveShot connections, interfaces and modes soon, but if you want to do a quick check of how LiveShot works in "**Loopback**" (a single LiveShot encoding and decoding the same media), it's fairly simple to do. Since the LiveShot Portable offers only composite video output, you'll need to use the rack to experience the full quality. Here are the steps:

- 1 Connect a video source (camera) to LiveShot. On the Portable you can use **HD-SDI**, **HDMI**, or **Composite**. On the Rackmount you can use **HD-SDI** or **Composite**. Note that the Portable **HDMI** input does not support copy-protected sources (i.e., it is not HDCP compliant), so **HDMI** connection from DVD or Blu-ray players won't work (unless the source disc does not have copy protection enabled, like a home video).
- 2 Connect a video monitor to LiveShot (via **HDMI** or **HD-SDI** on Rackmount, **Composite** on Portable).
- 3 Power up the unit and wait for the **Network** light on the front of the Portable (**Status** light on Rackmount) to glow red. This indicates that the units have booted completely. If the light subsequently goes out, it means they have detected network connectivity.
- 4 "**Long Press**" **F2** on the Portable (hold for 3 seconds). If using the Rackmount, press the front panel **Enter** button and scroll down to the entry labeled **Auto Connect #4**. Press **Enter** and watch the show! **F2** (Portable) or **Enter** (Rackmount) will break this connection.

Loopback involves a full encode/decode cycle of LiveShot audio and video. By default this is a 5Mbps video stream and a 48Kbps audio stream. This mode is useful to estimate video and audio quality, as well as best-case delay. Since no real network is involved in this test, any additional delay on a real connection will either be caused by network latency or network jitter causing the decode buffers to expand.

II. LIVESHOT CONNECTIONS, CONTROLS, INDICATORS

LIVESHOT PORTABLE CONNECTIONS, CONTROLS, INDICATORS

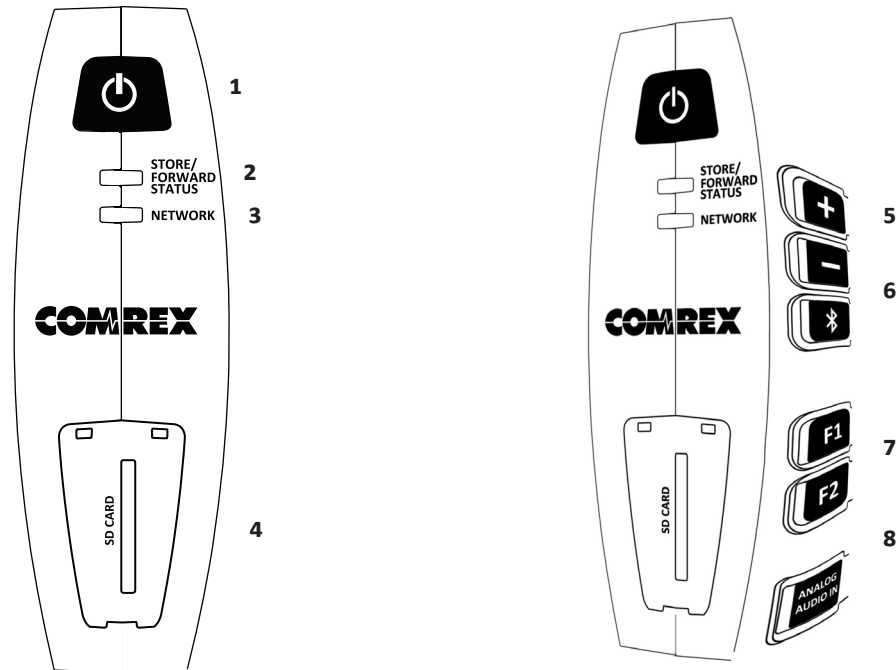


FIGURE 1 LIVESHOT PORTABLE FRONT

Figure 1 shows the front panel of the LiveShot Portable:

- 1 **Power Button** - Press this for two seconds to power the device on and off.
- 2 **Store/Forward Status Indicator** - For future use.
- 3 **Network Status Indicator** - Shows current network status:
 - Red** - No network found
 - Off** - Network OK
 - Green** - CrossLock VPN established
 - Flashing Green** - Active video stream
- 4 **SD card Compartment** - For future use.
- 5 **Volume Up/Down** - Allows level control of the headset connection used for the cue channel feature.
- 6 **Bluetooth On/Off** - For future use.

- 7 **F1 & F2 keys** - Used for special functions. In current firmware, these are “**hot connect**” keys that are programmed to make outgoing connections. As shipped from factory, “**Long Press**” of **F2** establishes a loopback connection for testing (internal encoder - internal decoder). Three other functions are available (short press F1, F2, long press F1). Each of these can be assigned to trigger an outgoing connection.
- 8 **Analog Audio In Button** - Instructs the LiveShot to ignore embedded digital audio sources on **HD-SDI** and **HDMI** ports and encode the analog audio input only.

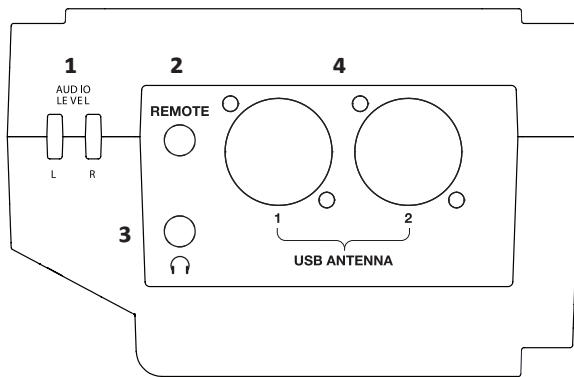


FIGURE 2 LIVESHOT PORTABLE TOP PANEL

Figure 2 shows the top panel of LiveShot Portable:

- 1 **Audio level indicators** - Measures audio level of incoming audio. Green means good, Orange means approaching clipping.
- 2 **Remote connector** - For future use.
- 3 **Wired headset connector** - 4 pole TRRS style connector for attachment of a wired headset. Provides send/receive cue channel audio.
- 4 **USB ports** - These 4-pin XLR female connectors are designed to be attached to the USB gooseneck adapters provided. Either or both may be used.

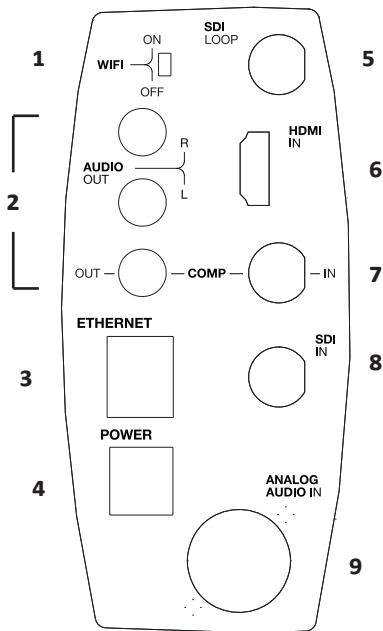


FIGURE 3 LIVESHOT PORTABLE REAR PANEL

Figure 3 shows the rear panel of LiveShot Portable:

- 1 **Wi-Fi On/Off switch** - Enables or disables the internal Wi-Fi access point (associate a laptop or smartphone to this signal for control of the unit).
- 2 **Composite Video/Audio Output** - This port presents the return video/audio signal from the far end (if enabled in the connection profile).
- 3 **Ethernet Port** - For use on wired networks.
- 4 **Power Jack** - Plug in the supplied external power supply here. Requires 15V DC at approximately 1A.
- 5 **SDI Loop Output** - Provides a loop-through output for the signal attached to the **SDI-IN** port.
- 6 **HDMI In** - For connection to camera with HDMI outputs. This port does not support HDCP copy protection. Copy protected sources (like DVD or Blu-ray players, and some cameras) will not work here. 1080p60 not supported.
- 7 **Composite Video In** - Analog **Composite** video input is attached here.
- 8 **SDI In** - HD-SDI or SDI video with or without embedded audio is attached here. 1080p60 and 3G-SDI not supported.
- 9 **Analog Audio In** - When using **Composite Video In**, (or analog audio along with digital video sources) connect to this 5-pin XLR port.

PORTABLE CONNECTOR PINOUT

Power in - 5 pin mini-DIN

Accepts 15V DC @ 1A

- 1) UNCONNECTED
- 2) & 4) GROUND
- 3) & 5) +15V DC

Analog Audio in - 5 Pin XLR-F

Input level is 0dBu nominal Ground

- Pin 1 GROUND
- Pin 2 BALANCED LEFT AUDIO +
- Pin 3 BALANCED LEFT AUDIO -
- Pin 4 BALANCED RIGHT AUDIO +
- Pin 5 BALANCED RIGHT AUDIO -

For unbalanced input connections, connect Pins 1, 2 and 4 together and apply L & R + signal to Pins 3 and 5 respectively.

USB connections

Pin alignment to USB standard

- 1-1+5V DC
- 2-2DATA -
- 3-3DATA +
- 4-4GROUND

Wired Headset connector (iPhone-style pinning)

- Tip - CUE AUDIO OUT L
- Ring 1 - CUE AUDIO OUT R
- Ring 2 - GROUND
- Sleeve - ELECTRET MIC IN

PORTABLE POWER DETAILS

The LiveShot Portable is designed to be powered from either its external desktop-style supply or via an Anton Bauer Gold-Mount (also known as 3-stud) compatible battery. The Portable may also be mounted to the back of a camera that uses a Gold-Mount battery. In this case, the LiveShot is “*sandwiched*” between the battery and the camera, and the LiveShot draws power from the battery and passes it through to the camera.

LiveShot can be powered from an Anton Bauer style battery without being mounted to a camera.

When a battery is attached, and the power supply is also attached, LiveShot will accept power from only the power supply, while still passing battery power through to a camera (if attached). The arrangement may be “**hot switched**” without affecting active streams.

LiveShot will not deliver power from its own power supply to the camera, nor will it charge the battery or apply power to the battery terminals in any way.

When using Gold-Mount compatible batteries and cameras, LiveShot will pass through the battery data leads, if they exist.

Adapters are available from Comrex and other sources to use V-mount style cameras and batteries. When V-mount adapters are used, battery data information is not sent through the LiveShot.

LIVESHOT RACKMOUNT CONNECTIONS, CONTROLS, INDICATORS

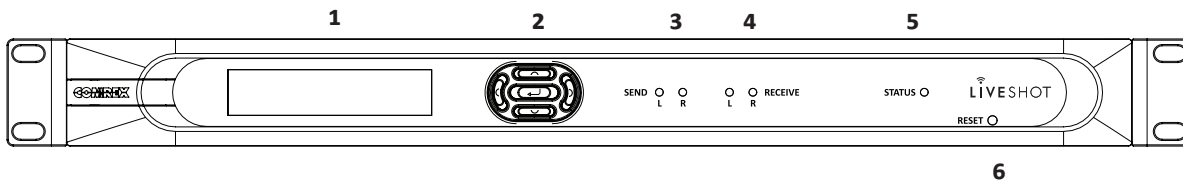


FIGURE 4 LIVESHOT RACKMOUNT FRONT PANEL

Figure 4 shows the front panel of LiveShot Rackmount:

- 1 & 2 **Display/Control buttons** - Allows basic configuration and operation. LiveShot is designed to be driven from its web interface, but the front panel controls provide an alternate means for some basic functions.
- 3 **Send Audio Indicators** - Measures audio level of incoming audio. Green means good, Orange means approaching clipping.
- 4 **Receive Audio Indicators** - Measures audio level coming from remote side. Green means good, Orange means clipping.
- 5 **Status Indicator** - Used to deliver network status info:
 - Red** = Network lost
 - Off** = Network active
 - Green** = CrossLock VPN active
 - Flashing Green** = Active video stream
- 6 **Reset button** - Press here to reboot LiveShot.

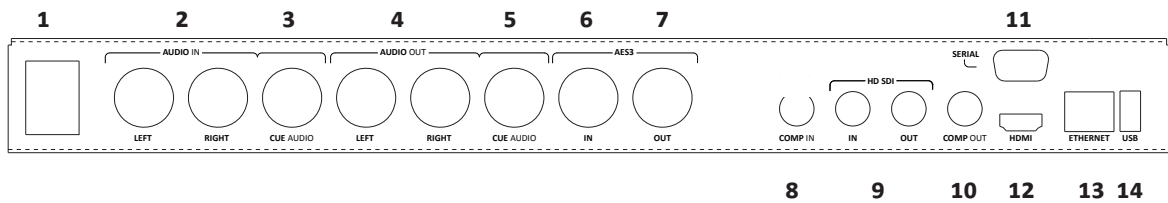


FIGURE 5 LIVESHOT RACKMOUNT REAR PANEL

Figure 5 shows the rear panel of LiveShot Rackmount:

- 1 **Mains AC Power** - Universal IEC connector accepts 110-240VAC 50/60Hz.
- 2 **Analog Audio In L/R** - When using composite input, these balanced XLR-3F ports accept analog audio.
- 3 **Cue Audio** - Apply audio here to be sent out via the cue audio channel.
- 4 **Analog Audio Out L/R** - Analog Audio output of the incoming stream. These outputs are active even when using a digital video output with embedded audio.
- 5 **Cue Audio Out** - Cue audio received from other LiveShots will be available here.
- 6 **AES3 Audio In** - Digital audio input for use with **Composite** video in. When stereo AES3 audio is applied to this port, the **Analog Audio In** ports are automatically disabled.
- 7 **AES3 Audio Out** - Digital audio output from incoming stream active simultaneously with all other audio output ports.
- 8 **Composite Video In** - Analog video input to send is applied here.
- 9 **HD-SDI In/Out** - Send and receive HD-SDI video (with embedded audio) is applied and extracted here, respectively.
- 10 **Composite Out** - When the system is configured to output SD video modes, this output is active.
- 11 **Serial** - For future use.
- 12 **HDMI Out** - Digital video output with embedded digital audio is available here. In HD modes, video is available on **HD-SDI out** and **HDMI out** simultaneously. In some SD output modes, this port is disabled unless chosen as the primary output in the configuration interface (in which case **SDI out** is disabled instead).
- 13 **Ethernet connection** - 10/100BaseT Ethernet port for connection to your network.
- 14 **USB** - For future use.

RACKMOUNT CONNECTOR PINOUT

Analog XLR pinning (L&R in, L&R out) 0dBu nominal level (+20dBu clip)

Cue Audio In/Out pinning -10dBu nominal level (+6dBu clip)

Pin 1 GROUND

Pin 2 BALANCED AUDIO +

Pin 3 BALANCED AUDIO -

To use unbalanced sources, connect Pins 1 and 3 to Ground, and connect the audio + signal to Pin 2. This is valid for outputs, as the output stage can detect an unbalanced connection and adapt.

AES3 in and out XLR pinning

Pin 1 GROUND

Pin 2 AES3 DATA +

Pin 3 AES3 DATA -

ABOUT LIVESHOT VIDEO I/O

Summary - LiveShot will adapt to most I/O resolutions automatically and use default coding resolutions which may be different still.

On digital video inputs and outputs, LiveShot supports 1080i50/60, 720p50/60, and all SD modes.

On **Composite In/Out**, LiveShot supports SD modes.

LiveShot video inputs are automatic; an active video input is automatically selected and the resolution and frame rate are adapted to by the encoder. LiveShot Portable lights an indicator next to the active video input. LiveShot Rackmount indicates the active input (and the detected resolution) on the display. This information is also available on the web interface of each device.

Simultaneous connection of video inputs may cause issues, except in the case of the **Composite** input on LiveShot Rackmount.

LiveShot Portable's single A/V output is **Composite** along with **Analog** audio. Hence, all video available here will be downscaled to SD quality, and progressive decode modes will be re-interlaced.

It's important to note the distinction between LiveShot's input resolution, output resolution, and encode/decode resolution, which are independent and may be different. Input resolution is automatically detected and adapted. Encode/decode resolution is selected in the connection profile chosen via the user interface. On LiveShot Rackmount, the system will attempt to match the output resolution to be the same as the video was when it was inputted to the far end encoder. On LiveShot Portable, output is always adapted to SD modes. Under most circumstances, LiveShot will upscale, downscale, de-interlace and re-interlace to adapt automatically. This is shown in **Figure 6**, where a full duplex connection is presented. In the direction to the LiveShot Rackmount, the decoder output resolution will be matched to the native encoder 1080i input signal, although all processing in between is done at 480p. In the direction to the Portable, the output will be matched to the 480i composite output resolution, regardless of the native input or processing resolution.

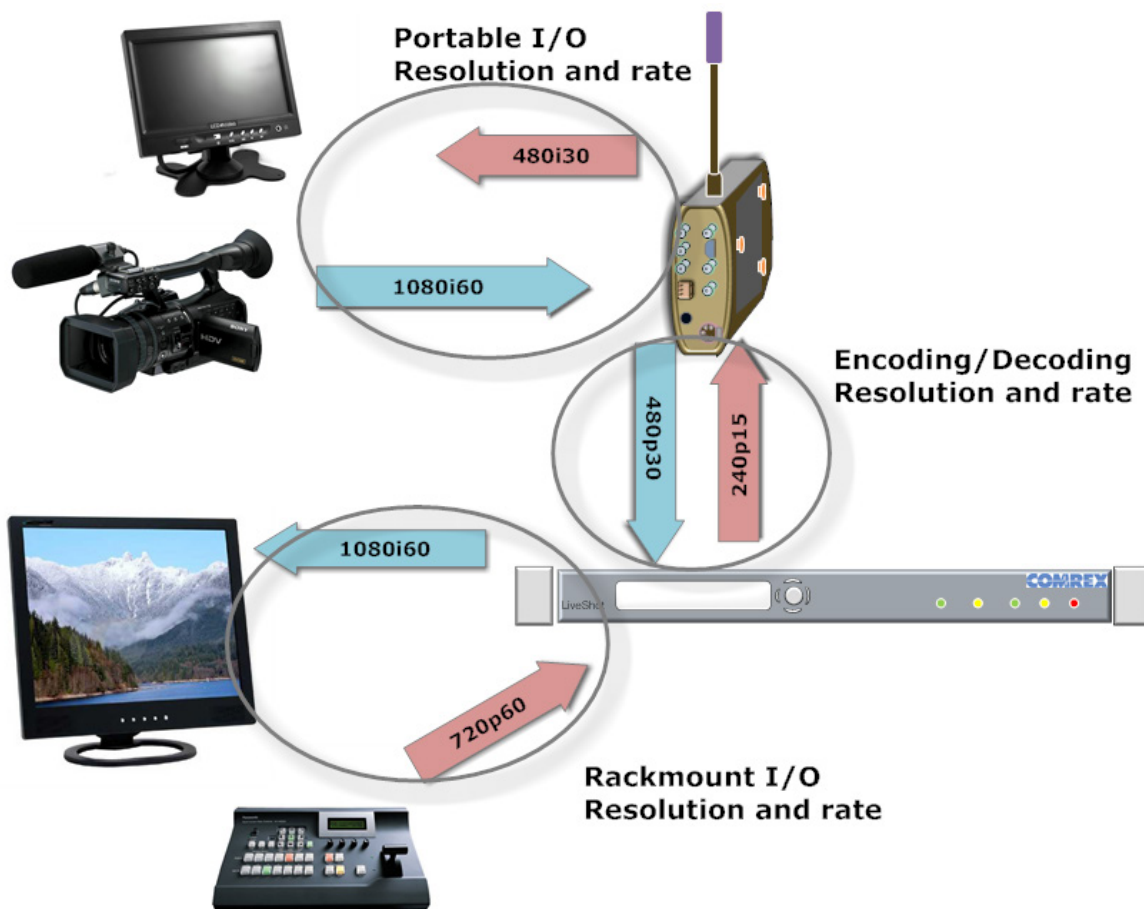


FIGURE 6

Also referring to **Figure 6**, frame rates typically remain constant throughout the system, except that the LiveShot encoder can be set to reduce the input video frame rate by a value of 2, 4, etc. But even though the encode/decode process is happening at a reduced frame rate, the decoder output frame rate will be increased to automatically match that of the native input video. Again, the exception is the Portable output, which will adapt to an SD frame rate.

The output of the **HDMI** port on LiveShot Rackmount may also adapt based on the detected resolution of the device connected to it.

As shown in the diagram, LiveShot is capable of processing entirely different frame rates and resolutions in each direction.

ABOUT LIVESHOT VIDEO CODING

Before we begin discussing video coding, let's define the term "**video quality**". Obviously, quality is a highly subjective topic. When we use the term quality here, we use it as a substitute for the more technical term "**encoding efficiency**". This means relative to a certain encoding bitrate (note: everything is relative to bitrate in LiveShot), the encoder will produce a certain amount of video artifacts or "**noise**" based on some of the other options chosen. Some options may decrease delay or increase error resilience at the expense of "**quality**".

Our "**quality**" term should not be confused with resolution. The number of encoded video lines (and whether the signal is processed as interlaced or progressive) is just another factor affecting the overall quality at a given bitrate.

LiveShot includes a highly optimized version of the well regarded **H.264** encoder. The **H.264** standard contains many options, and LiveShot has implemented those options that best balance video quality with delay and error resilience.

There is never a need to set any decode parameters on LiveShot - the decoder will automatically adapt to changes in encode mode.

The encoder parameters are highly configurable. On LiveShot, these parameters are defined in **Profiles** that set all the available encoding options. Profiles can be user defined from scratch, but we have defined several factory profiles that we feel best balance each of these parameters for various users at specific bitrates. If you plan to create your own profile, it's often easiest to start with one of these, copy and rename it, and start changing parameters from there.

BITRATE

The most important encoding parameter is bitrate, defined as number of encoded bits per second. This parameter must be defined by the user based on his knowledge of the target network. While the video encoding bitrate does not define the size of the entire network stream, it does account for most of it. As a rule of thumb, if you plan to utilize x bits of total network bandwidth, choose a video encoding rate around 75% of x. The other 25% will consist of audio streams, and the various overhead data required for IP transmission.

H.264 is a variable bitrate encoder. The network bandwidth used is constrained by a parameter called target bitrate. Due to the nature of video encoding, the target bitrate is only a long-term estimate. The bitrate measured over a short term window may rise and fall dramatically around the target. This burstiness may cause issues on some networks in the form of delay or lost data. There are encoding parameters available to reduce this bursty aspect (at the expense of our other critical parameters of

quality, delay etc). In general, simple video (few acute details and colors without motion) will require a smaller bandwidth than what is specified as the target.

When specifying a target bitrate, you should take care to stay below the maximum specified speed of your network. E.g., if your 4G network claims upload speeds of 5Mbps, it's a good idea to start by using network streams that utilize less than half that bandwidth. Also, since many wireless services charge by amount of data used, it's often a good idea not to use a higher bitrate than you need.

