

SIENNA



NDI PROCESSING ENGINE

White Paper v6.10



An IP Video Protocol which works today

NDI Protocol

The NDI (Network Device Interface) protocol has delivered broadcasters and video professionals with a practical, and useful mechanism to connect video software and hardware on a local area network. NDI carries high quality compressed video, uncompressed audio and bi-directional metadata over a TCP socket connection. NDI includes a very fast, good quality codec to allow low latency, low CPU overhead encoding and decoding to pass resolution, aspect ratio and frame rate independent video across existing gigabit networks. NDI Services are advertised with mDNS and are thus automatically discoverable by other NDI devices on the same LAN. A wide variety of products, and utilities exist to support the NDI protocol, including free utilities to create, and view NDI sources. NDI is offered to the world, without qualification and with a royalty free license by its creators, Newtek Inc.

- **Works perfectly on existing Gigabit LANs and high quality WIFI networks**
- **Compressed video - ProRes / DNxHD type quality**
- **Very fast, license free codec included - 250 fps HD encoding per CPU core**
- **~ 100mBit/s for HD, scalable to 4K and beyond.**
- **Low latency, typically about 1 frame**
- **Uncompressed multi channel audio**
- **Use bonjour discovery for very easy deployment**
- **Bi-directional metadata support**
- **Compatible with Mobile Devices - mobile phone NDI Camera products**
- **Embedded support for Alpha Channel on same stream using BGRA**

Unsurprisingly NDI has been rapidly adopted by hundreds of product developers and the end user installed-base of NDI now dwarfs that of all other professional IP video protocols combined.

NDI was designed for local area networks, using TCP sockets and bonjour (mDNS) service announcements. With the rapid adoption of NDI, customers are now beginning to ask for a mechanism to extend their NDI local area networks, to create entire production facilities with native NDI across the workflow.

Building an NDI Based Facility

The Challenge

With the numerous benefits offered by NDI compared to traditional video interconnect, some companies are investigating the idea of building a completely NDI Based facility. Whilst the basic point to point interconnect can be easily implemented with NDI, a number of 'glue' type functions which form part of a regular SDI facility need to be implemented in NDI to complete the end to end broadcast chain.

- **Audio Embedding and De Embedding via AES67**
- **ProcAmp type image pre-processors**
- **Up / Down conversion**
- **Bug Insertion**
- **NDI Routing**
- **Many more simple and complex glue functions**

The Solution

In order to provide practical solutions for an NDI based Facility, Sienna have developed the NDI Smart Processing Router infrastructure - a modular, scalable platform for construction of complex processing chains and glue interconnect. It consists of two primary software applications, the NDI Router (detailed in another document), and the NDI Processing Engine.

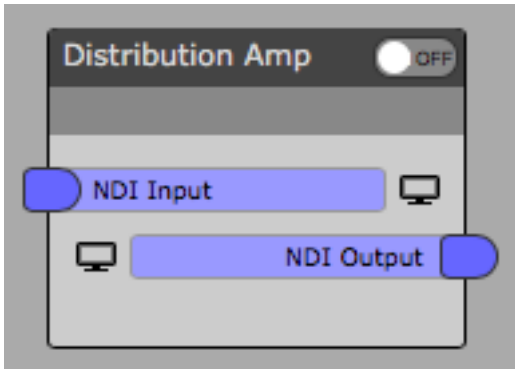
The NDI Processing Engine is a software based engine where NDI based plug-ins can provide both simple and complex modules to be linked together in a graphical layout using a web interface.

The plug in format will be used by Sienna and also by 3rd parties to create modules to fulfil both common and also specialist glue type functions as NDI workflows become more sophisticated.

The engine has been designed to scale from a single computer to a larger blade type engine, where processing modules are offloaded to companion CPUs - allowing the construction of very large processing workflows.