VIDEO LINES

LiveShot specifies resolution in the “**number of video lines used by the encoder**”. The factory profiles offer a good guide as to what video encoding resolutions look best at which range of bitrates. As you'll see, at data rates below 2Mbps, we have chosen what would be considered SD (480 lines) resolutions for encoding, as we feel it provides higher “**quality**” than trying to encode HD modes. At 2Mbps and above, our profiles switch to encoding 720 lines, what most consider HD. As the bitrates get extended in each direction, the profiles will change appropriately. To reiterate, the number of lines we specify for the encode cycle are not necessarily related to the input/output resolution.

FRAME RATE

The choice of frame rate can have a significant impact on encoding quality, with lower frame rates offering improved quality (as defined above). Frame rates on LiveShot are defined as a fraction of the native input frame rate. As an example, if your native input frame rate is 60fps, the encoder can be set to 60 (full rate), 30 (1/2 rate), 15 (1/4 rate) etc. If your native frame rate is lower, these options will scale down. Again, the factory profiles can be a guide to reasonable settings. Profiles defined as “**High motion**” at a particular bitrate often have reduced frame rates, as an attempt to reduce motion artifacts. The frame rate reduction function is only available on profiles set to process video in progressive format (i.e progressive video source or deinterlacer set on). Once again, note that these settings don't affect the I/O frame rate, just the internal processing rate.

ABOUT LIVESHOT AUDIO CODING

Comrex has been serving the Radio Broadcast industry for decades and we take special pride in providing excellence in our audio features. To that end, LiveShot contains a state-of-the art audio encoder based on AAC. This provides compatibility with streaming players (e.g. “streaming server” session mode, described later). Profiles can be altered to provide HE-AAC or AAC-ELD coding. Target bit rates and mono/stereo choices are predefined in the factory profiles but can be altered in custom profiles.

LIVESHOT ENCODE/DECODE LIMITS

The codec engine within LiveShot has a lot of responsibility, including maintaining a consistent video encode and decode stream (if a full-duplex profile is chosen). There are many options involving bitrates and resolutions that can make this engine work very hard. Here are some general limits to what you can expect from LiveShot.

- 1 The aggregate video bitrate (send and receive) in a LiveShot profile should be 15Mbps or less. E.g., if you are running one-way video, your profile can encode up to 15Mbps. If you are running full duplex with a 2Mbps return channel, limit your outgoing video encoder to 13Mbps.
- 2 LiveShot can not generally support 1080i encoding in both directions simultaneously. If you need 1080i encoding in the outgoing direction, encode the return channel at 720 lines or less. Note this limitation is in regard to the actual encode bitrate, not the input video resolution. LiveShot can handle 1080i inputs and outputs in each direction.
- 3 Use of the cue channel loads LiveShot significantly, and should not be used at all when the encode rate in either direction is 6Mbps or above.
- 4 Use of more than two networks simultaneously (e.g. with LiveShot hub or with Ethernet + two wireless modems) requires significant load from the system. The cue channel should not be used in conjunction with more than two simultaneous networks.

ABOUT LIVESHOT NETWORKING AND PROTOCOLS

LiveShots connect together using a variety of protocols that are layered on top of each other. This concept is illustrated in **Figure 7**.

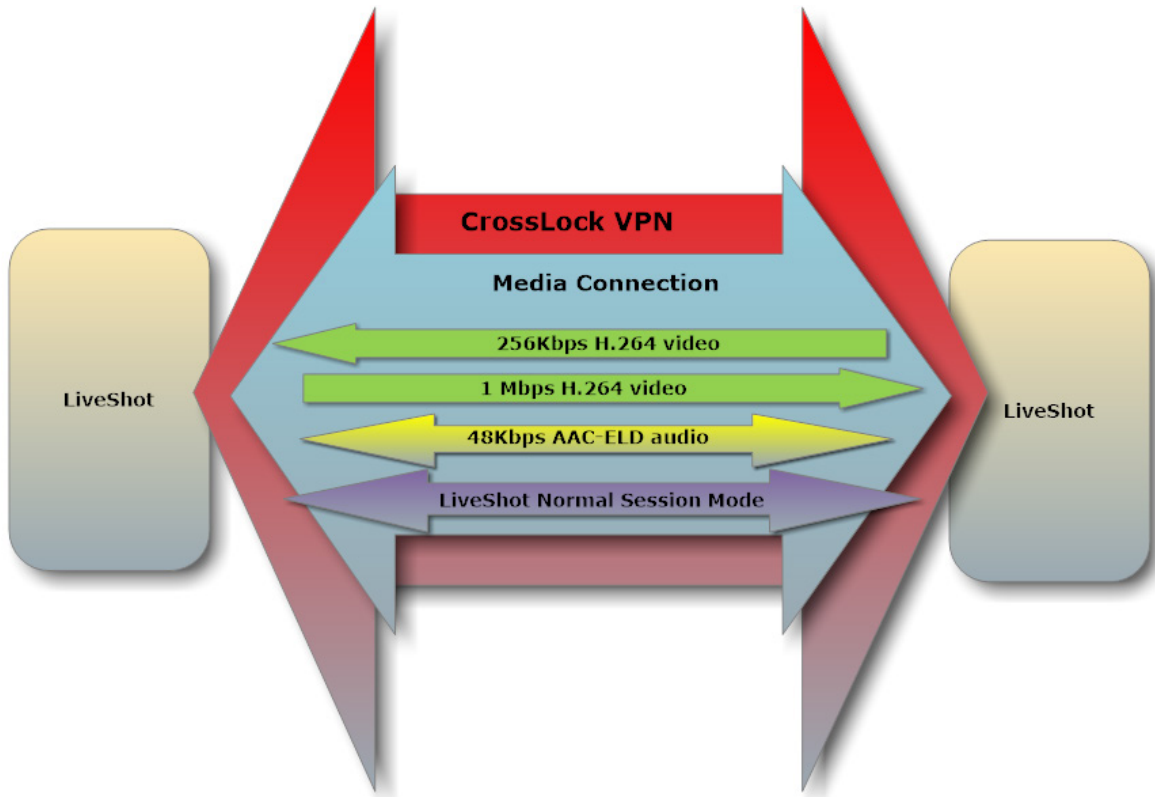


FIGURE 7 LIVESHOT LAYERS

The lowest layer protocol is called a **Stream**, and consists of a one-way or bi-directional video or audio stream.

Along with the stream definitions, we define a “**Session Mode**” as a group of protocols used by the LiveShots to establish and translate how the streams work. The default **Session Mode** in LiveShot is called **LiveShot Normal**. Most users don’t need to be aware of **Session Modes**, but they can be altered under advanced settings. Technically, the LiveShot Normal Session Mode is based on the widely used protocol called **SIP (Session Initialization Protocol)** common to the Voice-over-IP industry.

One or more media streams is packed along with the “**Session Mode**” into a “**Media Connection**” which defines the destination IP address.

CrossLock is the outermost layer and gets established between LiveShot first. Crosslock handles the ability to aggregate multiple network devices on each end of a link. It also provides statistics to the far end and determines the rate at which each network applied is capable of working, throttling the encoders if necessary to fit within the available bandwidth.

In environments where a single pair of LiveShots is always used, CrossLock can be configured to stay active even in the absence of Media Connections. This is reasonable to do because CrossLock itself uses only a small amount of network bandwidth.

MORE ABOUT CROSSLICK

Once CrossLock is established it creates a true VPN between LiveShot devices. LiveShots have their own, private addressing scheme on this VPN.

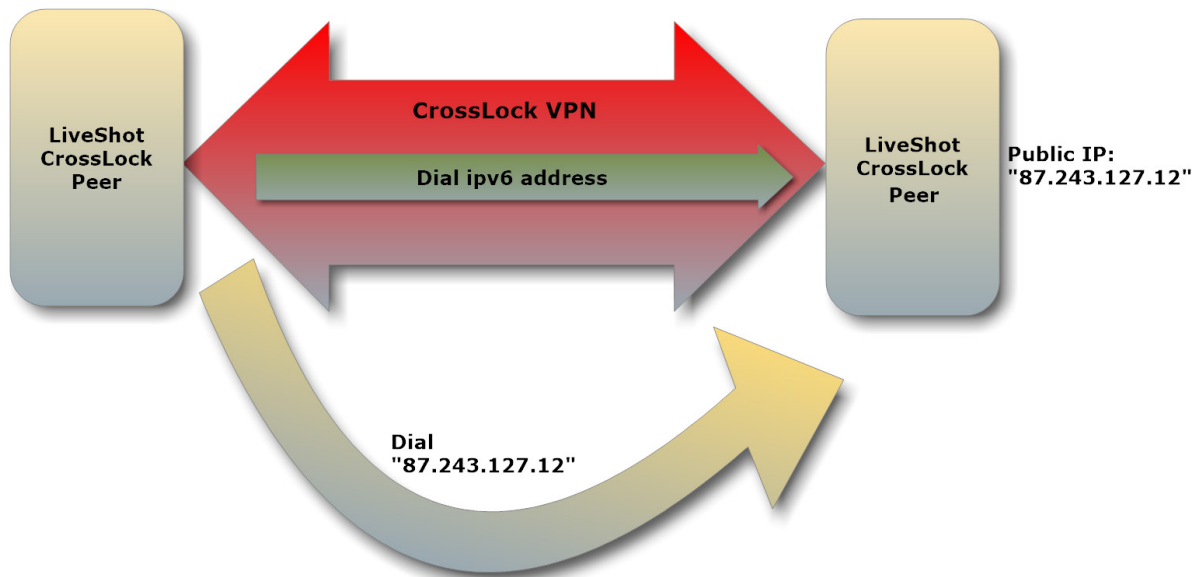


FIGURE 8

As shown in **Figure 8**, once CrossLock is established between LiveShots, media streams are sent using the VPN addressing scheme, based on the IPV6 protocol (The IPV6 connections aspect is mostly invisible to the user).

Alternately, as shown, it is possible to dial a stream directly between the peers without using Crosslock. In this case, the public IP address of the destination LiveShot must be known. This connection will not have the benefits of CrossLock, like throttling and multi-network support.

CrossLock works in conjunction with Switchboard server (maintained by Comrex) to allow for the IP address of LiveShots to change (as they move around) without any reconfiguration of dialing destinations. This is shown in **Figure 9**. LiveShots will ping the Switchboard server with their IP address information, and will run some tests against the server to determine whether there are router or firewall issues that might impair peer-to-peer connections. Other LiveShots in the fleet have access to this information and use it to establish CrossLock connections between them.

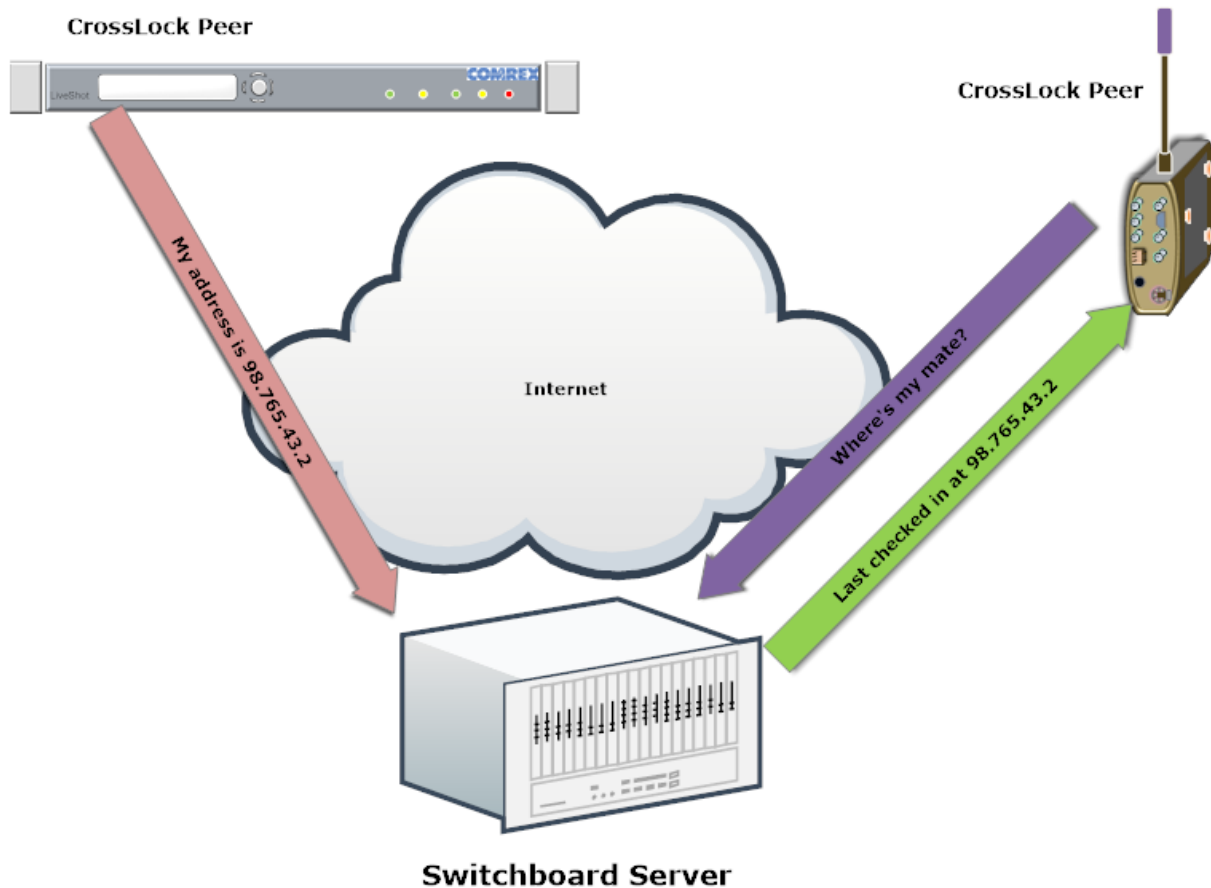


FIGURE 9

In this scenario, the LiveShot Portable is likely on a private IP address (i.e., behind a NAT router) since it's unusual to find temporary wired or wireless links with public addresses. As long as the LiveShot Rackmount in the studio is on a public address (or has the correct ports routed), the connection should always be established. In many instances, even without the proper port forwarding in the studio, Switchboard can instruct the LiveShots how to "work around" the challenge of peer-to-peer connections behind routers.

Here's another advantage of CrossLock--Normally in this scenario (one LiveShot on Private IP, one on Public IP), connections could only be made in the direction of the Public unit. Connections attempted toward the Private unit would be blocked by the NAT router. CrossLock maintains a VPN connection "*tunnel*" through the NAT router and allows media connections to be established from either end.

One of the key features of CrossLock is the ability to "*bond*" multiple network channels in a single device. Typically, CrossLock would handle the channel split between two 3G wireless modems on the Portable end of the link. Technically, CrossLock is capable of bonding its Ethernet, Wi-Fi, or any other active networks.

The concept is shown in **Figure 10**. Once CrossLock detects an additional valid IP network, it "*splits*" the data channel and utilizes each network's bandwidth proportionately. Only a single IP address and port is required on the opposite end of the link.

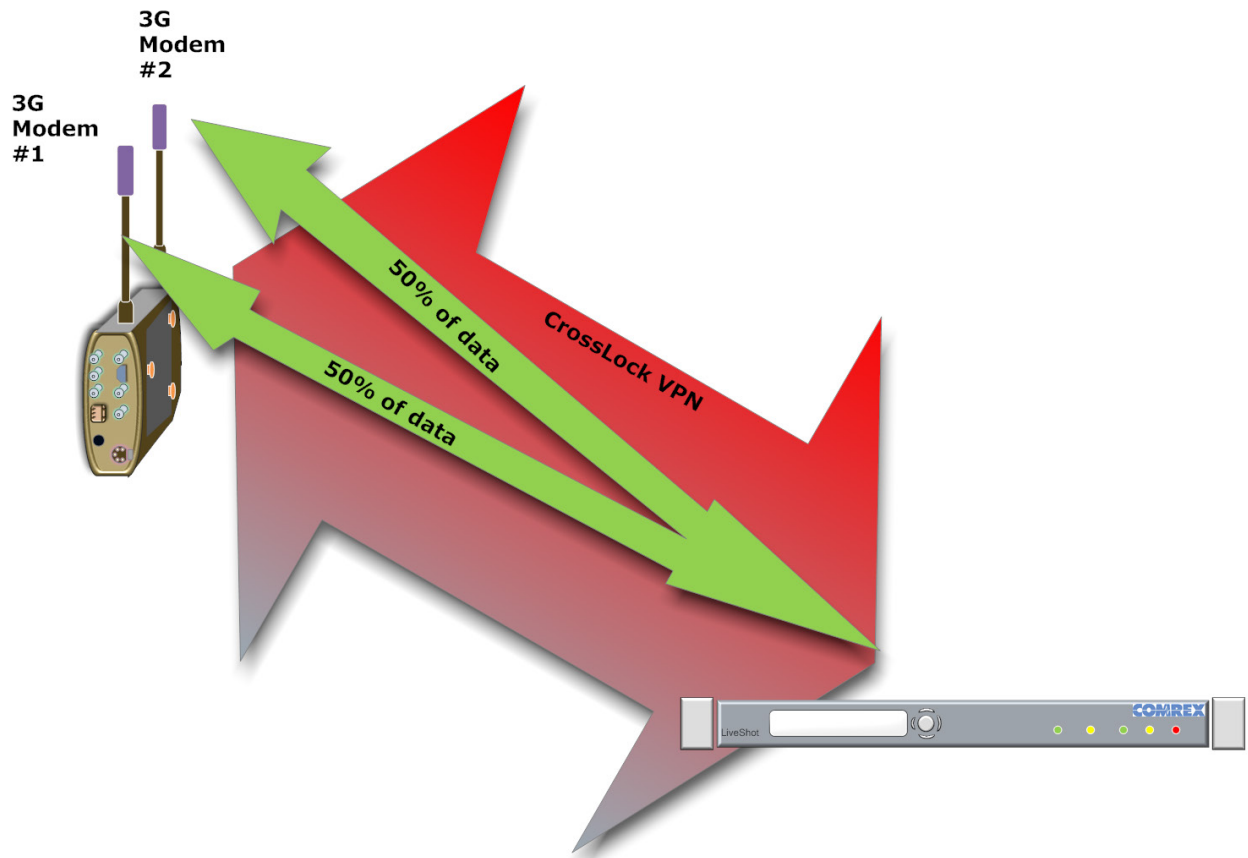


FIGURE 10

III. GETTING STARTED WITH LIVESHOT RACKMOUNT

CONNECTING TO A NETWORK

*Summary: Connect LiveShot Rackmount to a Public IP, or a Private IP with **UDP 9001** forwarded.*

LiveShot Rackmount connects to your network via 100BaseT Ethernet. Factory default is **DHCP**, so LiveShot will get an address from your network and display it on the front panel display.

Since LiveShot Rackmount is controlled from the web page served from the unit, it is often useful to assign it a static IP address in your network. The easiest way to do this is via the **Comrex Device Manager** Windows utility, which can be found on the CD-ROM disc accompanying your new LiveShot codec or downloaded for free from our website: www.comrex.com.

When using **Device Manager**, LiveShot's IP address information can only be changed during the first five minutes after power-up. It's a good idea to cycle power on the unit just before you plan to use the **Device Manager** to change settings.

After installing **Device Manager** on a Windows computer attached to the same LAN as LiveShot, start the application. Pressing the **Scan for Devices** control will display a list of all Comrex devices on your network. Select the LiveShot from the list. If the default password for your LiveShot has been changed, you will be prompted for the new password before proceeding.

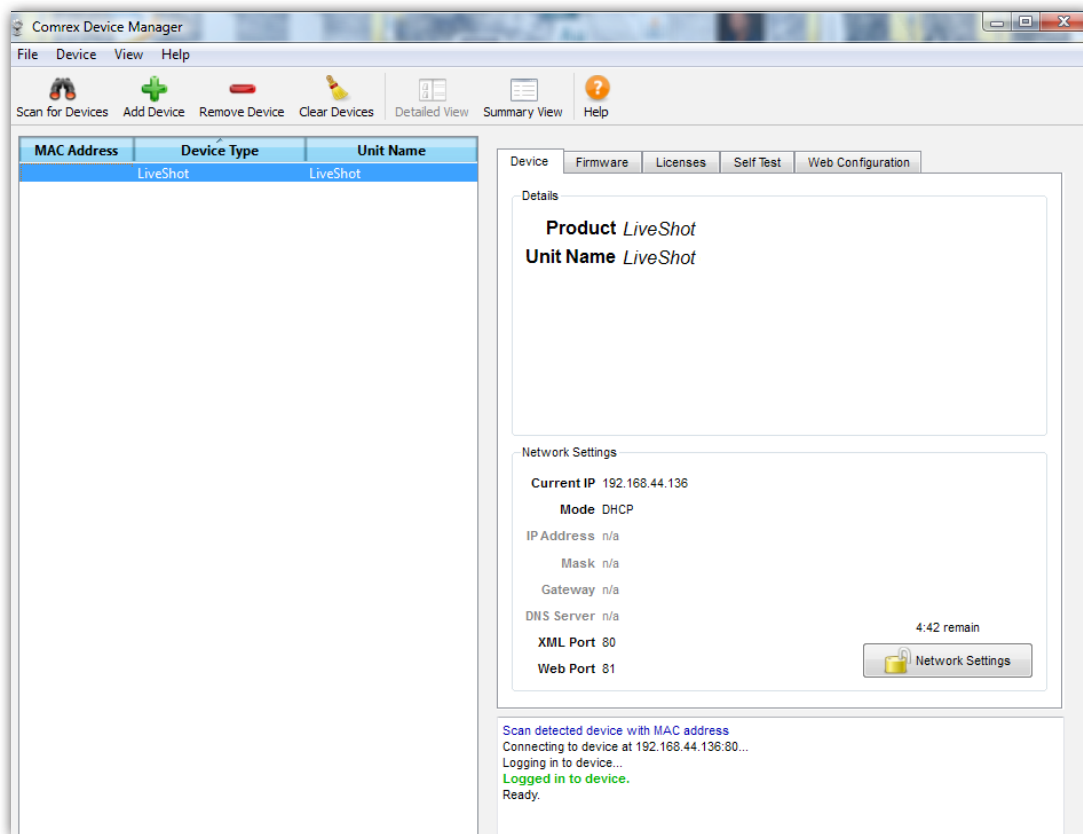


FIGURE 11 DEVICE MANAGER

Staying on the **Device** tab, look for the button labeled **Network Settings** on the right side as shown in **Figure 11**. You will see a timer that shows how much longer the LiveShot has before IP configuration function is disabled for security purposes. After the timer expires, the button will be disabled and it will read **IP config locked**.

The fields that appear when you press **Network Settings** allow you to select between **Static** and **DHCP** addressing, as well as entry fields for the various Static address settings. It is important that subnet, gateway, and at least one DNS server address be entered correctly for proper operation on static addresses.

Once the new IP address is configured, cycle power in the LiveShot to be sure the new entries are activated. Keying in the address into a web browser will open the LiveShot control page.

As shown in **Figure 11**, a basic control interface is available under “**Web Configuration**”. This utility, called the “**Toolbox**” interface, can perform many of the functions of the main Web GUI Interface, but without many of the graphical features like stats or video preview. Detailed operation of the Toolbox interface is not covered in this manual.

As an alternative to using the **Device Manager** to view and set the IP address information, the LiveShot Rackmount front panel interface can perform this function. See the section on **Using the LiveShot Rackmount Front Panel**.

CONNECTING INPUT AUDIO/VIDEO

Summary - Choose in and out connections. LiveShot will detect them.

Choose which type of input video (if any) to apply to LiveShot Rackmount. Input A/V is only required if you plan to stream media back to LiveShot Portable.

The input signal detected will appear on the LiveShot Rack front panel display.

It's important to have the video input connected and active before a connection is made. "**Hot swapping**" video inputs while a stream is active is not supported.

If you are connecting to the **Composite** input, you have a choice between analog audio input and AES3 digital input. If AES3 audio is detected at the **AES3** input port, the analog inputs are disabled automatically.

Nominal analog audio input level is 0dBu, with clipping level at +20dBu. This level is not adjustable. Check for proper input level with the front panel input indicators, which should glow green at proper level and start to change to orange as clipping is approached.

If you are connecting audio I/O for the optional cue audio channel, note that the nominal level of these ports are lower, at -10dBu (+6 dBu clip).

IV. GETTING STARTED WITH LIVESHOT PORTABLE

CONNECTING TO A NETWORK

ETHERNET

Summary - Ethernet on Portable is usually plug-and-play.

In most circumstances, it won't be important to set the Portable to a static IP address. This is because the connection is usually initiated from LiveShot Portable, so it's not important for the Portable to have unsolicited incoming connectivity from the Internet. In the rare case that this is important, you can follow the directions for setting up the Rackmount using the **Device Manager** software. The difference is that the LiveShot Portable cannot display the address it's currently using, so you must use the scan function to find the unit on your LAN. (An alternative is to log in to the Portable's internal Wi-Fi access point, as described in the section **Getting Started with the LiveShot Web Interface**).

Because LiveShot Portable is shipped as DHCP by default for Ethernet, the Portable should be essentially "**plug and play**" with the unit capable of establishing outgoing connections as soon as a valid network is detected.

WIRELESS DEVICES

Wireless USB-style modems are attached via one or both of the LiveShot Portable's USB gooseneck connectors. Before initial use, some wireless devices require some quick configuration, but can be set to automatically connect to wireless networks on future insertions. This configuration must be done via the LiveShot's Web interface, accessed either via the address assigned to the Ethernet port, or via the internal Wi-Fi access point.

CONNECTING INPUT AUDIO/VIDEO

Choose the type of input video you plan to connect to LiveShot Portable. It's important to have the video input connected and active before a connection is made. "**Hot swapping**" video inputs while a stream is active is not supported.

The LiveShot Portable offers inputs via **HD-SDI** (with embedded audio), **HDMI** (with embedded audio) and **Composite** (with analog audio input). Once an input is attached, it is selected automatically and an indicator lights beside the input. Multiple simultaneous inputs are not supported.

It's important to remember that the LiveShot **HDMI** input does not support copy protection--devices like DVD or Blu-ray or computers playing protected content will not work on these ports. Some cameras inadvertently apply copy protection to their **HDMI** output ports. These should be avoided.

CONNECTING OUTPUT AUDIO/VIDEO

The LiveShot Portable offers only **Composite** video out along with analog audio. The default resolution (480i vs. 576i) is set via the Web interface.

v. GETTING STARTED WITH CROSSLICK

One of the most important elements of LiveShot operation is CrossLock. See the above section titled **About LiveShot Networking and Protocols** for theory of CrossLock operation.

One of the key elements of the Comrex LiveShot system is its ability to create a “tunnel” (much like a VPN) between two units. We call this CrossLock VPN. CrossLock is established between two LiveShot peers in advance of any audio or video streams. Because CrossLock uses an insignificant amount of bandwidth while not in use, it can be configured to remain active between two LiveShots whenever they are powered up.

The LiveShot CrossLock VPN has the following advantages:

- Only one IP port is utilized in connections between LiveShots, so special network arrangements (e.g., port forwarding) are minimized.
- If CrossLock VPN is kept open always, connections are possible in both directions, even if a NAT router is involved on one end (i.e., CrossLock can be established from the field, but media streams then established from the studio).
- CrossLock VPN can (optionally) provide for encryption and protection of media streams using 128-bit AES-CTR, and protection of media streams using HMACSHA1.
- CrossLock VPN can bond multiple networks (e.g., a pair of wireless modems), establishing what appears to the rest of the LiveShot system as a single media source/destination.
- CrossLock has the intelligence built in to determine if a network is capable of carrying a full stream, and instruct the video encoder to reduce quality when a selected profile can't be supported.
- CrossLock can work with the Comrex Switchboard server to connect in situations where NAT routers would normally block peer-to-peer connections.

In order to make the most reliable connections, CrossLock needs one special arrangement - **UDP port 9001** should be available directly to one of your LiveShots (typically in the studio) from the Internet without blockage or translation. This means if the LiveShot is located on a LAN, with addressing provided by NAT (very common), a special port forwarding rule should be implemented in the router to forward **UDP 9001** to the LiveShot. Alternatively, LiveShot can be placed on an open Internet connection with a public IP address, or it can be put on a DMZ within your LAN.

CrossLock's primary function is to provide stability over poor networks. To this end, it will have control over video data rate, frame rate and other functions that will affect media quality. There may be circumstances where CrossLock is not desired. This may be when running over known good managed IP connections. In this case, connections can be made directly without engaging CrossLock at all. See the section on non-CrossLock connections to configure LiveShot for this mode.

In addition to port **UDP 9001** for incoming, LiveShot must not have certain ports blocked for outbound traffic in order to use the Switchboard server function to locate mating units automatically. This usually isn't a problem unless the network is heavily firewalled. The outbound traffic for these functions are sent to ports **UDP 3478** and **TCP 8090**.

vi. GETTING STARTED WITH THE LIVESHOT WEB INTERFACE

The LiveShot Web Interface is provided by an internal web server in LiveShot and delivered via any of the active network ports. On LiveShot Rackmount, the only network port is **Ethernet**, so the main LiveShot IP address is used in a browser. On LiveShot Portable, any device associated with the internal Wi-Fi Access Point can view it at a special address.

In order to deliver useful real-time statistics, moving graphs are employed. This requires a rich interface to be used. The **User Interface** employs **Adobe Flash**, and requires that desktop browser have the Flash plug-in to see it. Since Flash is not available for most mobile phone or tablet platforms, special LiveShot apps are available to display this interface on iPhones and Android platforms. The apps can be used in place of a browser to view the **User Interface** on the Rackmount or Portable through any of the network ports.

The most common way to get any control of the LiveShot Portable will be via use of the internal Wi-Fi access point. This is a separate, unrelated Wi-Fi router contained inside the unit. It is not suitable for actually carrying program streams in and out of LiveShot, but it is very useful for controlling the unit while a different network carries the media streams. To use the internal access point, it must be enabled in the Web interface (See section 6 - it is enabled when shipped from the factory) and the recessed switch on the Portable's rear panel labeled "**Wi-Fi**" must be set "**on**".

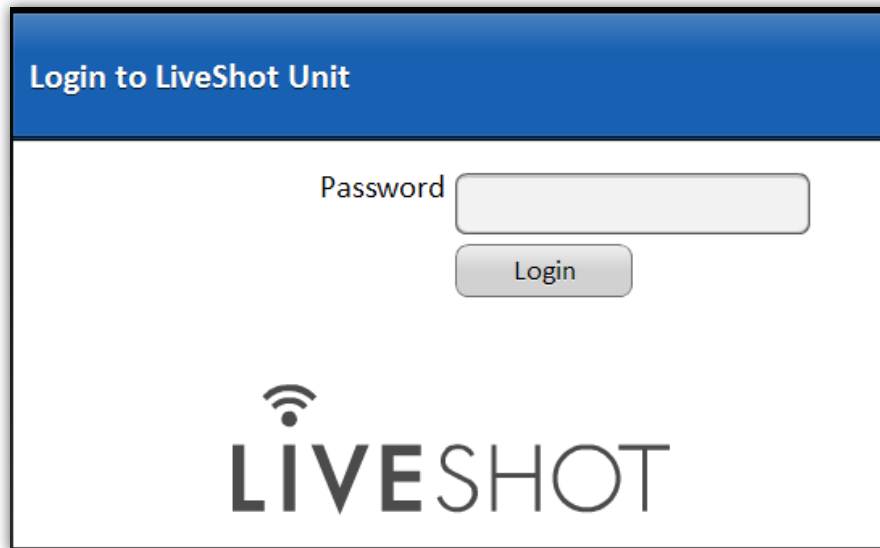
The internal Wi-Fi access point is designed to have lower power than most other networks, so the device used to see it will need to be in close proximity to the unit. It works very much like any other wireless access point--if you do a scan on your available networks, the access point should appear as **LiveShot <MAC address of unit>**.

In addition to connecting your app directly to the internal Wi-Fi access point, the app can talk to your LiveShot through the Internet via the Switchboard server. Assuming you have a Switchboard account set up and your LiveShot units are properly entered into it, you can select the option on the app labeled "**via Switchboard**" and you will get a listing of all your registered LiveShots. You can select any unit on the list and be taken to the user interface of that device. This is especially handy for connecting to a LiveShot rack, which has no access point, and may be located on a network that blocks direct connections.

More information about using apps via Switchboard is contained in the technote "**Switchboard for LiveShot**" available on the Comrex website.

Whether via web or app, the interface is identical and will attempt to log into LiveShot using the default password at the default address. The system will look for the web interface at **port 80**. If that fails, it will prompt you to enter a new interface port number.

The system will next attempt to log in using the default password (**comrex**) or the last one used. If that fails, it will prompt you for the correct password. (Enter password)



The image shows a login interface for a LiveShot unit. At the top, there is a blue header with the text "Login to LiveShot Unit". Below the header, the word "Password" is followed by a light gray rectangular input field. Underneath the input field is a gray button with the text "Login". At the bottom of the interface, there is a logo consisting of a Wi-Fi symbol above the word "LIVESHOT" in a bold, sans-serif font.

FIGURE 12

When using the Portable internal access point, the address to key into your browser or app is **10.10.10.10**. A URL of simply the word **comrex** works as well.

After logging in, the main web interface appears as shown in **Figure 13**. The interface is laid out in four main sections: **Network**, **Peers**, **Media Link**, and **Config**.

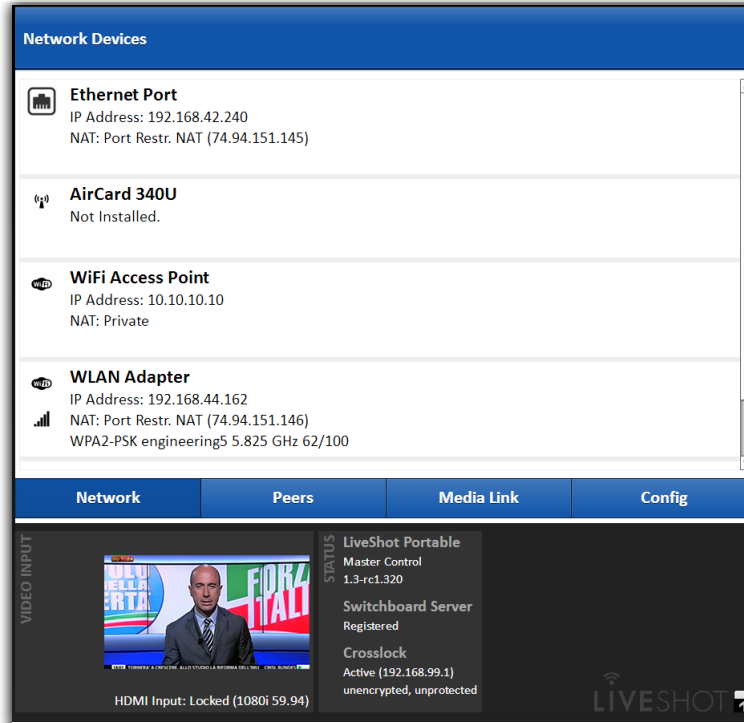


FIGURE 13

When one of these tabs is chosen, the area above the tabs fills with the options for that particular section. The area below the tabs is reserved for status and remains always visible.

Due to space constraints on mobile devices, the status section is moved to a fifth tab.

Here is a quick summary of what's on each section. Details are given in the Detail section for each tab.

STATUS SECTION

The bottom section of the interface (fifth tab on the app) is reserved for the unit's status information.

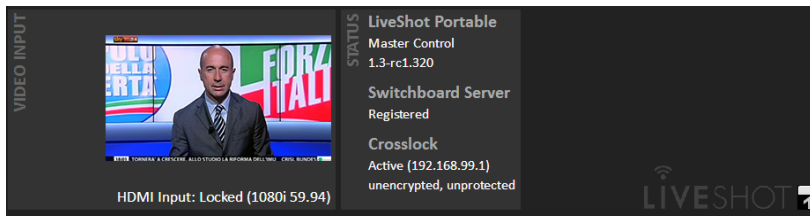


FIGURE 14

As shown in **Figure 14**, a thumbnail of any video that is applied to the input of the LiveShot is available in the lower left corner, along with the detected input resolution.

To the right of the thumbnail is a status bar giving some other critical LiveShot information.

- 1 **Unit Name** - either the default (**LiveShot <mac_address>**) name assigned to the unit, or the name set by the user in the admin settings
- 2 **Switchboard Server Status** - shows registration state with the Comrex Switchboard server. If this does not show “registered” it could indicate a network issue.
- 3 **CrossLock Status** - shows whether or not a CrossLock connection has been established, what the CrossLock destination address of the mating unit is, and whether encryption is applied to the CrossLock link.

The status bar, when active, can use a significant amount of data on the network, especially in updating the video thumbnail. If bandwidth is a concern, you can click the status section off with the button in the lower right corner. This will disable retrieval of the thumbnail, and expand the other menus to use the full screen.

NETWORK TAB

When this tab is chosen, as in **Figure 15**, the top section is populated with a list of network connected devices that have, at one point, been attached to LiveShot. The first device is always the internal Ethernet port, and on LiveShot Portable the second device is always the internal Wi-Fi access point.

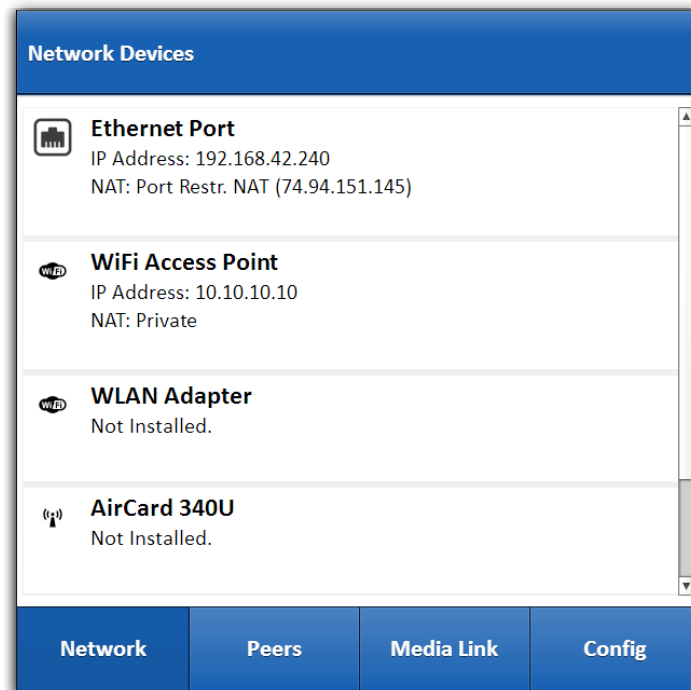


FIGURE 15

This is the section where, if necessary, you will configure your network devices. Often, this isn't necessary, because many configurations are saved in LiveShot. For example, it's often not necessary to configure any network parameters if:

- 1 You're using Ethernet and DHCP.
- 2 You're using a 3G/4G modem on a US wireless network (devices default to US settings).
- 3 You're using any adapter that has previously been installed and configured.
- 4 You're using the Wi-Fi adapter on a Wireless LAN that you've used before.

If you're doing any of the following for the first time, you'll need to access and configure the network device:

- 1 Using Ethernet on a static IP for the first time.
- 2 Using a 3G/4G network adapter on a non-US network.
- 3 Using a specific Wireless LAN for the first time.

Under each entry in the device list you'll see relevant status for that device. This information includes private IP address extracted from the network device. In addition, LiveShot does a sync with a server maintained by Comrex and displays two other pieces of information: The public IP address (this could be the public address of the entire LAN), and the type of Network Address Translation (if any) that is detected on the network.

Network devices are active on LiveShot if they show a valid IP address. Any active device on LiveShot is added to the CrossLock connection, and used for media when a media connection is established over CrossLock. More specific directions are provided in the **Network Tab Details** section

PEERS TAB

Figure 16 shows the **Peers** tab, which offers a list of destinations to connect to. Under many circumstances, (when the user has only a pair of LiveShots), there will only be one destination. But several entries can be created to dial to the same location using different profiles.

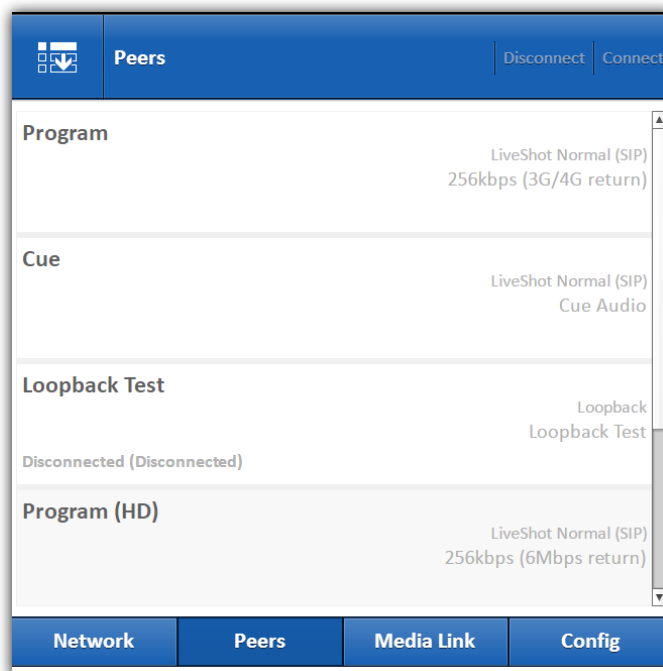


FIGURE 16

By default, three entries exist in the list - One to dial the Default Peer using a default audio/video profile, one to connect a cue channel and one to establish a loopback diagnostic test on the local LiveShot.

Details on the peer list are given in the **Peers Tab Details** section.

MEDIA LINK TAB

Figure 17 shows the **Media Link** Tab. All the statistics relevant to connections that are active are presented here. Graphs show network utilization and packet loss, as well as delay and error correction information. These graphs are available for both the local transmit and local receive paths. In addition, each network device can be selected on the right side, and statistics relevant only to that network are available. Also available here is a slide settings for “**delay limit**”, which is a critical choice for the user to balance delay and quality on poor networks.

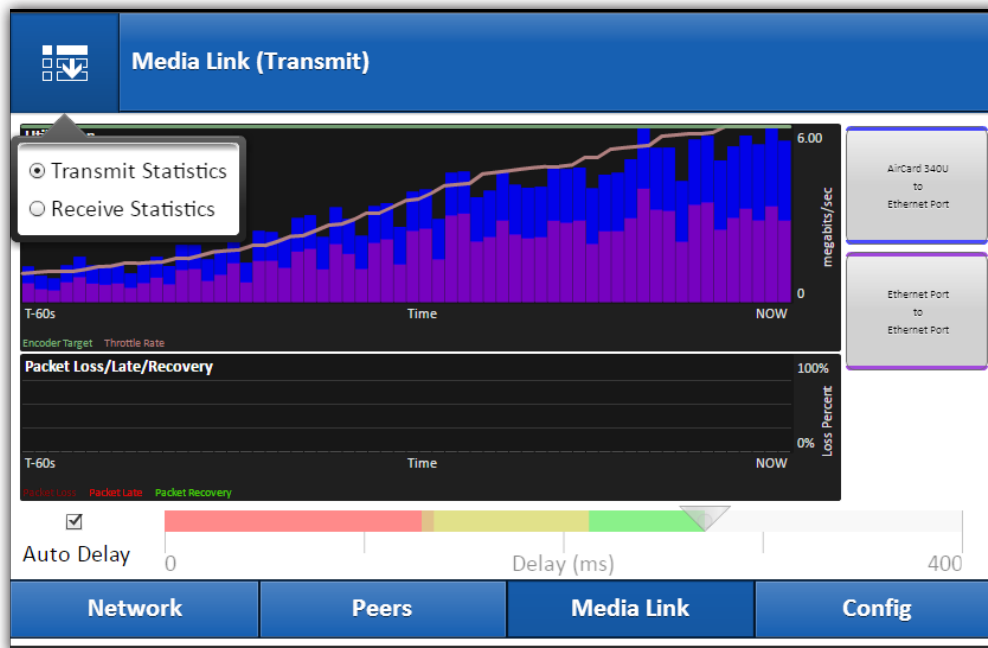


FIGURE 17

Details are given in the **Media Link** section.

CONFIG TAB

Figure 18 shows the **Config** tab, which is used to set all global configuration for the LiveShot. Options here are available to define audio and video profiles, configure A/V hardware ports, and set up CrossLock and administration functions. Details are in the **Config** section.