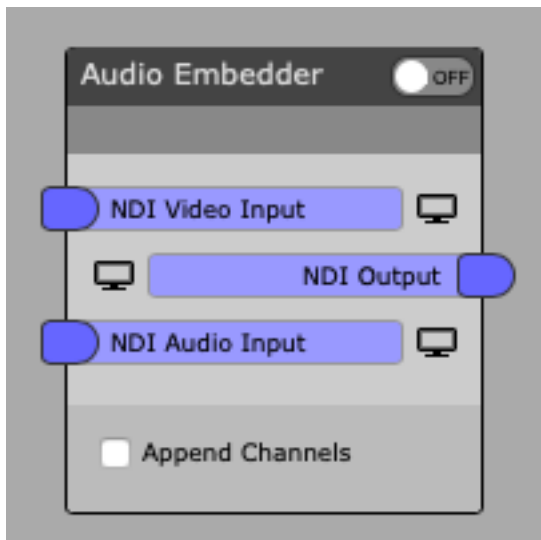
NDI Processing Engine Modules

Over the next few pages you can see some examples of Modules available in the NDI Processing Engine. Many more are available and custom modules can be created to your specification.



Distribution Amplifier

The standard TCP based NDI protocol supports multiple connected receivers. However, each additional receiver adds some load to the source and in some cases it may be appropriate to delegate this extra load to the smart processing router. For this function the NDI Distribution Amplifier was created.



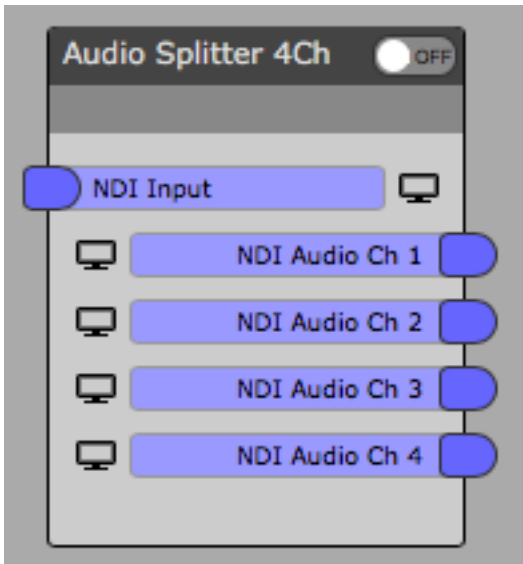
Audio Embedder

Takes an NDI Video Source and another NDI Source, which includes audio. The Audio from the Audio Input is merged with the Video from the Video input to create one Embedded NDI Output. Any audio in the Video Source and Video in the audio Source are discarded. If you check 'Append' the source channels are kept and additional channels added from the secondary input



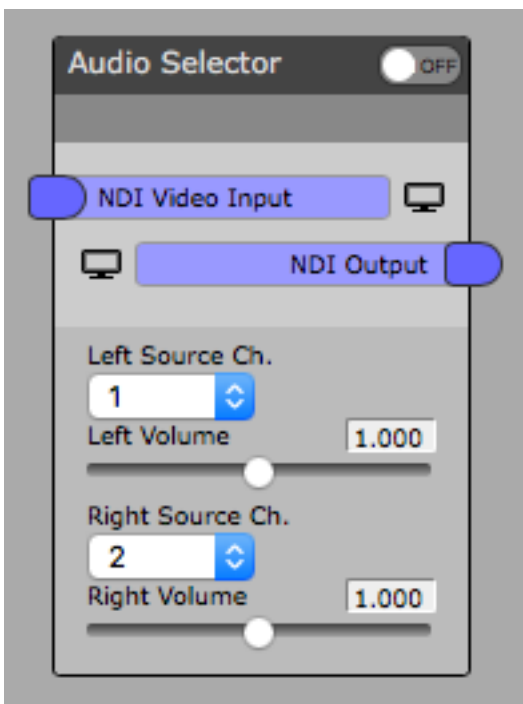
Audio DeEmbedder

Takes an NDI Video and Audio Source. The Audio from the Source is output as a channel multiplexed audio-only NDI Source. Also see: **Audio Splitter**



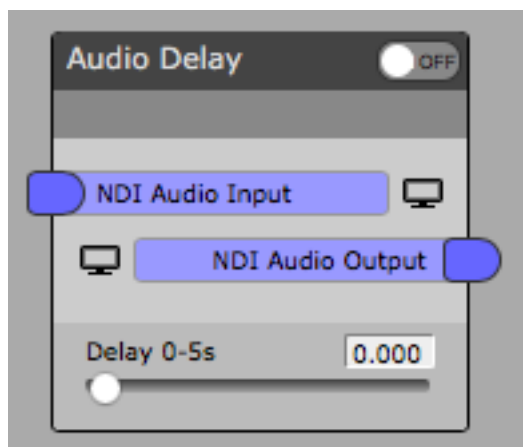
Audio Splitter

This module takes in an NDI Source which has multiple audio channels and breaks them out as individual mono NDI Audio feeds. There are versions for 4 Mono Channels 8 Mono Channels and 4 Stereo Channels.