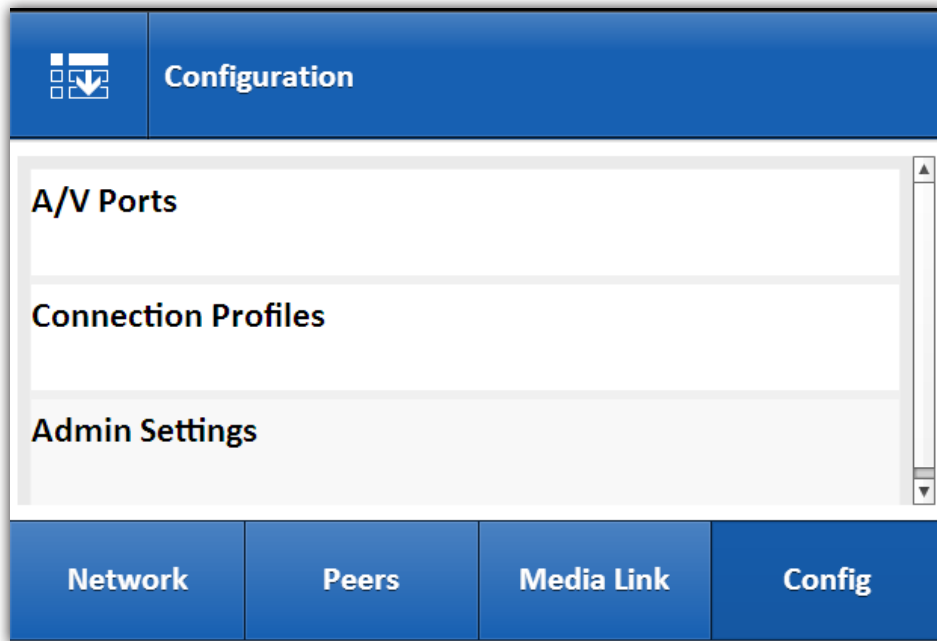


FIGURE 18

vii. NETWORK TAB DETAILS

Many devices in the network tab will be “**plug and play**”, meaning that if drivers are included in the LiveShot’s firmware, and no special configuration is needed, the device should just attach to the network, and CrossLock should become enabled. Devices can be “**hot plugged**” into the LiveShot’s USB ports, and if supported, will appear in the network tab list as shown in **Figure 19**.

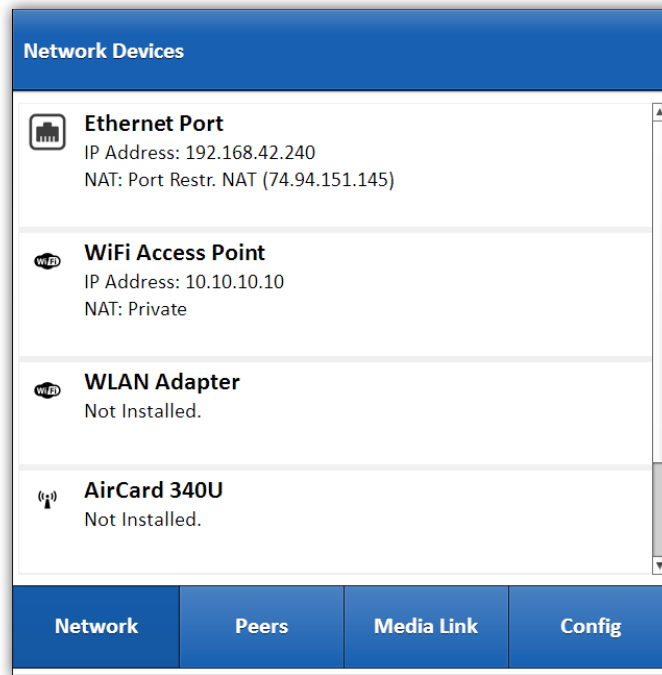


FIGURE 19

New USB modems (except the provided Wi-Fi modem) should always be attached and tested on a computer before attaching them to LiveShot. Often, initial provision is only supported by the carrier when used with their custom computer-based drivers.

LOCATIONS

LiveShot implements a feature called **Locations**, which allows the user to store several profiles for each network interface. This way, several different configurations can be stored for the same network interface and switched easily when LiveShot is moved between networks. Examples are Ethernet networks that require specific static settings (that are used variably in conjunction with DHCP-based Ethernet networks) or Wi-Fi networks that are mixed and matched regularly. As shown in **Figure 20**, each network has a factory-configured **Location** called **Default**, and more can be created.

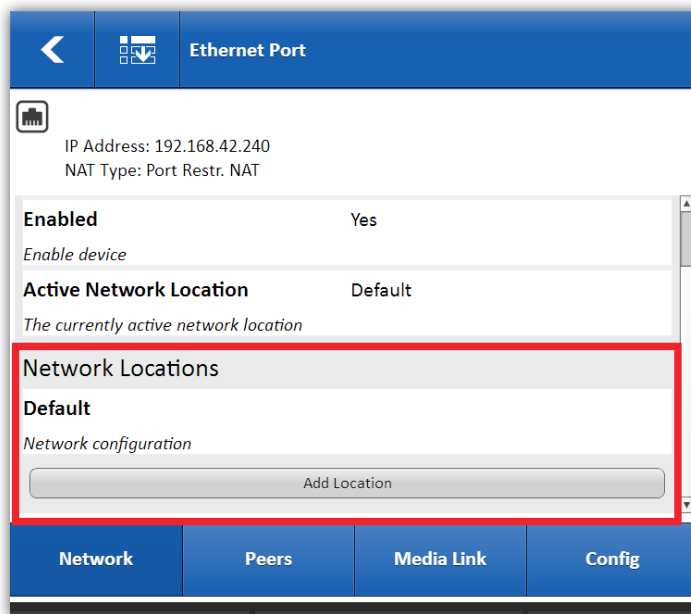
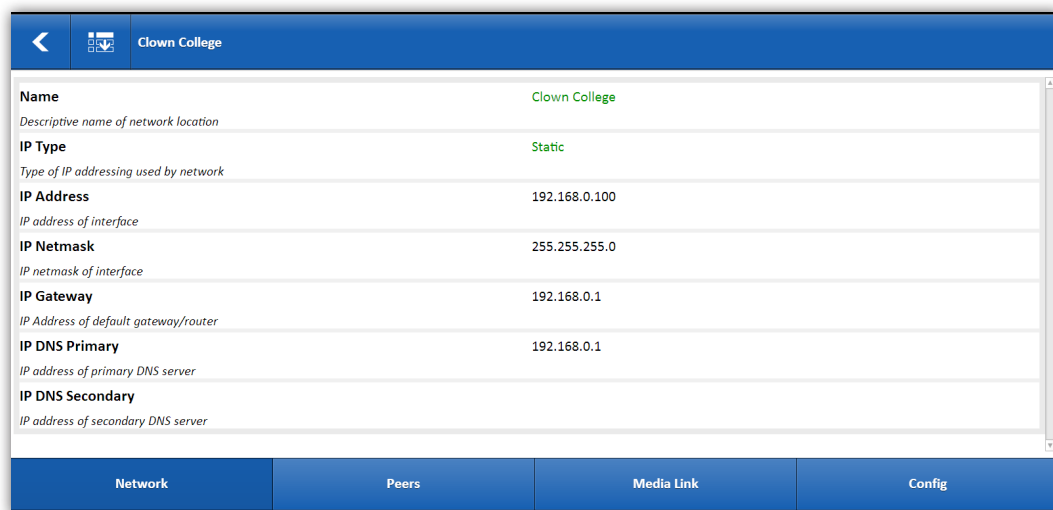


FIGURE 20

ETHERNET SETTINGS

Unless your LiveShot will always be used on the same network, we recommend that new Locations be created for custom Ethernet settings, leaving the **Default Location** as DHCP. This will allow quick reversion to DHCP where necessary.

Figure 21 shows the creation of a new Ethernet Location. Once the default setting of DHCP is set to **Static**, new entries will appear to allow setting of all the vital static Ethernet fields. These include **IP address**, **Gateway Address**, and **DNS** entries. All these entries are required. Give your location a descriptive name (e.g. **West Coast Studio**) to help you remember it.



The screenshot shows a web interface for configuring network settings. The top navigation bar is blue with a back arrow, a logo, and the text "Clown College". Below this is a form with the following fields:

Name <i>Descriptive name of network location</i>	Clown College
IP Type <i>Type of IP addressing used by network</i>	Static
IP Address <i>IP address of interface</i>	192.168.0.100
IP Netmask <i>IP netmask of interface</i>	255.255.255.0
IP Gateway <i>IP Address of default gateway/router</i>	192.168.0.1
IP DNS Primary <i>IP address of primary DNS server</i>	192.168.0.1
IP DNS Secondary <i>IP address of secondary DNS server</i>	

At the bottom of the form is a blue navigation bar with four tabs: "Network", "Peers", "Media Link", and "Config". The "Network" tab is currently selected.

FIGURE 21

Changing the active network location is shown in **Figure 22**. It's important to remember that if you choose a new active **Location**, and are configuring LiveShot via that network, you will lose web connectivity when the new **Location** is chosen.

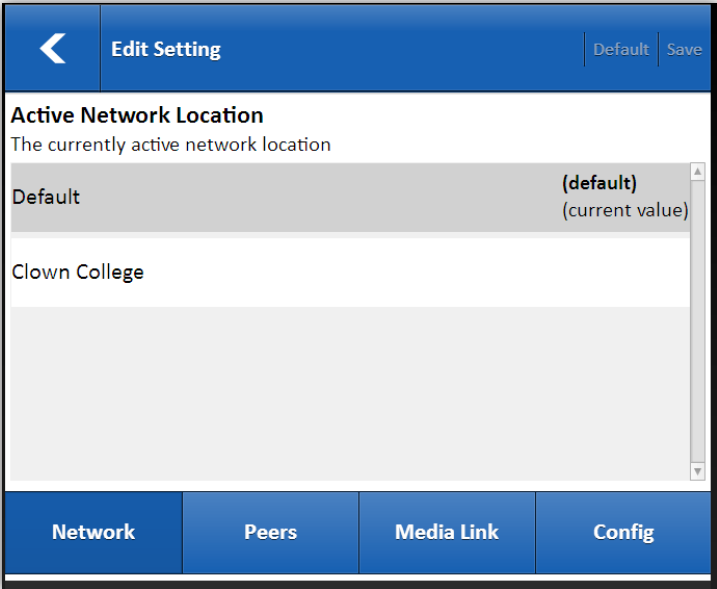


FIGURE 22

It is always recommended that LiveShot be manually rebooted whenever the Ethernet settings have been changed.

WLAN SETTINGS

Once the included Wi-Fi adapter is attached to LiveShot, an entry will appear for WLAN network. Because users tend to change Wi-Fi networks often, a special function is offered under the **Locations** feature.

The **Default Location** of the WLAN adapter has a network choice of “**Auto**”. In this mode, LiveShot will scan for all other previous **Locations** that have been configured. It will attach and use the first Wi-Fi signal found to match any previous **Location** configured.

Setting up a new WLAN location is done by choosing a new Wi-Fi network to attach to. Whether the new location is entered manually or found by pressing the “**scan**” button, the location will be named after the Wi-Fi SSID. The Wi-Fi adapter provided is dual-band and will list all networks found in the 2.4 and 5.8 GHz Wi-Fi band. Networks with hidden IDs can be entered manually.

Once a network is chosen, the security requirements of that network will be detected. LiveShot supports networks with **WEP, WPA, WPA2, and WPA Enterprise (802.11x)** security requirements. Entries will be offered for user and/or passcodes for the detected network security.

3G/4G SETTINGS

Some 3G and 4G modems require the proper setting of an **APN (Access Point Name)** value to configure which wireless network they should operate on. This, if necessary, is usually the only setting required by the user to get these modems to work. If a modem is supported by a USA wireless network, this **APN** is usually chosen by default, and may need to be changed for non-US networks. Other modems may support commands that “**instruct**” which **APN** value to use, and LiveShot will use these commands and automatically populate **APN** where possible.

If you need to set the **APN** value manually, this process is shown in **Figure 23**.

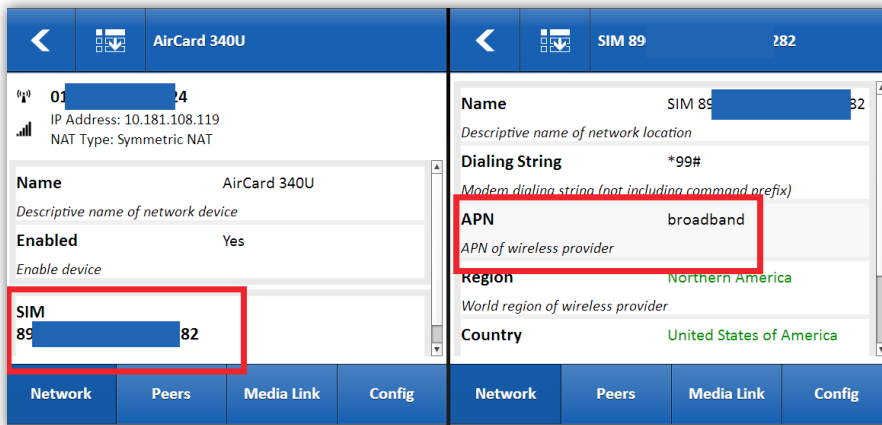


FIGURE 23

Select the device in the interface to open the configuration settings. Search for an entry marked “**SIM**”, which contains all the carrier-specific values for that modem. Under “**APN**”, a menu will be offered to select the region and country of use, then a list of available carriers. Selecting a carrier should add the correct **APN**. Carrier **APNs** are subject to change, and the **APN** can be input manually by choosing the actual **APN** setting field and changing that.

DUAL MODEM SUPPORT

When more than one Network Device is enabled and active on LiveShot Portable (regardless of whether it’s wired or wireless, Wi-Fi or 3G/4G), the system will attempt to connect its CrossLock VPN link over both devices simultaneously. Any connections made between LiveShots will be “**load balanced**” with active media flowing both ways on all connections. This allows for “**doubling**” of bandwidth on networks with low data rates.

When using more than one wireless modem with LiveShot, it’s advisable to bend the USB goosenecks as far apart as reasonable for operation. This is to avoid the common problem of one modem’s transmitter affecting operation of the other modem’s receiver.

INTERNAL ACCESS POINT

On LiveShot Portable only, an additional entry appears in the **Network** list for the internal WLAN access point. This is the Wi-Fi host used to communicate with wireless devices like phones, tablets and laptops, allowing field configuration.

By default, this access point is open and has no security. It is recommended to apply **WPA security** to this feature by adding password protection here.

ADVANCED NETWORK FEATURES

GATEWAY MODE

Gateway mode allows you to share one network with another. While technically it can be applied to any network, it's most valuable when applied to the portable's internal access point. When Gateway mode is enabled here, and a different network interface on LiveShot has Internet connectivity, that connectivity will be "**bridged**" to any user attached to the access point. This means that using a phone, tablet or laptop, you can connect to the Internet without having a separate wireless device. Gateway mode is especially useful in Ethernet or Wi-Fi networks that present a login page. **Figure 24** shows how to change the network type setting under the internal access point's settings.

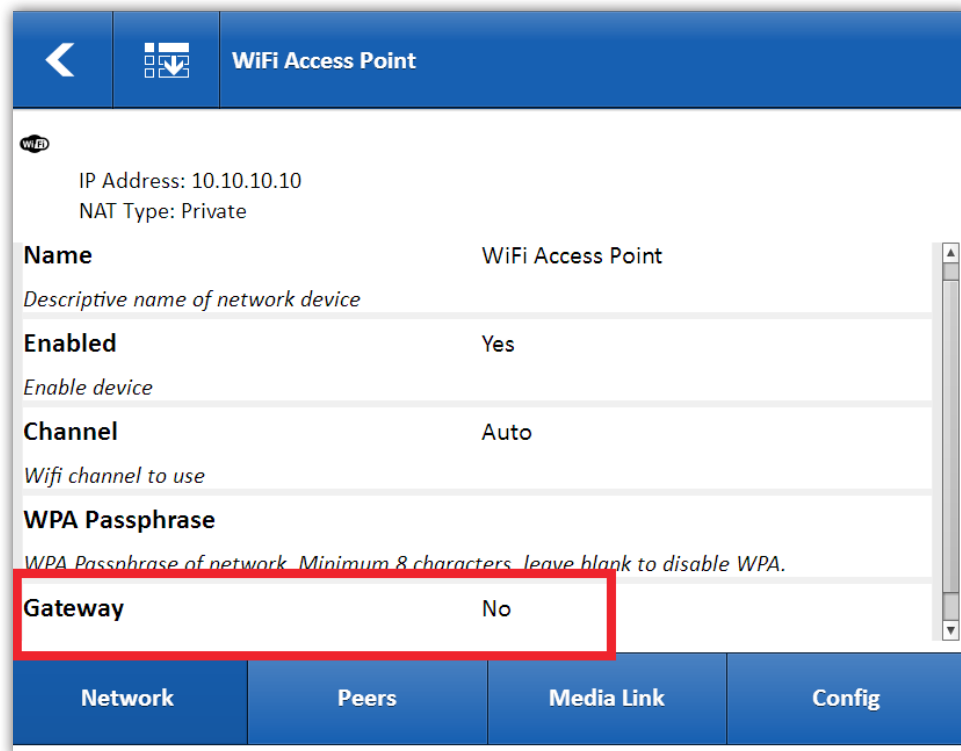


FIGURE 24

Figure 25 illustrates how data is bridged to external devices in **Gateway** mode.

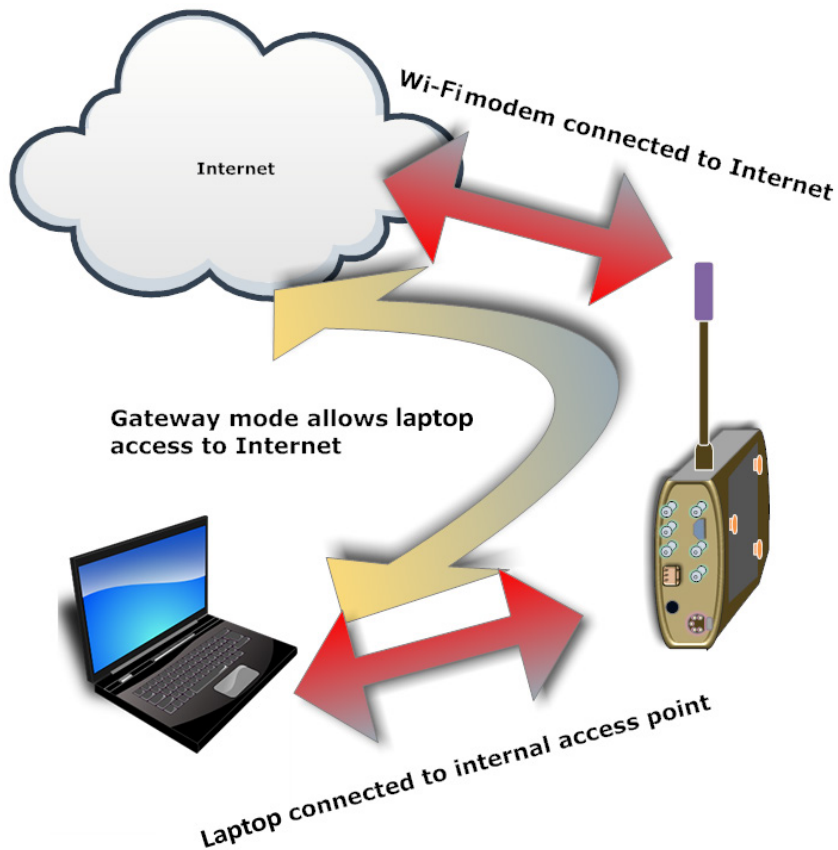


FIGURE 25

PRESERVE AFTER RESET

When LiveShot is reset to factory settings, it removes all configuration files resident to the hardware. Factory Reset can be performed by the **Device Manager** utility or can be done from the control buttons on the LiveShot hardware. Factory reset erases all internal settings that contain user profiles and destinations, and all network information.

In some environments (e.g., Ethernet connections with static addresses) it's an advantage to not have your network lose all its settings on a factory reset. By choosing the advanced option "**Preserve after Reset**" and setting it to "**Yes**", you can make sure this particular network's settings are never "wiped" as part of the reset procedure.

USE WITH CROSSLOCK

By default, CrossLock (and therefore media streams) will use any available network deemed to be worthy of media transport (except for the internal access point on LiveShot Portable). There may be circumstances where one network is desired for remote control only and is not intended to move media streams.

An example of this is troubleshooting wireless connections remotely. You might want to attach a LiveShot to Ethernet so you can view statistics generated by the device, but use only the wireless network(s) for media.

Any network present on the LiveShot can be told not to participate in CrossLock connections through the advanced menu item **“Use with CrossLock”**. Setting this to **“no”** sets this network to be used only for control functions.

BROADCAST CONFIG

This setting allows the chosen network to respond to “pings” from the Comrex **Device Manager “Scan Network”** function. Unless specifically required to be disabled on your network, this should be set to **“yes”**

The **Peers** tab lists your destination addresses. Incoming calls are reflected here as well. The list contains three default values, which will be edited by the user. Many users will need no more than this, but it is possible to create others.

A Peer entry consists of several pieces of information, as shown in **Figure 26**.

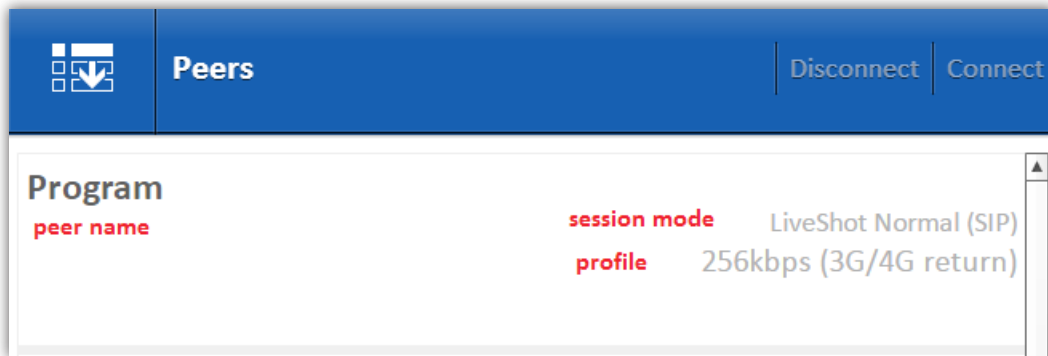


FIGURE 26

- 1 **Descriptive Name** - The name you've assigned to this outgoing connection so you can remember it (e.g. traffic cam 7)
- 2 **State** - The current state of the connection (e.g. Disconnected, Connected, Negotiating)
- 3 **Last state** - A record of the last status message displayed
- 4 **Session Mode** - Transport layer used by this connection (usually LiveShot Normal, see section on Session modes in the **Config Tab** section of this manual)
- 5 **Profile** - User or factory configured profile that defines all media streams in each direction

Peers do not need to go to unique destinations. It's OK to set several Peer entries to the same destination, with different names and profiles chosen.

The default peers are designed to be the main ones you will use. These are:

- 1 **Program** - This entry is designed to be the way to make audio/video connections between LiveShots using the CrossLock VPN feature. You will need to edit this entry and choose a destination (and perhaps give it a friendlier name) before using it. The profile chosen for this default mode is the 3G/4G profile, which is actually a good choice for many applications, whether or not they are wireless. In the forward direction (Portable->Rack) the system will attempt to encode a 2Mbps video stream, along with two channel audio. In the return direction (assuming the rack has a video input applied) it will attempt a lower-grade 256Kbps confidence feed with two-channel audio.
- 2 **Cue** - This peer is designed to be connected simultaneously with the main media peer and to the same location. It creates a low quality (telephone bandwidth) audio channel routed to the headset jack (on the portable) and the cue audio ports (on the rack). It must also be edited to choose a destination before use.
- 3 **Program (HD)** - This entry is set to deliver a 6Mbps video profile (with 720p encoding) with a low quality return.
- 4 **The Loopback Test Peer** - This peer designed as a diagnostic test. Loopback connects the local encoder and decoder together so you can sample your video input after the encode/decode process. A good way to evaluate LiveShot video quality is to experiment with the encode rate and resolution of the "**Loopback Test**" profile defined in the system. Profiles are described under the **Configuration** tab.

EDITING PEERS

Peers are edited by highlighting one and choosing the pull-down options menu in the upper left corner, and selecting “**Edit**”. The four parameters described above are displayed as shown in **Figure 27**, and may be individually selected, changed and saved.

Parameter	Value
Name <i>Descriptive name of Connection</i>	To Default Peer via CrossLock
Remote Unit <i>Unit to connect to via crosslock.</i>	Weather Patrol
Session Mode <i>Session mode to use</i>	LiveShot Normal (SIP)
Profile <i>Connection profile to use</i>	256kbps (3G/4G return)

FIGURE 27

Before you can use any of your outgoing peers, you need to select a peer by choosing the “**Remote unit**” option here. If your LiveShot is configured as a Switchboard client, a list will be offered here of all other LiveShots contained in your Switchboard contact list. Much more information about Switchboard is given in the Switchboard section.

If you are planning on making a connection without the use of CrossLock (so therefore without Switchboard) you will have to choose “**Manual Destination**” here. Details on this function are in the section called “**Making Non-CrossLock Connections**” on page 81.

Unless you are happy with the default profile chosen, you will need to choose an encode/decode profile here as well. More information on **Profiles** is available in the **Config** section.

IX. MEDIA LINK TAB DETAILS

The **Media Link** tab is the one designed to have all the graphs and controls necessary for the user while a media stream is active. It contains a wealth of information about network performance in each direction. All graphical data in the **Media Link** tab is updated once every second. The main **Media Link** graph is shown in **Figure 28**, and contains two main displays.

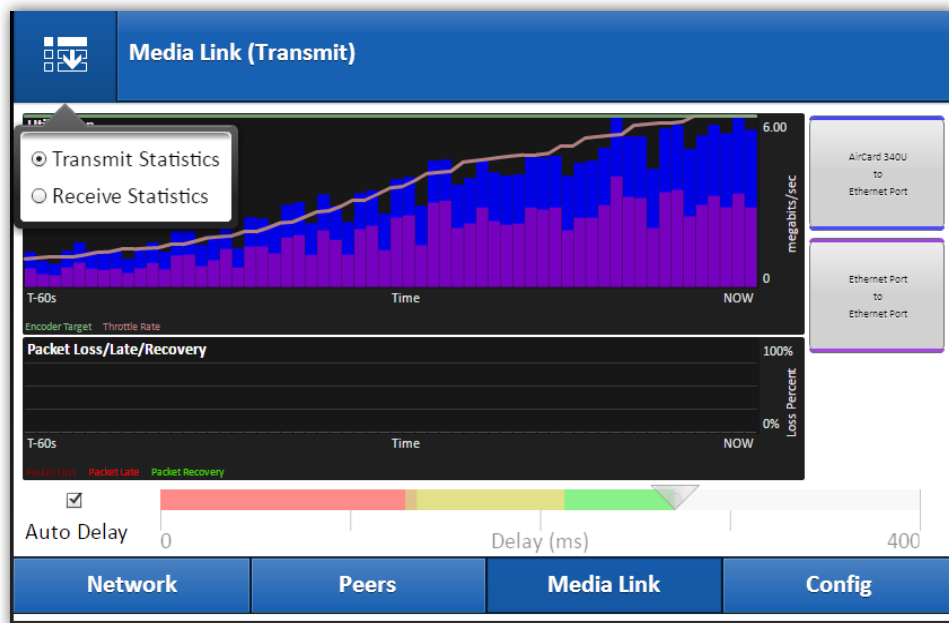


FIGURE 28

UTILIZATION GRAPH

The top section contains a graph of the outgoing (or incoming) utilization of the network. The bars indicate the average data rate used by the system during each one second window. It is expected that the size of these bars will vary due to a variety of factors including:

- 1 **H.264** video is a variable bitrate system, and source material will affect the data rate. Static, simple images require much less network throughput than complex, moving images.
- 2 CrossLock has control over data rate through a technique called “**throttling**”. Based on network feedback statistics, CrossLock will reduce and increase the utilization dynamically.

If more than one network device is in use, the utilization graph will be color coded, indicating the relative utilization of each network device. This is illustrated in **Figure 28**. The color code key for each network device appears on the right side of the graph.

Overlaid on the network utilization graph are two colored lines:

- 1 **Encoder target** - This reflects the bitrate chosen in the profile used in the connection. This is treated as a maximum value, so utilization should mostly remain below this line. Because these values are averaged, there may be moments where the utilization moves above the target line momentarily.
- 2 **Throttle rate** - When CrossLock throttling is enabled (the default state) this line indicates how much throttling will be applied. You will see utilization stay mostly below the throttling line. On stream startup on a new CrossLock connection, throttling will tend to be more aggressive until the system finds a good throttling level (usually within 30 seconds).

PACKET LOSS GRAPH

The bottom graph indicates, in percentage terms, what’s gone wrong on the network during each one-second window. Three different color-coded entries appear here:

- 1 **Packet Loss (dark red)** - The system has detected a packet has been completely dropped by the network and was never received by the decoder.
- 2 **Packet Late (bright red)** - The system received the packet, but it was too late for decoding and playout.
- 3 **Packet recovered (green)** - The packet was either lost or late, but was recovered either by the **Forward Error Correction (FEC)** or **Automatic Repeat Query (ARQ)** error correction built into CrossLock.

DELAY SLIDER

The most powerful way to stabilize a LiveShot connection is to have the decoder add a delay buffer to the CrossLock connection. This compensates for changes in the rate packets are received - known as jitter in Internet speak. LiveShot uses a combination of decode delay buffering and error correction to keep connections stable. The activity of the delay buffer is illustrated and controlled via the delay slider on the **Media Link** tab.

Figure 29 shows the Delay Slider. In this figure, the slider is in **“Auto Delay”** mode and the information on the slider is purely for informational purposes. Clicking off the **“Auto Delay”** box sets the system to **Manual Delay** mode and allows the slider to be moved with a mouse.

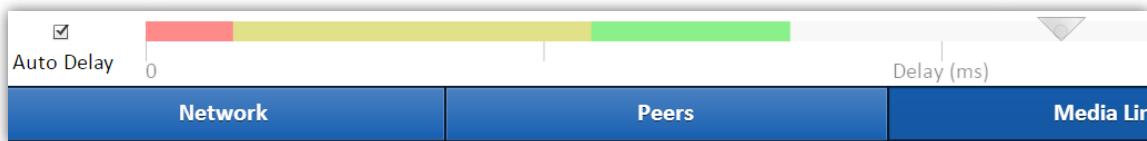


FIGURE 29

The entire slider is scalable, and the range of it from left to right will vary from one hundred milliseconds to several seconds depending on the range of delays currently being addressed.

In either Auto or Manual mode, a series of color bars are overlaid on the slider, to signify delay **“zones”** of safety. Furthest left is the red zone, which indicates a buffer level that is too low for stable transmission. The yellow zone indicates a delay buffer that may have stability issues, and the green zone indicates a buffer level that should provide stability. These **“zones”** scale, increase and decrease in size based on the history of jitter experienced by LiveShot on the network.

In **“Auto Delay”** mode, two other elements are of interest. The downward arrow signifies the **“Target Delay”**, which is the best compromise value calculated by the system to balance stability and delay. The **“bubble”** indicates **Current Delay**. The **Current Delay** bubble will attempt to track with the Target Delay Arrow, but may at times fall outside it. This usually indicates that the system is actively reducing or increasing the buffer.

Figure 30 shows the slider in **“Manual Mode”**. Here, the arrow becomes a moveable cursor, and it’s up to the operator to determine how best to set the compromise between delay and stability.

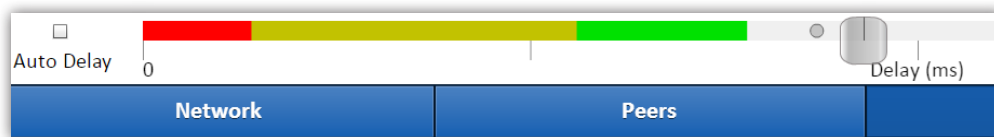


FIGURE 30

MEDIA LINK DETAILED VIEW

A powerful feature of the **Media Link** tab is to allow the user to “**drill down**” to the statistics for each network interface, and view the performance of that network alone. By clicking the button that appears for each interface on the right side of the tab, a new window opens that shows graphs similar to the “**overview**” graph, but limited to the performance of that particular network. This is shown in **Figure 31 R1 - R3**.

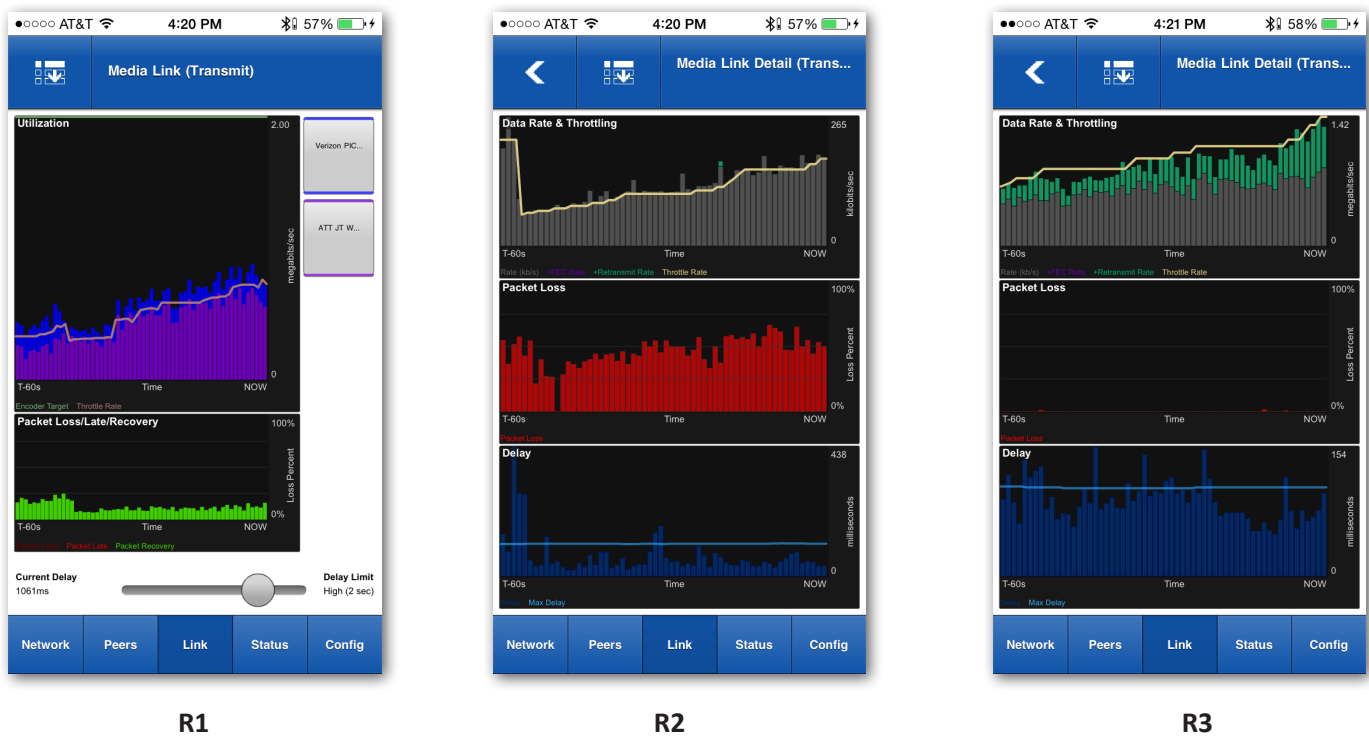


FIGURE 31

The series of these three screenshots identifies a working cellular connection with two modems. Both are performing, but one is doing far better.

The green bars in **R1** show the amount of successfully re-sent packets from a combined network connection.

To “**drill down**” for each network, click on the button for that network. **R2** displays the top modem results showing a preponderance of resent packets. This could signify a poor cellular connection.

R3 shows the other modem from **R1**, showing hardly any packets that were re-sent.

The differences with these graphs are:

- 1 Encoder target rate is not shown on these graphs, since it might be an order of magnitude larger than the information shown.
- 2 The rate of error correction applied to this interface is shown in the top graph overlaid on the utilization data. This is shown as **FEC** rate (violet) and **Retransmit** rate (Green).
- 3 The **Packet Loss** graph (middle) shows only truly lost packets, as opposed to late and recovered.
- 4 A third graph is added to indicate an approximate one-way delay figure calculated for this interface.

The **Detailed View** is most useful when more than one network is being used by LiveShot, as it allows comparison of the quality and delay figures of the various networks. As with the overview graphs, a choice is available in the pull-down menu to select between transmit (outgoing) data and receive (incoming) data for each modem.

As shown in **Figure 32**, the **Config** tab has three main options:

- 1 A/V ports
- 2 Connection Profiles
- 3 Admin Settings

Each of these sections is a complex topic and is treated in its own section below

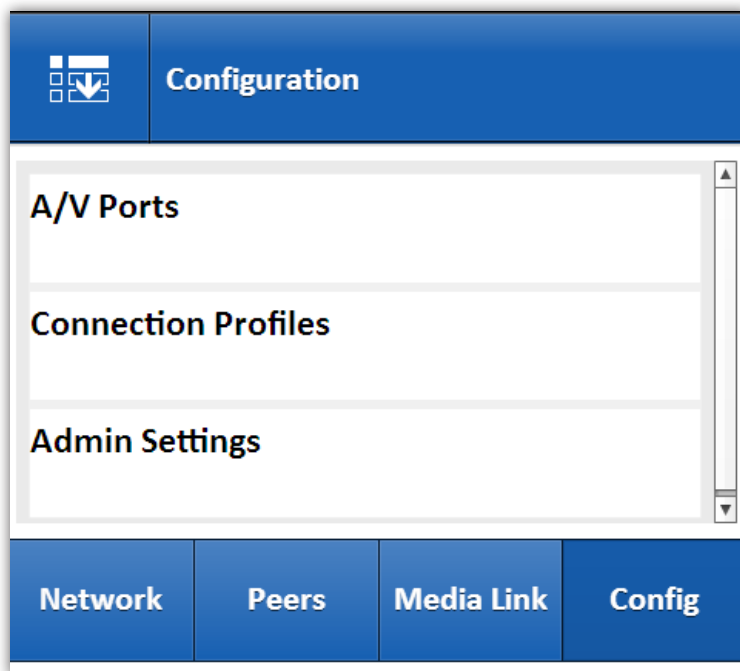


FIGURE 32

A/V PORTS

Figure 33 shows the LiveShot A/V Ports page. Each of the available inputs can be clicked to open a configuration page.

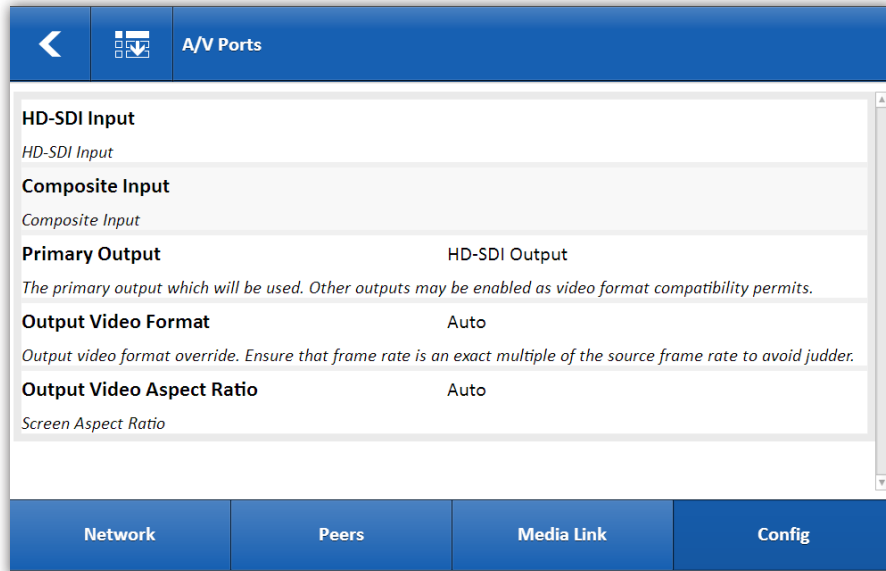


FIGURE 33

The **Composite Input** config page is shown in Figure 34.

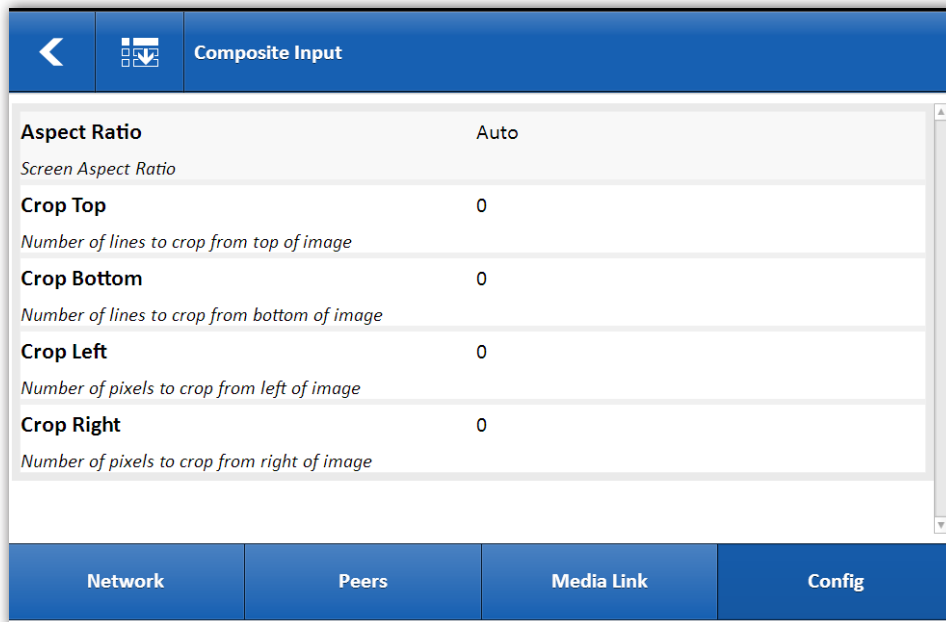


FIGURE 34

Inputs have a setting where the aspect ratio can be manually set between **4:3** and **16:9**. The “**auto**” setting usually works best. In addition, inputs provide options to crop undesired input video lines from the top and bottom and undesired pixel columns from left and right. These values are all set to zero by default.

As shown in **Figure 33**, the last three (two on LiveShot Portable) options are global outputs settings. The “**primary output**” (LiveShot Rack only) setting allows you to set an A/V output that will always be enabled regardless of resolution. The default is **HD-SDI**. The other outputs will be active if they can support “simultaneous output mode”.

With the other two global entries (format/aspect ratio) set to “auto”, the following will happen:

- 1 The output video format and aspect ratio will be set to that of the input video format on the transmitting LiveShot.
- 2 In the case of the **HDMI** and **Composite** outputs, there are limits to what output formats are supported. In the case of **HDMI**, the permitted output formats are read from the downstream HDMI device. In the case of composite, the outputs are limited to 480/576i. If one of these outputs is active, and the input video format is not supported, the format will be rescaled to the nearest one supported by the output (e.g., a connection with an input format of 1080i at the encoder will be rescaled to 480i to match the composite output).
- 3 In the case of multiple outputs connected simultaneously, the LiveShot will give priority to the HD/SDI output, followed by the HDMI output, and lock into a mode to support that output.

One important limitation to LiveShot Rackmount is that 480i SD output resolution is not supported on the two digital outputs (**HD/SDI** and **HDMI**) simultaneously. This means that depending on the transmitter input resolution, some connectors cannot output video simultaneously. Here’s a chart to show some of the capabilities and limitations of simultaneous output connections in “**auto**” mode.

Encoder input format	HD-SDI	HDMI	Composite
HD, ED (1080i, 720p, 480p) and SD 576i	√	√	
SD 480i with HD-SDI out connected	√		√
SD 480i with HD-SDI out disconnected		√	√

Alternatively, you can set a “**Primary Output**” via the pull-down menu, and that output will always be active regardless of coding resolution. The other outputs will be active if they can be supported alongside the current encode/decode resolution and primary output choice.

Also, you can choose an output format (regardless of input format) by setting it discretely in the pull-down menu. Note that some formats won’t be supported (e.g. HD modes on composite) and the video may be rescaled to match your output choice. The actual format being delivered will be displayed next to the choice during a connection.

ADVANCED A/V SETTINGS

Clicking **Show Advanced** in the **A/V Ports** page opens several new options:

- 1 **Output settings** - A setting option will appear for each output on the device (**SDI**, **HDMI**, **Composite** on rack, **Composite** on Portable). These are placeholders for future features. The exception is **HDMI** (Rack only) which provides an option to “**force enable**”, or make the **HDMI** output work without a proper HDMI monitor detected on the port.
- 2 **Audio Input** - This option allows for use of the analog audio inputs in conjunction with digital video inputs. “**Auto**” setting (default) will assume the audio input is the default for the video (HDMI->embedded HDMI, HD-SDI->Embedded HD-SDI, Composite->Analog in). If this setting is changed, then any embedded digital audio at the selected video inputs (**HD-SDI** or **HDMI**) will be ignored, and the chosen audio inputs will be “embedded” in the stream (assuming a profile has an outgoing audio channel enabled).
- 3 **Video Input** - LiveShot is able to detect its active video inputs and switch automatically. In cases where this isn’t desired, the active video input may be chosen discretely here.
- 4 **Deinterlace to Progressive*** - As mentioned before, if an interlaced video signal is presented at the input to the encoder, the output of the decoder will output interlaced video as well, even if the encode/decode profile is progressive. Enabling this option will defeat this feature, so if a video signal is decoded as progressive it will output as progressive. Note that this may involve the decoder changing format dynamically, so the downstream device should be equipped to handle this.