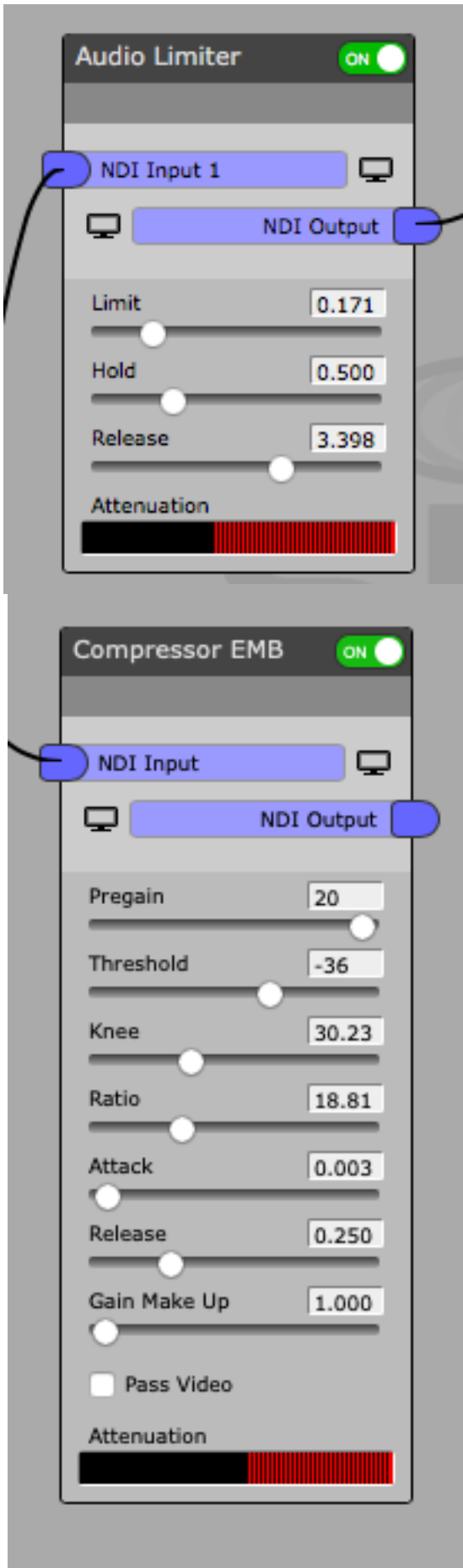
Audio Selector

Takes an NDI Source with Video and Multichannel audio and allows you to select which incoming audio channels you wish to use for the stereo audio and video output stream. Great for foreign language selection from a Stacked multi-language feed. There are 2 channel, 4 Channel and 8 Channel variants.



Audio Delay

Takes an NDI Audio Source and delays it by up to 5 seconds, outputting another NDI Audio Source.

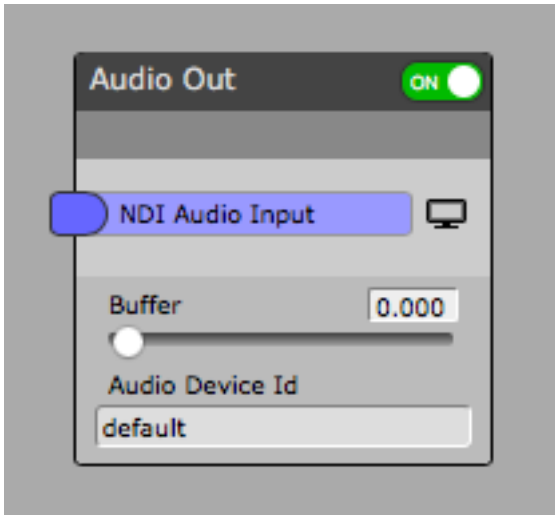


Audio Limiter

This module takes in an NDI Audio Video Source and applies an audio Limiter to the audio channels. Limit threshold, Hold Time and Release Time are configurable, and a real time display shows the level of attenuation applied to the audio.