***Only Available at Full Frame Rate**

CONNECTION PROFILES

Profiles define all the media parameters of a LiveShot connection. Profiles define audio and video coding parameters for each direction of a connection, along with parameters used to control decoder receive buffer management. In this way, the initiator of a LiveShot stream (the only one who can assign a profile) is master of all media streams in both directions.

LiveShot contains a long list of factory defined profiles to use (as shown in **Figure 35**), and it's possible to use the system very well without ever having to create or edit a profile.

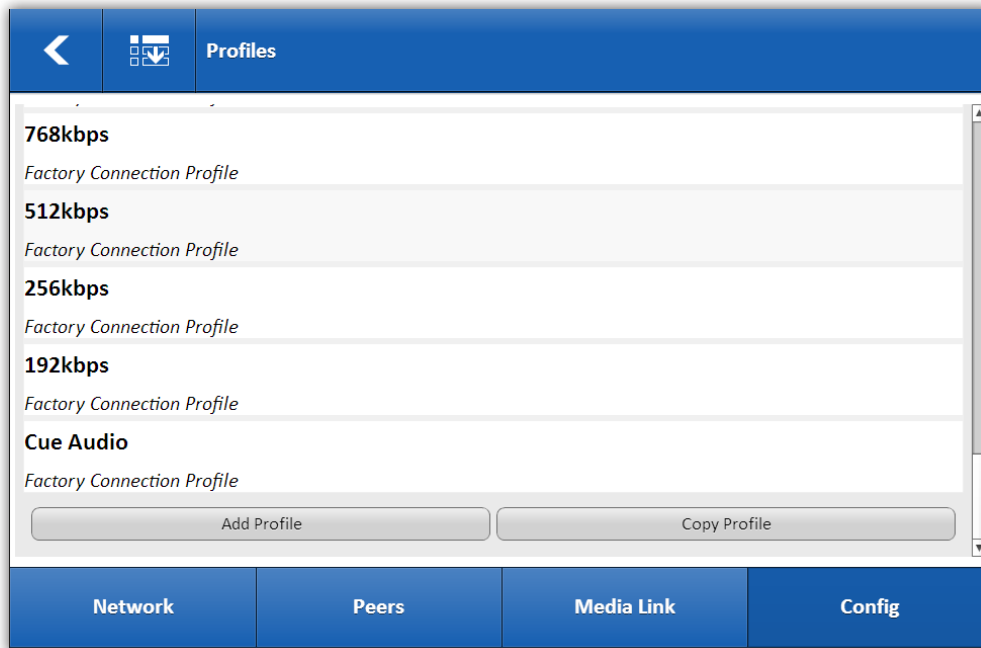


FIGURE 35

Factory profiles are named by the approximate network bandwidth required, along with whether they are one-way, duplex, or asymmetrical (different options in each direction). The profiles provided have audio and video settings determined to be a good choice for the chosen network capacity.

Factory profiles cannot be edited. For changes, it's best to click the “**copy**” button at the bottom of the list, and choose a factory profile to copy and edit, giving it a new name. You can also create an entirely new profile from scratch by choosing **Add Profile** at the bottom of the list. Note that profile setting has no effect on actual media until that profile is assigned to an outgoing connection.

When you choose to create or edit a profile, you'll be presented with the page shown in **Figure 36**.

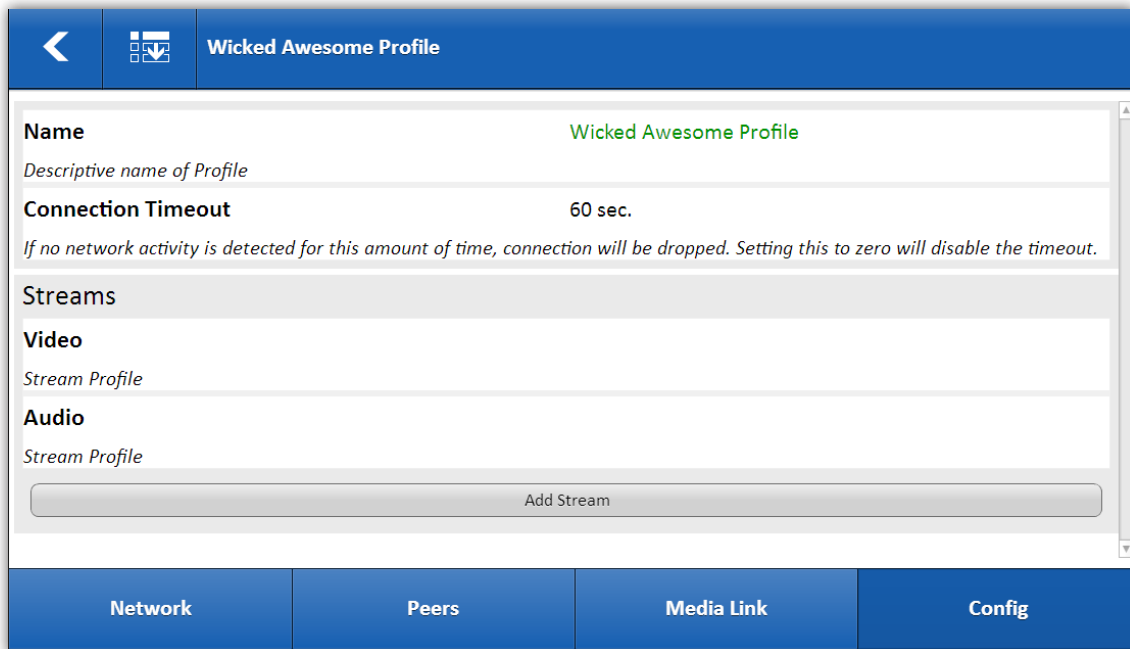


FIGURE 36

First, you'll give the profile a descriptive name (e.g., **1Mbps full duplex**). Then you will proceed to **"build"** individual streams into your profile with the bitrates and other parameters you desire. A separate audio and video stream must be created for each direction one is desired. In the case that the stream has the same parameters in both directions, a single stream can be defined as **"bidirectional"** and only one entry is required.

As an example, if you wish to build a profile with high quality video and audio in one direction, but lower quality video and high quality audio in the other, you could build three streams:

- 1 One for the outgoing high quality video.
- 2 One for the incoming lower quality video.
- 3 One for the bidirectional high quality audio stream.

Create new one-way or bidirectional streams by clicking **"Add Stream"**.

VIDEO STREAMS

Entries for a sample video stream are shown in **Figure 37**. The relevant entries are:

Name - A descriptive name (e.g., **duplex video**, **tx video** etc).

Media Type - Choose H.264 video.

Media Direction - Relative to the unit making the outgoing call, the choices here are **Bidirectional**, **Transmit Only** (outgoing from this LiveShot), or **Receive Only** (incoming to this LiveShot).

Video Lines - 1080 or 720 (HD), 576 or 480 (SD), or lower resolutions are selectable.

Frame rate - This entry is relative to the input frame rate. The choices are:

Full rate -The video will be encoded at the same rate as the input.

Half rate - The video will be encoded at half the frame rate of the input (e.g., 50 Hz input = 25Hz encode rate) Other fractions of the native input frame rate are available.

As an example, if the input video frame rate is 24fps, 1/2 rate will be 12fps, etc.

Bit Rate - In bits per second, the target encoding rate desired (256000-1000000).

Parameter	Value
Name	Video
<i>Descriptive name of Stream Profile</i>	
Media Type	H.264 Video
<i>Media type of stream</i>	
Media Direction	Bidirectional
<i>Direction of media transmission</i>	
Video Lines	480
<i>Maximum number of video lines to encode. Actual number of lines will not be greater than source resolution.</i>	
Frame rate	Full Rate (60fps)
<i>Frame rate divider to use. Example frame rates are shown assuming a 60Hz input source. If using a 50Hz system, for example, 1/2 Rate w...</i>	
Bitrate	1500000 bps
<i>Average encoder bitrate target.</i>	

Navigation: Network | Peers | Media Link | Config

FIGURE 37

***Special note: When the CrossLock VPN function is being used, the system has license to reduce the Bit Rate and Frame rate Parameters dynamically based on network conditions. This is known as “throttling” and can be disabled in the settings. When throttling is active, the Bit Rate and Frame Rate settings are considered the maximum that should be attempted by the CrossLock system.**

VIDEO ADVANCED OPTIONS

By clicking “**Show Advanced Options**” (upper left menu button) several other encoding options are presented:

Bitrate Optimization - This option is set to “**Low**” for the typical bitrates used by LiveShot. It balances the choices made by the encoding algorithm between total network bandwidth and quality. In some cases, users may want to experiment with setting this parameter manually. Not recommended for casual users.

Deinterlacer - Video encoding on LiveShot can work in interlaced or progressive mode. This choice is made independently from the native format of the input and output video. With the deinterlacer turned on, the choice is made to encode in progressive format regardless of the format of the input video. The deinterlacer option is only available on profiles set to full native frame rate. If frame rate is reduced in the profile, the deinterlacer is always on, as this function requires that input video be progressive. Also, connections that utilize the CrossLock throttling function (recommended for wireless connections) also require to encode in progressive, so this option should be left “**on**”. If you are applying interlaced video to the LiveShot encoder, (and not utilizing the CrossLock function e.g. on a managed WAN) the way to avoid unnecessary conversions from interlaced to progressive is to set the **Deinterlacer** option to **disabled**.

INTERLACED MODE

When the encoding interlaced video (interlaced video applied to LiveShot and Deinterlacer set to disabled), this option determines which of three encoding modes to choose. This option has no effect on progressive video (the default when using CrossLock throttling).

The options are:

Field Encoding (default) - Encodes each field separately as an individual picture.

Picture Adaptive - (also called **PicAFF** or **PAFF**), looks at each field pair and decides whether there was any motion in the scene at all. If motion was detected, field encoding is chosen. If there was no motion, the fields are combined into a single frame and encoded. This can be more efficient because there is substantial common data between the two fields.

Macroblock Adaptive (commonly called MBAFF) - makes the same decision as Picture Adaptive, but it does so for each macroblock in the field pair. So, an image that has motion in some parts but not others (which for many types of content accounts for the majority of the frames) can take advantage of both approaches.

Field encoding is chosen as the default because **PAFF** and **MBAFF**, although higher efficiency, have been shown to produce visual artifacts in some instances. The options are there for experimentation on certain video sources.

Intra-Refresh (IR)* - This setting (normally disabled) allows a special mode that alters how reference frames are sent from encoder to decoder over the network.

IR mode has the following advantages:

- 1 **Lower Delay** - For those for whom low delay is paramount, **IR** mode offers a slight reduction in processing delay.
- 2 **Network Burst Reduction** - Normally, when the encoder sends a reference frame to the decoder, it results in a short-term burst of higher-than-normal data rate. Some networks react poorly to this in the form of higher delay or errors. **IR** mode “smooths out” the data rate, making the data flow more constant. Factory profiles with the “burst constrained” label use IR mode.

***Only Available at Full Frame Rate**

Intra-Refresh mode has the following disadvantages:

- 1 **Rolling Bar** - Especially pronounced at lower data rates, IR mode can introduce an artifact of a refresh bar scrolling from top to bottom of the video. The bar tends to be more pronounced based on how hard the encoder is working (e.g., high motion, high detail, low data rate). The effect can be minimized by increasing the data rate, if possible.
- 2 **Error Resilience** - On networks with packet loss, **IR** mode may enhance video errors in the form of blocks or pixelation by taking longer to correct them. **IR** mode is recommended off for most users.

Rate Control - This option allows you to control some encode parameters that have an effect on how the network is utilized. The options are:

- 1 **Unconstrained (default)** - The encoder is given the ability to be as “bursty” as necessary to encode the data in the best possible way with reasonable compromise for latency.

- 2 **Low Latency** - Latency is considered to be an overriding factor over quality in this mode. Use only in environments where the lowest possible latency is important. For most users, the amount of latency reduced in this mode is a poor tradeoff for quality.
- 3 **Constrained Bitrate** - This mode limits the “burstiness” of the encoder to 1.5x the target bitrate over a one second window. It’s useful for networks that perform poorly when bursty data is applied.

Scene Complexity Detection - In an effort to avoid artifacts when sending video with many constant scene changes (like edited video), LiveShot can reduce the overall quality slightly in order to better compensate for these changes. Normally disabled.

Digital Noise Reduction (DNR) - At low bitrates, it can sometimes be helpful to apply a filter to “soften” the video image. This can be perceived as the image being “cleaner” with less “digital noise”. This option is available but off by default.

GOP Structure - This option determines the number of B-frames sent by the H.264 encoder. Use of B frames can increase performance in instances of high motion and high detail, but increases delay because a buffer must be added to the process. Default is not to use B frames, but if your video quality is critical and delay is not a concern, adding one, two or three B frame sequences to the encoder can improve the image.

Keyframe Interval - In H.264 video coding, reference frames are sent periodically to reset the predictions made by the encoder algorithm. This results in most errors being corrected, and overall artifacts reduced when this “Keyframe” is processed. This option determines how often the keyframe is sent. Default is 1 second. Lowering this can provide error resilience at the cost of quality and bandwidth. Raising it can lower bandwidth but reduce error resilience. When **Intra-refresh** mode is enabled, this will affect the cadence of the “rolling bar” artifact.

Buffer Parameters - These options are common for all types of streams, so they are treated in their own separate section below.

Stream Optional - This option determines whether a connection will fail in the absence of a source for this particular stream. For example, if a video input is left unconnected, but a stream is defined to use it, the system can be set to fail or complete the connection anyway. For bidirectional streams, it’s possible to set one or the other direction to **optional** individually.

AUDIO STREAMS

LiveShot by default encodes audio using the **AAC-ELD** algorithm, which is a highly regarded codec designed to balance low delay and high quality audio. It is a variant of the **AAC-LC** algorithm, popularized by Portable media players.

AAC-ELD adds to **AAC-LC** in two ways:

- 1 **Low Delay (LD) Operation** - Using a shorter framesize, overall processing delay is reduced to a fraction of **AAC-LC**. This is important because of LiveShot's extremely low delay video codec. Use of **AAC-ELD** removes the need to delay video in order to maintain A/V sync.
- 2 **Spectral Band Replication (SBR)** - This is a technique used to reduce network bitrate by applying synthesis algorithms to high frequencies. The **AAC** variant that utilizes **SBR** (without the low delay aspect) is known as **HE-AAC**.

Each of these options of **AAC** (LD and SBR) can be enabled and disabled in your audio stream. This may be important for compatibility with other decoding devices or players. In order to create a stream using an **AAC** variant, use this guide:

- **AAC-LC** (or just plain AAC) --- LD and SBR disabled.
- **HE-AAC** --- LD mode disabled, SBR enabled.
- **AAC-LD** --- LD mode enabled, SBR disabled.
- **AAC-ELD** --- LD and SBR modes enabled.

Figure 38 shows the options in setting up an audio stream:

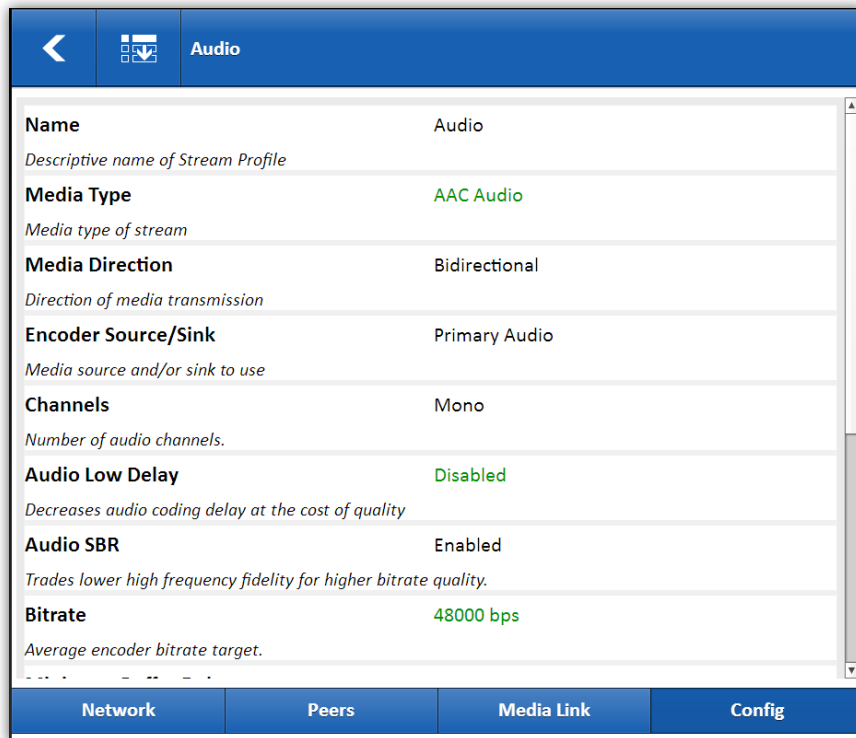


FIGURE 38

Name - A descriptive name (e.g., **duplex audio**, **tx audio** etc).

Media Type - Choose **AAC Audio**.

Media Direction - Relative to the unit making the outgoing call, the choices here are **Bidirectional**, **Transmit Only** (outgoing from this LiveShot) or **Receive Only** (incoming to this LiveShot).

Channels - Choices are **mono** or **stereo**.

Low Delay - Chooses a low audio coding frame size, lessening delay.

Audio SBR - Adds spectral band replication to reduce bitrate.

Bit Rate - The overall network utilization that should be reserved for audio. Set in bits/second. For guidelines, ordinary **AAC** and **AAC-LD** works best above 64kb/s per channel. **HE-AAC** and **AAC-ELD** work best at above 32kb/s per channel.

AUDIO ADVANCED OPTIONS

Buffer Parameters - These options are common for all types of streams, so they are treated in their own separate section below.

Stream Optional - This option determines whether a connection will fail in the absence of a source for this particular stream. For example, if an audio input set to embedded SDI or HDMI, and a stream is defined to use it but it is not present, the system can be set to fail or complete the connection anyway. For bidirectional streams, it's possible to set one or the other direction to **optional** individually.

HOW BUFFER PARAMETERS WORK

LiveShot has an integral **Receive Buffer Manager**. The responsibility of the manager is to provide the minimum required receive jitter buffer for incoming streams in order to correctly balance delay and resiliency on a feed. For most users, the default parameters work best, as they have been tested extensively to provide the best performance on most networks. In the rare case that the user wants to adjust the behavior of the receive buffer managers, these advanced options are provided.

The Receive Buffer Manager is dynamic - it will automatically increase and decrease delay based on several factors measured on the network, within the limits that are set by the system. The adjustments listed here change the default limits within which the **Manager** can do its job.

When adjusting the buffer manager within a stream, it's important to remember these changes will affect how the decoder in that direction will work. E.g., if a "**transmit only**" stream is adjusted, the receive side of that transmitted stream (on the other LiveShot) will show the changes. In bidirectional streams, the changes are made to the receive buffers on both ends of the link.

Here are the adjustments that can be made to stream buffers:

Minimum Buffer Delay - This setting instructs the **Manager** never to reduce the buffer below this value (in milliseconds) - This will add a fixed minimum delay to your stream.

Maximum Buffer Delay - This setting instructs the Manager never to increase the buffer above this value (in milliseconds). If network jitter rises above this value, media errors will result.

Buffer Delay Cushion - Once a network jitter value is calculated, the **Manager** will choose a target buffer delay and attempt to increase/decrease the buffer to achieve this delay. This value "**pads**" that calculation, adding the fixed specified value in milliseconds to the calculation.

Buffer Delay Deadband - The **Deadband** setting applies some hysteresis to the jitter calculation. The **Manager** will not react to changes in jitter above and below the Deadband setting. This is a way to “dampen” the **Manager’s** buffer adjustments, causing it to move less. This can result in fewer video or audio frame adjustments.

Loss Cushion - This is another way to “dampen” the effects of the **Manager**, by specifying a percentage of packet loss that is tolerable before adjustments kick in.

Jitter Window - This setting affects how large a historical window is used by the **Manager** to calculate network performance. Larger values result in slower adjustments, as temporary network shifts will be weighted less in calculations.

ABOUT CONNECTION PROFILE COMBOS

Most users will only be making a connection to one location--the mated LiveShot in their system. But with the **Profile** settings, it’s easy to create multiple outgoing connections to the same place (e.g., one with a profile optimized for Wi-Fi, and another with a profile optimized for 4G).

ADMIN SETTINGS

The third option in the **Config Tab** lets you define some global parameters for LiveShot operation.

- 1 The Web Server port allows you to change the port used to deliver web control interface. Note that if you change this from the default **port 80**, you will need to add a port number to your URL in order to access these pages (e.g., **10.10.10.10:88**). Also, the **Device Manager** software will need to be configured for this change as well.
- 2 The **Remote Access Password** is very important. The default is **comrex**, and we highly recommend changing this if your LiveShot will be exposed to the public Internet without NAT routers. This password will be used for the web interface, the mobile phone apps, and the **Device Manager** software.
- 3 The unit name is set by default to LiveShot <**mac address of LiveShot Ethernet**>. Changing this name affects how the unit is displayed in web browsers and apps, Device Manager, CrossLock status, and internal Wi-Fi Access Point SSID (The SSID can be overridden in the network settings). Feel free to change the name of your LiveShot to something familiar but unique to other LiveShots.

ADMIN ADVANCED OPTIONS

Clicking **Show Advanced** under **Admin Settings** opens a few more options for the advanced user.

The **Diagnostics** setting allows use of an **SSH port** on LiveShot so Comrex tech support personnel can access it remotely. Use of this port requires a key code that Comrex does not provide to customers, so it is secure when turned on, but some users may still have security concerns. Setting this value to **No** disables the diagnostic port.

The **Remote Network Management/RNM** Port settings are special functions designed to allow use by legacy utilities, and should be left at their default settings (**disabled/81**).

The **System Watchdog** should normally be enabled, but may be disabled during troubleshooting by Comrex support.

ADVANCED CONFIG OPTIONS

Choosing “**Advanced Options**” in the **Config** Tab options several new options

AUTO-CONNECT

The first Advanced mode under the Config Tab are the Auto-Connect options. This allows you to designate which of your defined connections are activated via the Hot-key connections. The Hot-keys are the **F1** and **F2** keys on LiveShot Portable. On LiveShot Rackmount, the Hot-key connections are enabled via the front panel menu.

The **F1** and **F2** keys on the portable each allow for two Hot-key connections via short and long presses. Auto-connect **#3** and **#4** entries are triggered via a “**long press**” (3 seconds) of **F1** and **F2** respectively.

As shown in **Figure 39**, the system allows you to designate which defined connection(s) are activated on Auto-connect **#1-4**. By default, a media connection to the Default Peer (the first entry in the peer list, 3G/4G profile) is active on **#1**, and a cue channel connection to the same destination unit is on **#2**. **#3** is tied to an HD video connection (entry **#4** in the peer list) and a Loopback test connection is active on **#4**.

Before you use hotkeys 1-3 you must define a destination for each of these entries in the peer list.

See “**Making LiveShot Connections**” for more on this.

You can change each of these hotkey settings to any peer you have defined in the peer list.

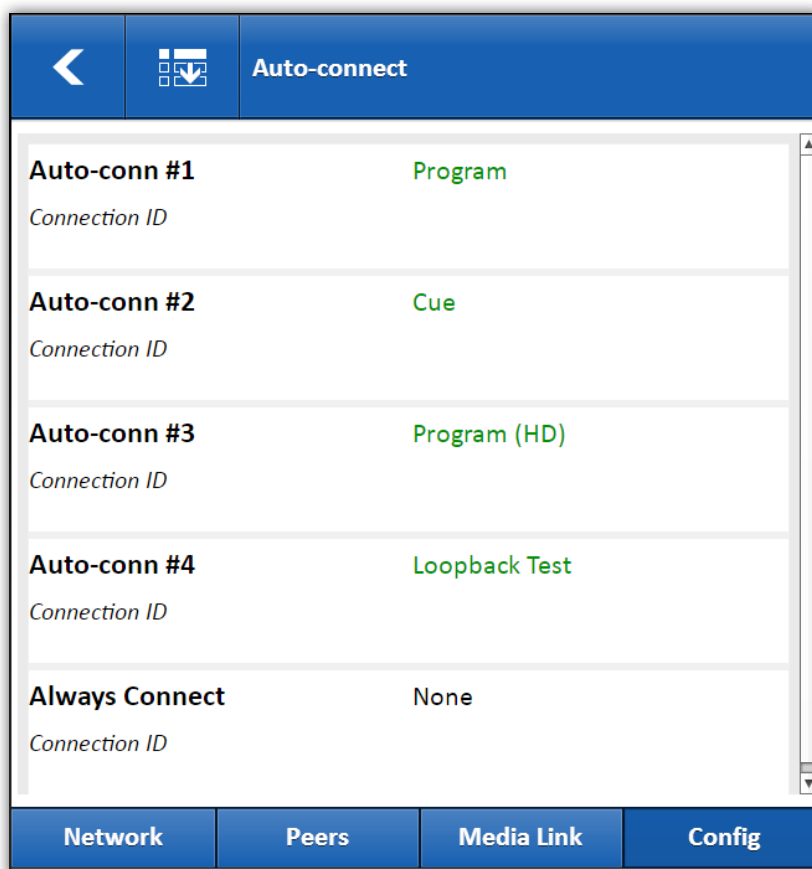


FIGURE 39

SESSION MODES

The **Session Modes** layer remains invisible to most users, but offers some options to the power Liveshot user. **Session Modes** describe the protocols used to transfer data between LiveShots, and other **Session Modes** besides the default are available to allow advanced functions.

Figure 40 shows the Session Modes list that appears when the option is selected.

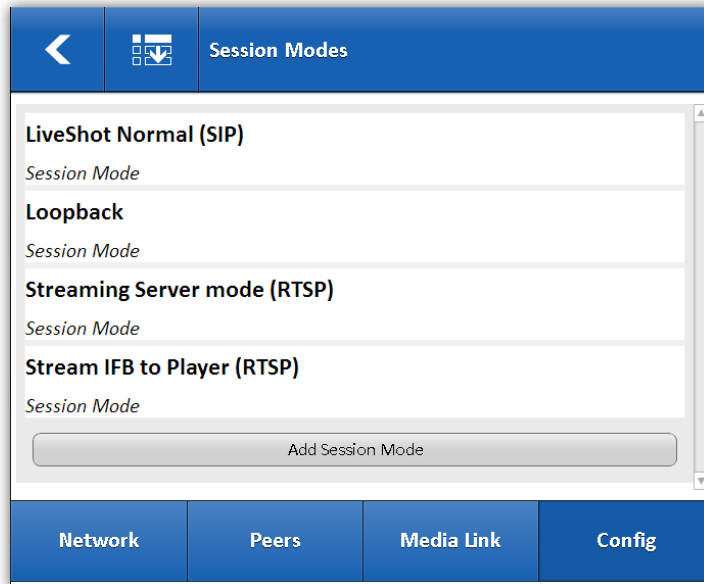


FIGURE 40

The **Session Mode** labeled Loopback is a special diagnostic mode used only to connect the local encoder to the local decoder for testing. There are no useful options under the **Session Mode**.

The entry labeled **LiveShot Normal (SIP)** is the one used on most LiveShot-to-LiveShot connections. Under the hood, it's based on the SIP protocol borrowed from the Voice-over-IP industry. This protocol is very complex with many options, most of which don't apply to average LiveShot connections.

One aspect of the SIP protocol that is not utilized normally in LiveShot is the ability to register with external SIP servers from telephone service providers. Under special circumstances, this can help manage and establish connections. The **LiveShot Normal Session Protocol** has the entries required for this registration, although they are not normally used. **Figure 40** shows these. We won't go into details of these settings in this manual, but more information can be obtained from Comrex tech support.

The last entry under LiveShot Normal Session mode is important. By default, this protocol is only enabled for use over **CrossLock VPN**. If you need to make LiveShot connections without this feature (by dialing a LiveShot’s “**real**” IP address, or accepting a call from a “**real**” address) you will need to change this setting to No to turn this restriction off. This special setting must be changed on both LiveShots in the link. See **Figure 41**.

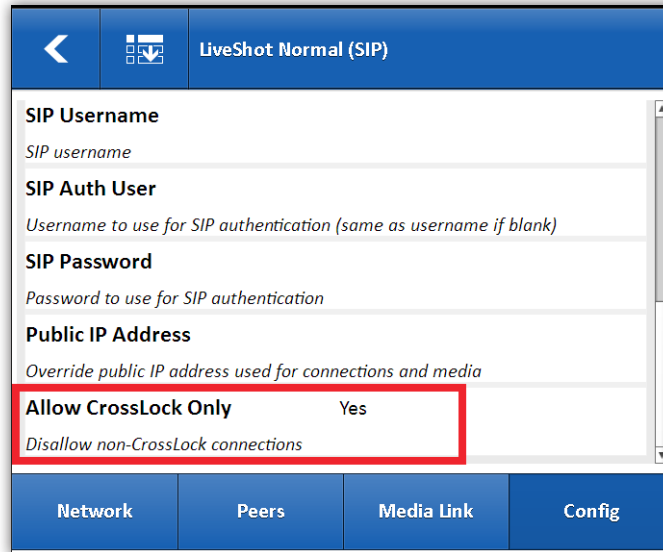


FIGURE 41

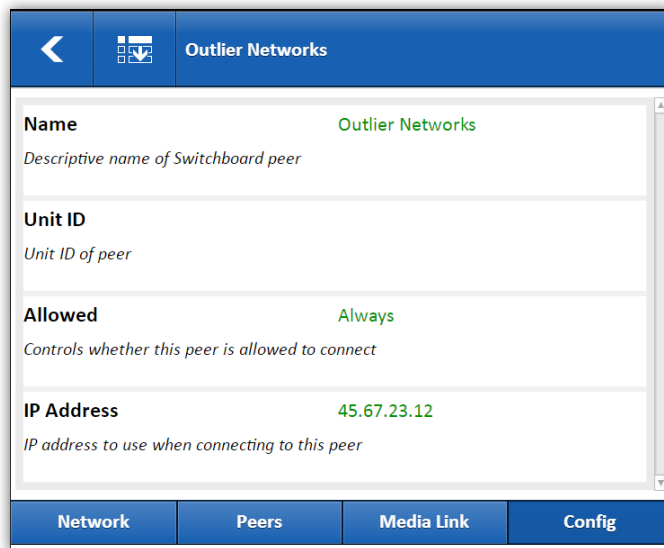
SYSTEM CLOCK

LiveShot uses a network reference to sync its clock. The clock function is used internally and will be useful in future upgrades. You can change the default time (**NTP**) server used by liveShot here. LiveShot normally uses **UTC** as its time reference. if you’d prefer to use a local time zone, you can choose the proper zone in the selection menu.

SWITCHBOARD SETTINGS

The LiveShot Switchboard server is maintained by Comrex on the public Internet at the address of **switchboard.comrex.com**. Organizations with larger fleets of products, and those who simply need to host their own server, can change the address of the server in this section.

Normally, LiveShots can only make CrossLock connections to other LiveShots in their Switchboard accounts. The list of other LiveShots detected within your account appears in the Switchboard Settings. If you need to make CrossLock connections to LiveShots outside your account, they can be added into the list of available CrossLock mates here. Select **“Add Peer”** at the bottom of the list. The fields required to add a peer are shown in **Figure 42**.



Outlier Networks	
Name	Outlier Networks
<i>Descriptive name of Switchboard peer</i>	
Unit ID	
<i>Unit ID of peer</i>	
Allowed	Always
<i>Controls whether this peer is allowed to connect</i>	
IP Address	45.67.23.12
<i>IP address to use when connecting to this peer</i>	

Network Peers Media Link Config

FIGURE 42

You should provide the name of the LiveShot unit in the name field, and the unit ID (Ethernet MAC address) in the next field.

Under **“Allowed”**, choose **“always”** to be sure connections are allowed regardless of Switchboard accounts. Finally, enter the public IP address of the new peer (if outgoing connections are desired).

Both sides need to add their respective peers in order for CrossLock connections to work in either direction outside the Switchboard environment.

In current firmware, the function of Switchboard is to help locate Crosslock mates, and to aid in factory support diagnostics. If neither of these functions is desired (e.g., Liveshot is working on a closed LAN), Switchboard can be disabled in this menu as well. In future firmware, Switchboard will handle additional functions like store and forward and making connections.

CROSSLOCK VPN

This section determines settings for the **CrossLock** reliability layer. Use of CrossLock is optional but highly recommended. Theory of operation of CrossLock is described in the section “**About LiveShot Networking and Protocols**” (page 21).

Previous versions of LiveShot firmware operated CrossLock in a “**client-server**” mode, but firmware 1.4 and higher changes this to a “**peer-peer**” model. For this reason, **CrossLock firmware below 1.4 is incompatible with connections to 1.4 and higher.**

The **CrossLock settings** are:

Enable - Use CrossLock as the primary means of connecting this LiveShot to others. (recommended)

UDP Port - By default, CrossLock uses **UDP port 9001** for connections. For best results, this port should be open for incoming data on at least one of the LiveShots in the link. This means that unless the LiveShot is an an “**open**” Internet connections (no firewalls or routers used) the port will need to be forwarded to LiveShot.

In instances where more than one LiveShot will be attached to the same public IP address, you may need to change the default incoming port. It can be changed here.

If this port is changed and Switchboard is used to establish connections, no further changes are required. In the case of connections without Switchboard, the port change will need to be noted in the outgoing address on the calling unit.

Encryption/Protection - LiveShot has the ability to prevent interception of streams (Encryption) and alteration of streams (Protection). The cpu requirements of these modes are large, and therefore it is not recommended to apply these options to streams greater than 4Mbps. They are set to **off** by default to conserve CPU.

Maximum Delay - CrossLock operates by choosing a “**Target Delay**” figure based on jitter performance of its various networks over a time window. To prevent excessive delay in the case of one extremely laggy network, it has a maximum delay setting here. In the case of multiple networks with very high jitter figures, this setting can be increased from the default two seconds by the user.

FEC- LiveShot has a powerful **Forward Error Correction** algorithm that is enabled in the presence of multiple networks, using any excess network bandwidth to add in the parity required. Use of **FEC** is recommended, but it can be disabled here.

FEC Delay - Controls both how much delay is introduced into the system by **FEC** , and also to an extent how effective the recovery is (which is dependent greatly on the packet rate). The default of 100mS should only be altered on recommendation of Comrex support.

Base FEC - This parameter applies a constant rate of **FEC** targeting recovery of the specified expected loss rate. It is measured in percent packet loss to be corrected. This is useful when retransmission is not effective (e.g., high delay network) and **auto-FEC** is not working as desired. It should be used on recommendation of Comrex support.

Retransmit - In addition to **FEC**, LiveShot utilizes an **ARQ** style algorithm to allow retransmission of lost packets when time permits. This mode is recommended but can be disabled here.

Stuffing - Due to the nature of H.264 video encoding, the network stream from LiveShot is often inherently bursty. Some networks respond poorly to bursty data. This mode allows LiveShot to include unused “**stuffing**” data to “**even out**” the encoder output. It is recommended off unless needed.

Header Compression - The nature of Internet packets sometimes results in IP overhead (RTP headers and other info) actually using nearly as much bandwidth as the payload. LiveShot by default compresses some of these headers to conserve network bandwidth. In instances where the network rejects this, or packet inspection is required, this compression can be disabled.

Encoder Throttle - When CrossLock is used, the system has the capability of instructing the encoder to reduce bitrate when network conditions are challenging. This can result in reduced frame rate and/or resolution. In instances where this can not be tolerated, the option can be disabled here. Setting **Encoder Throttle** off will usually result in a lower stability factor.

STUN Server - This is the address of a cloud server used to establish determination of public IP addresses and router firewall information automatically. It is important to the proper operation of Switchboard and CrossLock. By default, the setting points to the Comrex server. The user is free to set up their own STUN server, or to point to any alternate server here.

Always Connect - In situations where only one pair of LiveShots exist in the fleet, there may be an advantage to having the CrossLock layer maintained between the LiveShots regardless of whether media connections are established. CrossLock uses very little network bandwidth, so this is sometimes advantageous. If this is selected, you’ll see a list of available connection peers. Once it’s selected, CrossLock will be established and maintained with that peer until power or network are removed, then reestablished when restored.

xI. MAKING AND RECEIVING LIVESHOT CONNECTIONS

After all the configuration is done, it's time to actually use LiveShot. Before you make any connections, you'll need to at least choose your destination on the outgoing LiveShot in the **Peer** menu. You can create a new Peer with the steps outlined in the **Peers Tab** section, or you can edit the default Peers presented in the factory configuration.

If you are using Switchboard, this process is simple. As shown in **Figure 43**, choosing the “**Remote Unit**” option in the **Peer Edit** menu will present a list of all other LiveShots in that unit's contact list. Choose the target LiveShot here.

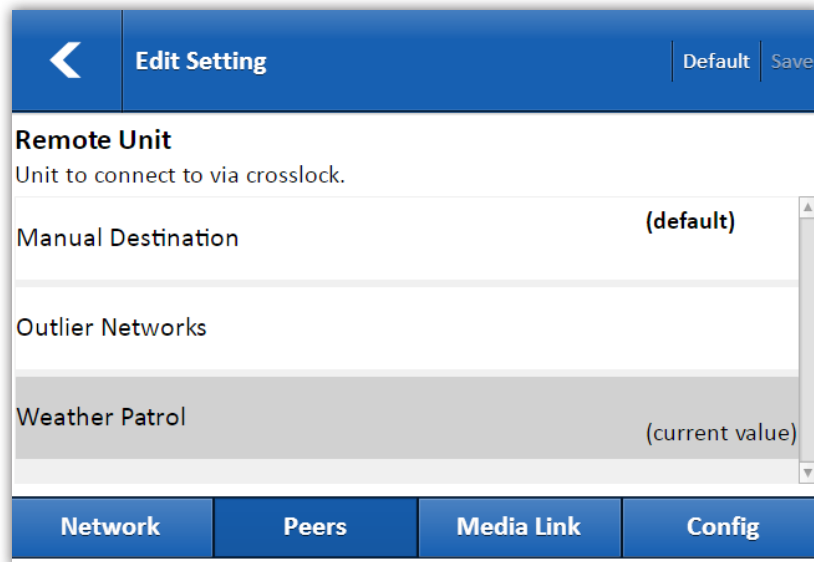


FIGURE 43

If you are not using Switchboard, special setup is required to authorize a new peer. That's outlined in the next section “**Making non-CrossLock Connections**” (page 83).

MAKING CONNECTIONS VIA THE WEB INTERFACE

Once the peer is created or edited to choose the proper destination (and a proper connection profile is selected) you can select “**Connect**” to make that connection. LiveShot will take several seconds to establish CrossLock with the Peer, then set up encoding and decoding parameters on each end. Finally it should enter the “**Connected**” state and you should have an active media connection. The **CrossLock Media Link** tab becomes active on connection, and allows a rich view of network performance in each direction.

Note that CrossLock usually starts its media flow at a throttled rate, so you may notice reduced frame rate or resolution during the start of a connection. It will reach either its target rate (if the network(s) support it) or throttle rate (if the network(s) require throttling long-term) within minutes.

LiveShots receiving incoming media streams will see a new entry appear in the peer list, labeled “**Incoming**”. If Switchboard is being used for the connection, there will be a unit name associated with the incoming connection. All encode options are defined by the outgoing profile, so no parameters may be adjusted for incoming connections.

Media can be halted by selecting the “**Disconnect**” option on either end of the link.

MAKING CONNECTIONS VIA HOTKEYS

The LiveShot Hotkeys (**F1** and **F2** on portable, “**Connect**” menu options on Rack) may be used to make easy “one press” connections. The first entry (Short press **F1** on portable) is pre-programmed to the first peer entry. The second entry (Short press **F2**) is programmed for the second (cue channel) and the third (long press **F1**) is programmed to the third (HD). The fourth (long press **F2**) is pre-programmed to the loopback test condition.

Peers must have a destination selected, a profile chosen, and the correct hotkey must be assigned to them before connections are possible this way. When using the hotkey function, network statistics are not available from the initiating LiveShot (unless the Web interface is also accessed).

Hotkeys on LiveShot portable will flash during the negotiation phase, and light steady when connected. Rack connections will display connect status on the front panel. Connections can be ended by pressing the lit key on the portable, or choosing “**Disconnect**” on the rack.

MAKING CROSSLOCK CONNECTIONS WITHOUT USING SWITCHBOARD

ABOUT CROSSLOCK SECURITY

LiveShot's default mode is to use CrossLock, which has many advantages in media stability on poor networks. CrossLock does more than add an enhanced media layer - It creates an actual VPN between your LiveShots, capable exchanging lots of different data. At the same time, LiveShot is connected to your LAN - possibly your station's main corporate LAN. This may raise security concerns.

While no path is explicitly provided to allow connection between the CrossLock VPN and the physical network it's connected to, it's wise to take security precautions in this type of situation. We do this several ways:

- 1 Only Comrex products with the proper certificate can make CrossLock connections
- 2 We limit the list of devices that can connect to your LiveShot via CrossLock. Units that are not in a LiveShot's Switchboard **Peer List** will be rejected.

The default Switchboard **Peer List** is downloaded from the Switchboard Server, and contains only those LiveShots that are in the unit's **Contact List** (this may be, by default, all LiveShots in the account, or may be edited to be a subset). It will also contain any LiveShots added via the Switchboard "**Shares**" function. Unless you take special steps, only these LiveShots can connect to you (and vice versa).

You may need to make connections on closed networks where Switchboard is not accessible. In this case, you will need to make special configurations to each LiveShot.

ADDING SWITCHBOARD PEERS MANUALLY

You have the option of adding manual Switchboard peers, which gives permission for the LiveShot to connect to them via CrossLock. To make a CrossLock connection this way, the respective peer must be added to **each** LiveShot Switchboard **Peer List**. In other words, both LiveShots must have the other as a manual Switchboard **Peer**.

You will need to know the Unit ID (Ethernet MAC address) of both LiveShots in the link, know the public IP address of the LiveShot that will receive the connection, and have access to both unit's web-based config pages.

The change is made in the **Config** tab under **Advanced Settings->Switchboard** menu. As shown in Figure 44, there's a **Peer List** in this menu, with the option to add a new peer at the bottom. Select the **Add Peer** option and you'll see a series of fields that need to be filled in for the opposite LiveShot. These include:

- 1 A familiar name for the peer
- 2 The unit ID (Ethernet MAC) of the peer
- 3 Change the **"Allowed"** entry to read **"always"**
- 4 If this LiveShot is meant to make outgoing connections to the new peer, you'll need to add the public IP address of the peer

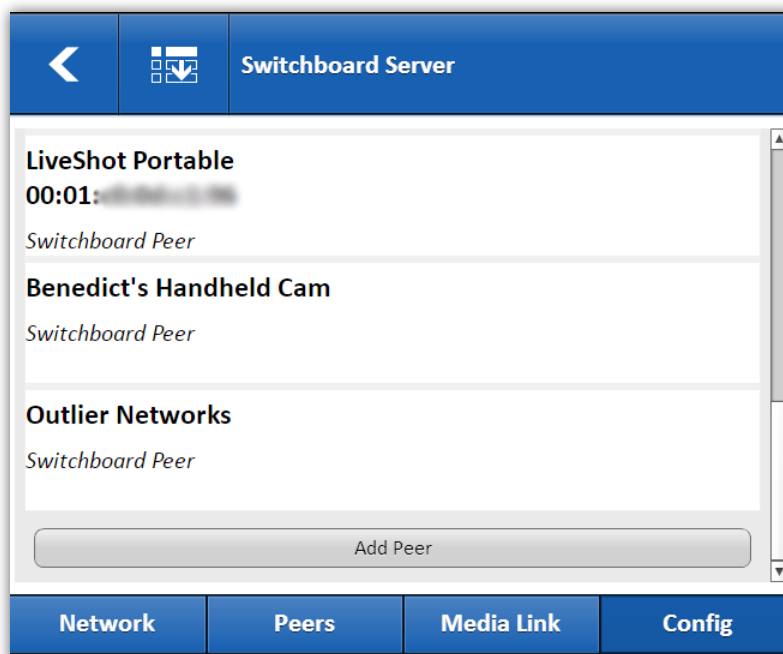


FIGURE 44

Once these entries are done and saved, CrossLock connections are possible. When a new outgoing connection is being created for the first time (see section on **Making Outgoing Connections**), the manual peer will appear in the list of places to connect. Remember, the same process must take place in the opposite LiveShot (using the local unit's information) before connections via CrossLock will work.