Audio Compressor

This module provides a fully flexible traditional audio compressor to control dynamics in a source, including maintaining consistent level. There is a meter to monitor current attenuation as you adjust the controls.



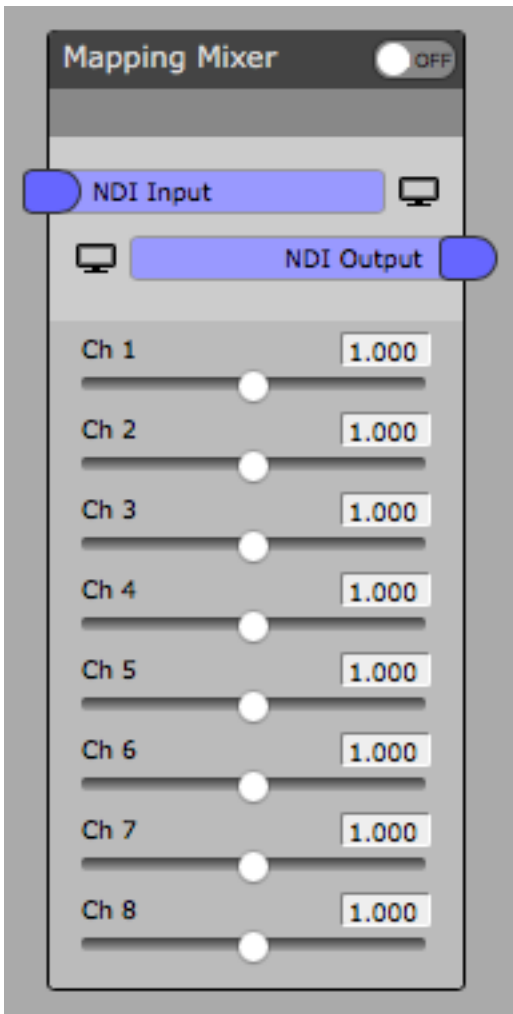
Audio Device Output

This module sends an NDI Audio stream to a system Audio Output Device (supported by libsoundio). This includes CoreAudio devices on macOS, and PulseAudio and ALSA devices on Ubuntu. Supports Virtual Sound Cards for DANTE, AES67 etc where available.



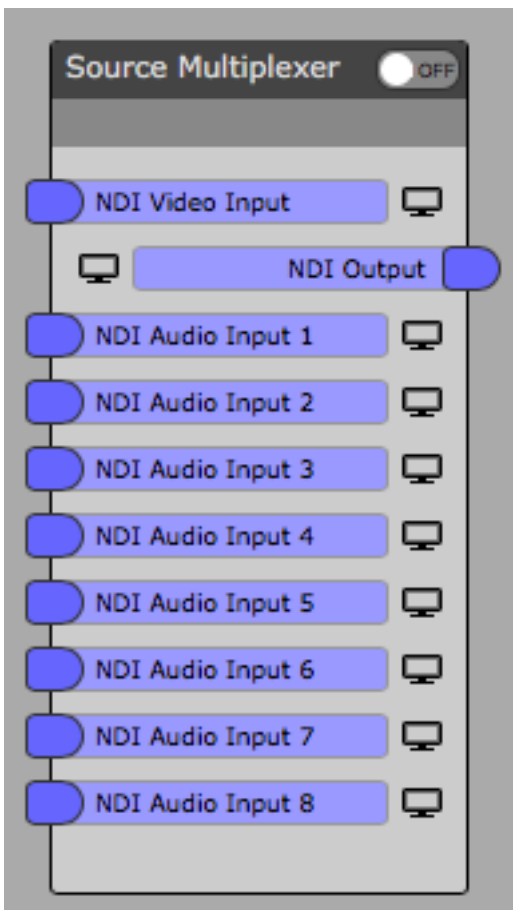
Audio Device Input

This module generates an NDI Audio stream from a system Audio Input Device (supported by libsoundio). This includes CoreAudio devices on macOS, and PulseAudio and ALSA devices on Ubuntu.



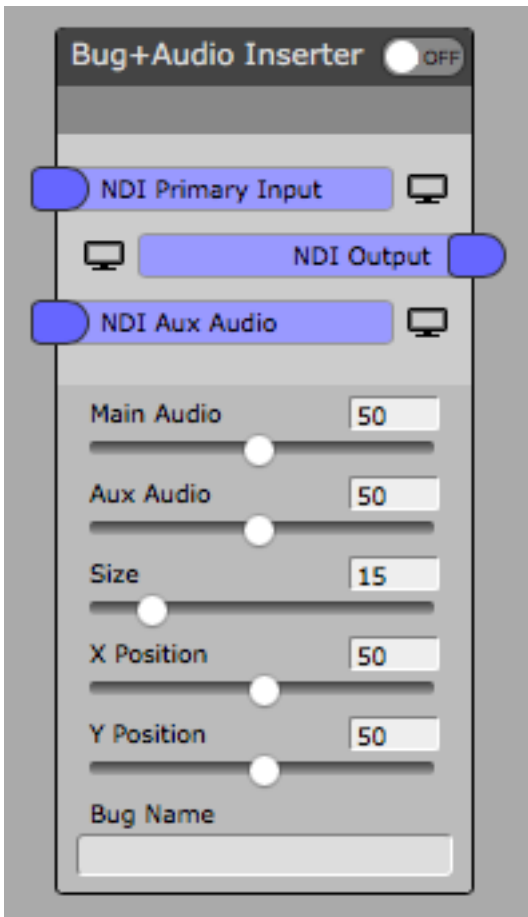
Mapping Mixer

This custom module can be configured to make any mix combination of 10 channels, creating an output mix of 10 channels where a bit map determines which source tracks are included in which destination track. There is a level fader for each input source. The mapping is defined in the XML manifest which wraps the module, customisable for the application.



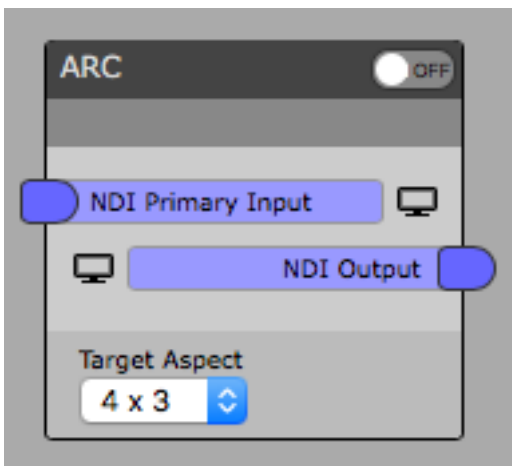
Source Multiplexer

Takes an NDI Video Source and up to 8 mono NDI Audio Sources, then multiplexes them into a single video + 8 ch Audio NDI Stream.



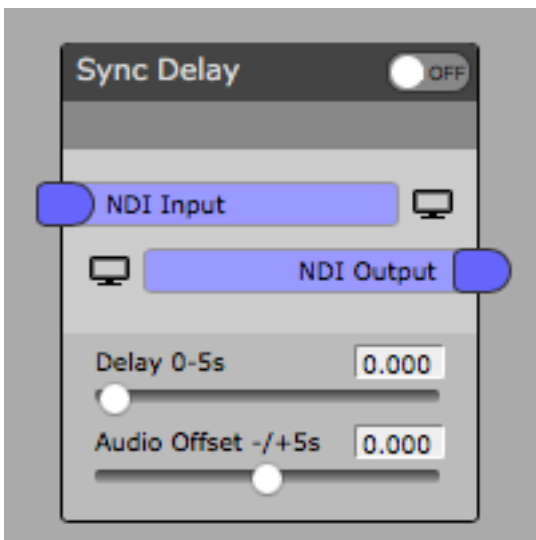
Bug Inserter

This module inserts a PNG file defined bug into the video input source. It can also mix in an auxiliary audio source with the main program audio. Controls allow for positioning and scaling of the bug as well as mixing the audio levels.



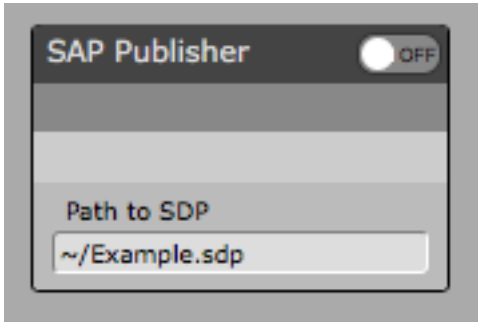
Aspect Ratio Converter

This module overwrites the Aspect ratio metadata in an NDI stream. Its not necessary to actually process the image since this will be done by downstream processes as they respond to the metadata.