Also note that this is different than the **"Manual Destination"** function in the Peer creation tab, which is used to make non-CrossLock connections (as described in the next section).

PERMISSIVE MODE

There may be situations (e.g. LiveShot is on an isolated network, or one on which security is less of a concern) where you want to disable all restrictions regarding who can establish CrossLock connections to your LiveShot. Note that only Comrex products with valid certificates can make these connections, but **Permissive Mode** opens LiveShot to all other LiveShots.

The Permissive mode setting is under the **Config Tab-> Advanced->CrossLock VPN->Permissive->On**. Before changing this setting, make sure you understand the implications described in “**About CrossLock Security**” above. Also note that this change affects only the local LiveShot. The respective LiveShot in the link must also grant permission to this one--via Switchboard, Manual Switchboard Peer entry, or Permissive mode.

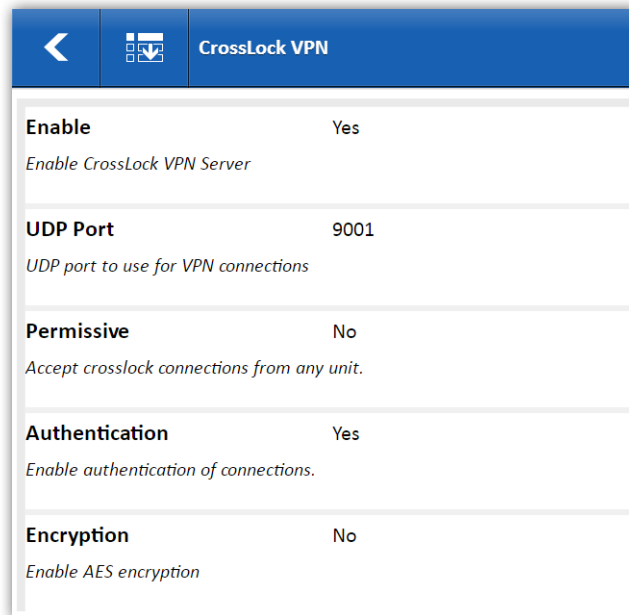


FIGURE 45

MAKING NON-CROSSLock CONNECTIONS

LiveShot may be compatible with other hardware and software capable of H.264 video and AAC audio encoding and decoding. Since these systems will not support the CrossLock VPN layer, in these instances you may want to make or receive connections without CrossLock applied.

Enabling connections without CrossLock is done in the **Config** tab under **Advanced Settings->Session Modes->LiveShot Normal (SIP) entry**. The last option is “**Allow CrossLock Only**”, and if set to **no**, allows LiveShot to receive connections using the SIP protocol but without the CrossLock layer.

If non-CrossLock connections are desired between two LiveShots, this setting must be changed on both LiveShots.

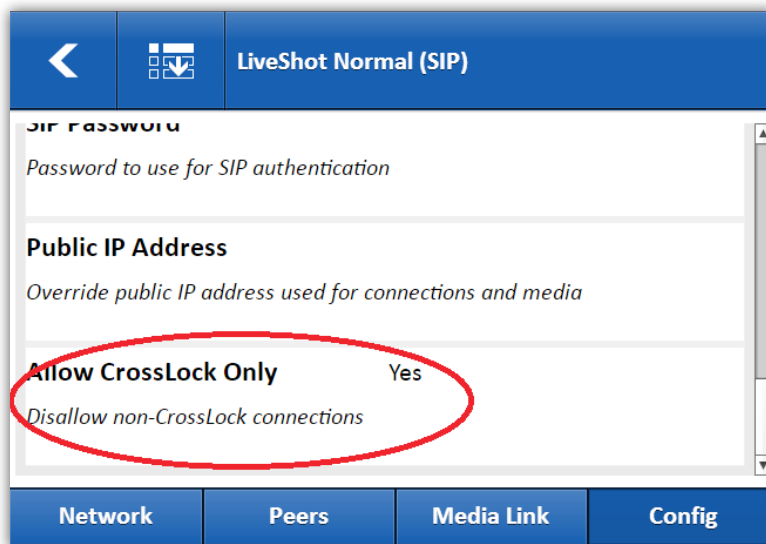


FIGURE 46

In addition to this, to make outgoing connections without CrossLock you'll need to create a peer in the **Peers** tab in a special way. This is shown in **Figure 47**.

Edit Peer	
Name <i>Descriptive name of Connection</i>	Ad-hoc bureau
Remote Unit <i>Unit to connect to via crosslock.</i>	Manual Destination
Destination <i>Remote address</i>	75.75.75.75
Session Mode <i>Session mode to use</i>	LiveShot Normal (SIP)
Profile <i>Connection profile to use</i>	3G/4G

FIGURE 47

Under the **“Remote Unit”** choice, where you'll normally see your list of Switchboard peers, you'll choose **“Manual Destination”**. This choice will enable another field labeled **“Destination”**. Here you will enter the public IP address of the unit you want to connect to.

Once this is set up, connection and disconnection of non-CrossLock peers happens in the normal way.

xii. USING THE LIVESHOT RACK FRONT PANEL INTERFACE

The LiveShot Rackmount, via its front panel buttons and display, allows setting of some of the basic features of LiveShot. The Interface can:

- Change Ethernet IP settings on the LiveShot.
- Make and break connections to the two **Hot-key** auto-connect destinations programmed into the LiveShot.
- Adjust settings in the LiveShot's A/V I/O ports.
- Restart LiveShot and reset it to factory defaults.
- Check connection status, send and receive audio levels, and video input specifications.

The Interface does not allow these operations:

- Create or edit new profiles or connection information.
- Edit or assign the **Hot-key** auto connections.
- Configure or enable **CrossLock VPN** modes.

Figure 48 and Figure 49 show a map of the various menu options on the Rackmount front panel interface.

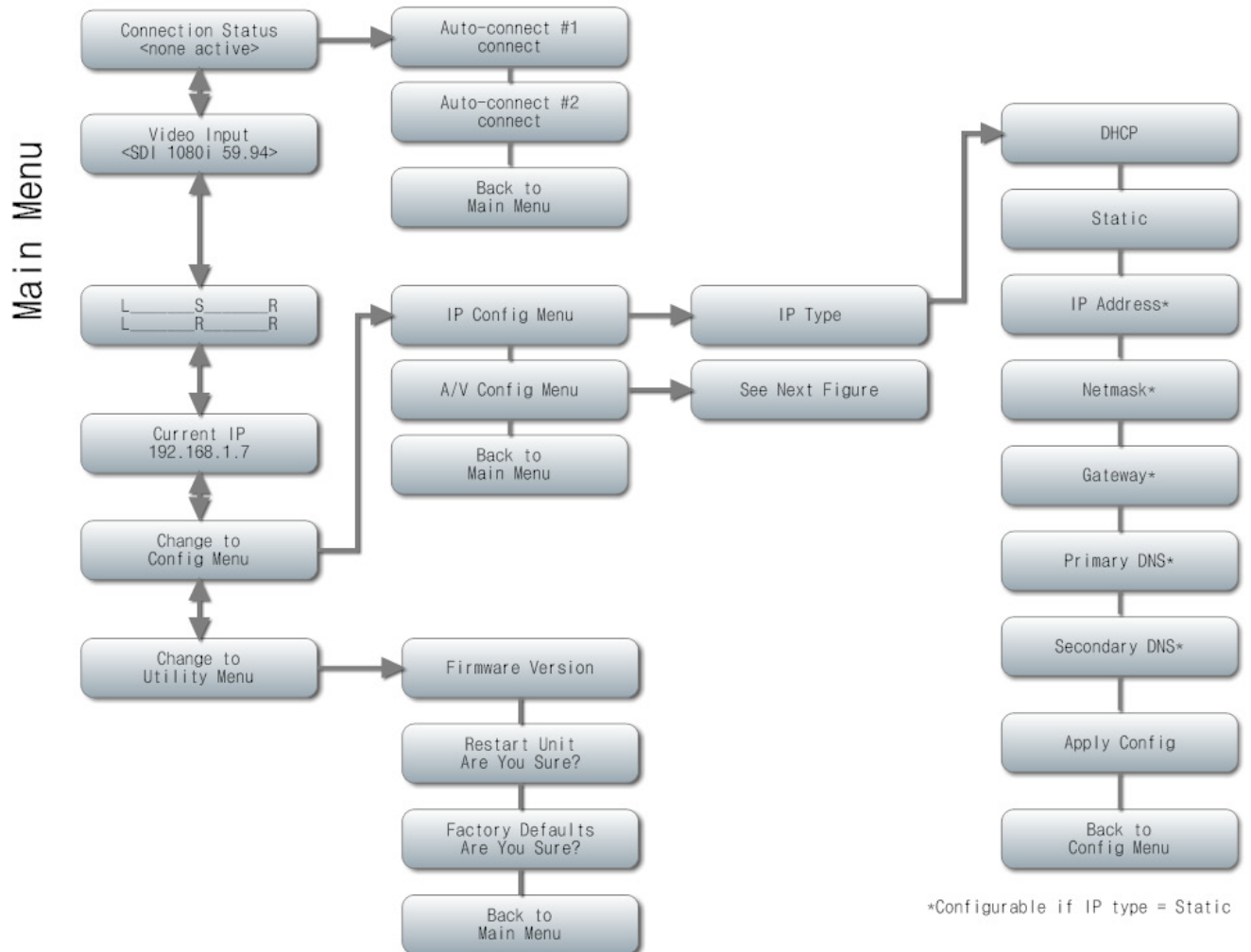


FIGURE 48

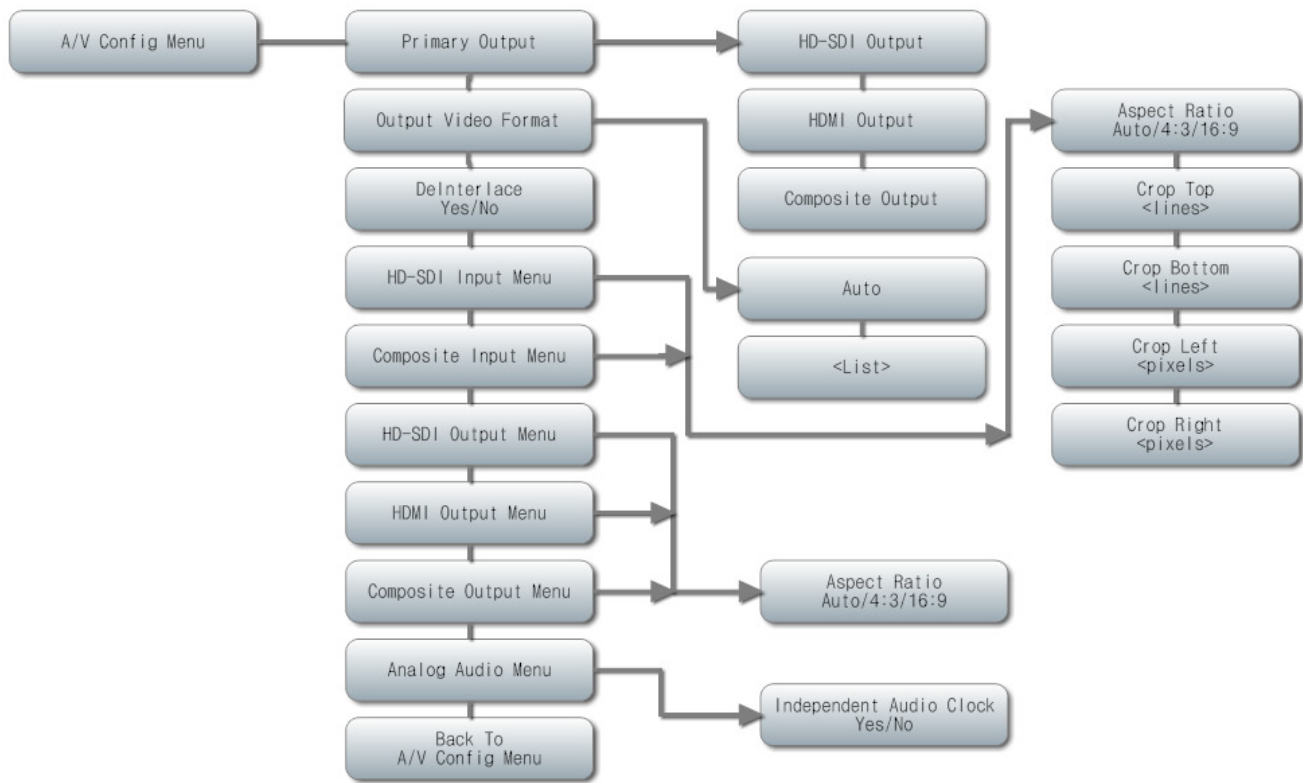
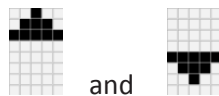



FIGURE 49



These options mirror options available via the LiveShot Web Interface. See details in that section ([page 32](#)) for more on these options.



Navigation is done through the arrow buttons and enter keys. To the farthest most side of the top line, cursor icons appear to offer which cursors are active.



Most menus are browsed using the  and  buttons. The last option in each list will return to the previous menu.

On menus that offer the ability to change a setting, the  will offer an option to cancel.


Each digit of a numerical value (e.g., IP addresses) can be altered with the  and 


buttons, and digits can be selected with the  and  buttons.


Scrolling all the way to the right on a numeric entry will offer an option to cancel your setting.

The legend on the right side of the bottom line of the display gives hints as to whether:

This item is purely informational and non-editable. 

This item takes you to a submenu. 

The **Enter** key will execute the chosen command. 

The current value can be edited by pressing **Enter**. 

The current value can be saved by pressing **Enter**.



The current operation can be cancelled by pressing **Enter**.



xiii. INFORMATION FOR IT MANAGERS - LIVESHOT

The purpose of this document is to describe all open ports and services available on the Comrex LiveShot. The Comrex LiveShot is a device designed to move real-time, wideband audio and video over IP networks. The main network interface is 100BaseT-Ethernet. The device contains an optimized version of Linux kernel. The IP parameters are set by a PC on the local LAN using a proprietary broadcast UDP protocol.

Comrex provides a Windows application to perform this function on the local PC. After five minutes of operation, this function is disabled.

IP parameters can also be changed online using the password protected toolbox interface at /cfg Updates to the system are provided by a custom on-line updater utility. This update process is password protected and requires access to TCP 80 and TCP 8081. In addition to the password protection, the update data itself must have a valid cryptographic signature from Comrex, or else it is rejected.

INCOMING SERVICES

Port	Service	Default
TCP 22	SSH	On
TCP 80	HTTP control	On
TCP 8081	Firmware upload	Open only during upgrade process
UDP 9001	CrossLock Media	On

*Only SSH clients with an authorized DSA key can access SSH services on the device. Other forms of authentication are disabled. This key is kept confidentially by Comrex for factory diagnostics only. SSH services may be disabled completely via the user interface.

OUTGOING SERVICES

Service	Destination
NTP	o.comrex.pool.ntp.org:123 (UDP)
Switchboard	switchboard.comrex.com:8090, switchboard.comrex.com:8081 (secondary) (TCP)
STUN	stun.comrex.com:3478 (UDP)

MULTIPLE CROSSLock CONNECTIONS

A single LiveShot is capable of connecting to multiple others simultaneously. We call this function “MultiStreaming”. This is shown in **Figure 50**. This is generally for the purpose of distributing media from one location to several. Three simultaneous CrossLock connections can be maintained from a LiveShot.

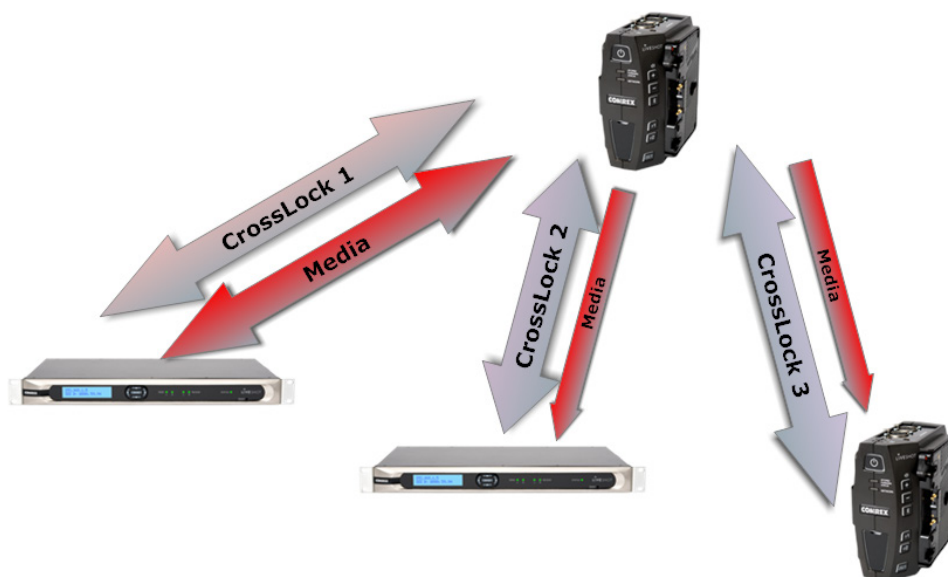


FIGURE 50

There are several limitations in this scenario. First, it’s important to disable the LiveShot’s Encoder throttle function (to avoid one poor link from reducing quality for the others). This is done in the **Config** tab under **Advanced->CossLock VPN->Encoder Throttle->No** on the end that will be delivering the multiple streams. Since this setting is universal for all connections, it should be set back to “yes” when using single LiveShot connections for best results.

Secondly, the LiveShot has only one encoder and one decoder. This means that during MultiStreaming all outgoing streams (from the MultiStreamer) must have their encoder profiles set identically, or connections will fail.

The simplest way to achieve Multistreaming is to build a single “**TX only**” profile on the MultiStreamer, and initiate connections from that LiveShot to all the peers. Connections can be achieved from the receiving peers, but because the connecting unit control parameters in both directions, it requires much more coordination regarding throttling and profile settings on each LiveShot.

It is actually possible for the MultiStreaming LiveShot to receive a media stream from one of the units in the group. This is possible by setting different profiles for the duplex vs. the “**Receive Only**” LiveShot connections.

The same is true for Cue connections. They can be established and maintained to several LiveShots simultaneously, but only one can be configured for duplex communication.

STREAMING MODES

RTSP STREAMING SESSION MODES

In current firmware, the use of RTSP Streaming Session modes should be considered experimental.

Comrex may not be able to support all use cases for these modes.

The RTSP Session modes provide a means for LiveShot to deliver audio and video streams to player software installed on PCs and mobile devices. Your player must support **H.264** and (optionally) **AAC** audio decoding via the RTSP protocol. These Session modes are disabled by default. To use them, you will need to access the advanced menu under the **Config** tab, and choose **Session Modes**. The **Session Modes** menu is shown in **Figure 51**.

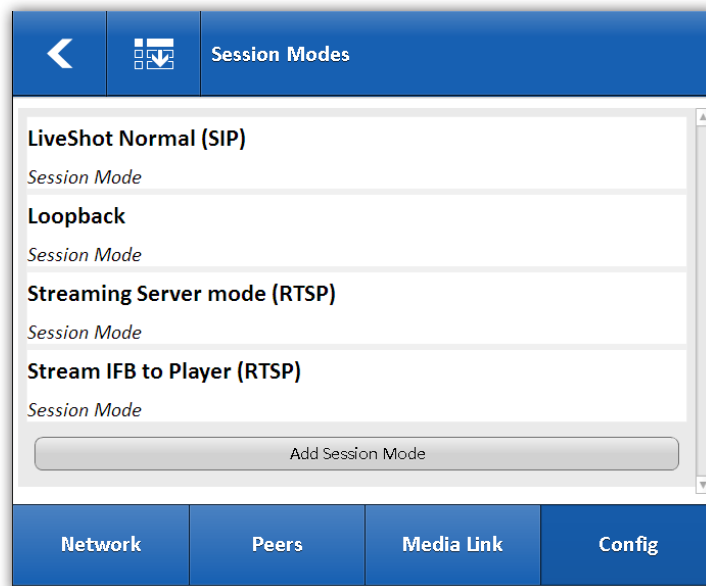


FIGURE 51

Each of the two supported Streaming modes outlined below can be enabled by choosing the appropriate entry and changing the “**disabled**” setting to “**enabled**”.

RTSP sessions are initiated from the player software by addressing the IP address of the LiveShot as described below.

STREAMING SERVER MODE

When this mode is enabled, LiveShot will deliver an A/V stream of the media presented to its encoder. So the player will receive the LiveShot’s input media stream. Multiple RTSP connections are possible, and can be simultaneously streamed along with LiveShot Normal streams to other LiveShots. If no LiveShot Normal stream is active, the last profile used in a connection will be active. It’s often useful to establish a “**Loopback**” connection in conjunction with this mode in order to define exactly which profile should be used.

This mode is delivered by default on IP **port 554**, which is usually the default port for RTSP players. If the port is changed in the session mode, the player will need to specify the desired port in the URL they use to extract the stream (e.g., **192.168.1.17:555**, with **555** being the new port number).

STREAM IFB TO PLAYER MODE

This mode provides an RTSP stream in very much the same way as Streaming Server mode, but the source of the stream is the media being received over a LiveShot Normal connection. Using this mode, the incoming media is decoded normally by LiveShot, but is also provided to the RTSP Streaming server for delivery to players. The main application of this mode is that return media can be viewed on mobile devices that are associated with LiveShot Portable’s internal access point.

By default this stream is delivered on IP **port 555**. Since this is not the typical default RTSP port for players, it should be added to the URL requested (e.g., **10.10.10.10:555**). This port is chosen to avoid conflict with the Streaming server mode. If these modes are not used simultaneously, the IFB Streamer port can be changed to the default of **554** in the setup menu.

CODEC AND BANDWIDTH CONCERNS IN RTSP STREAMING MODES

LiveShot contains several codec features that are not typically supported by RTSP players. Because LiveShot can only encode in a single profile (e.g., for both a LiveShot Normal connection and an RTSP Streaming connection) you may need to disable some features in the profile used in order to be compatible with players. Some features often not supported in players are **AAC-ELD** audio (usually **AAC** is supported), Intra-Refresh, Interlaced and Low Latency modes for video.

Network Bandwidth is usually a concern in RTSP modes for several reasons. First, the total bandwidth available on the network connected to LiveShot must be able to support the sum of all streams pulled from it, along with any LiveShot normal connection present. This may require a network connection many times the size of a typical LiveShot network.

Secondly, mobile players used in either mode have definite limitations to their processing power. Streams to be played on mobile devices should have relatively low bitrates assigned (below 1Mbps is often required). Again, this will affect the bitrate of the LiveShot normal connection, if present.

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