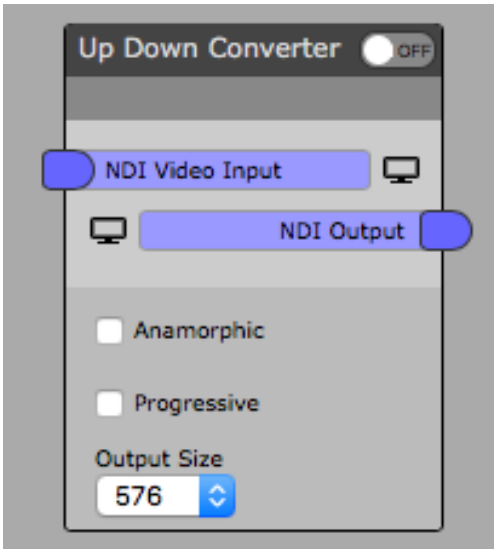
Sync Delay

An audio and video delay with up to 5 seconds additional offset between the 2. Can delay video up to 5 seconds and audio up to 10 seconds, as well as precisely shifting the AV relationship.



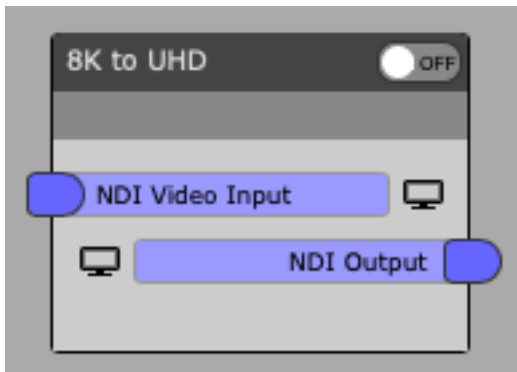
SAP Publisher

Designed to be used in conjunction with one or more IP Streamer modules, this plug in can publish multiple SDP files using SAP announcements to support the streaming feeds produced in other modules.



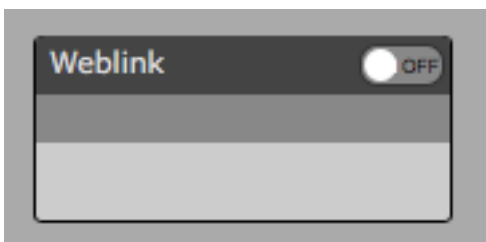
Up Down Converter

A module to scale an NDI stream between common image sizes. The Anamorphic flag can be used to signal that condition for standard definition resolutions, it will also letterbox HD->SD



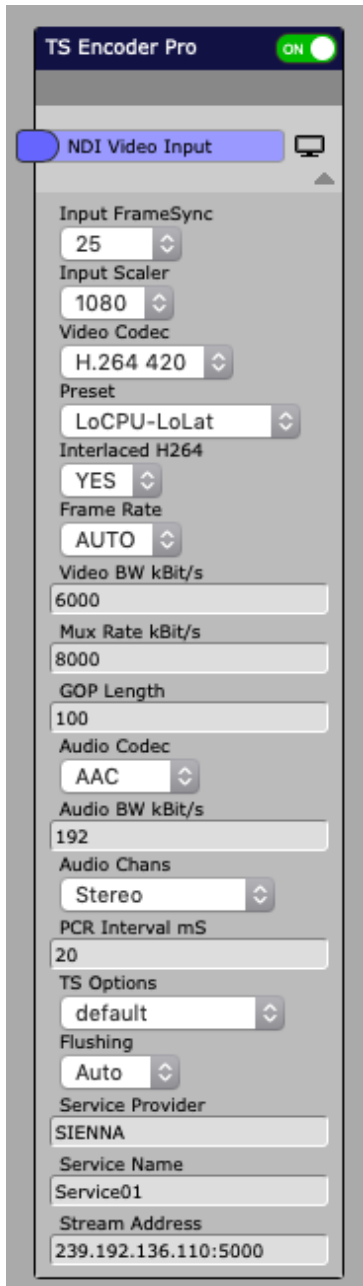
8K to UHD Down Converter

8K workflows are extremely challenging due to the massive data rates involved in the uncompressed domain. To provide a simple downscale from 8K to UHD this module uses a super efficient scaler.



Weblink

A gateway module which provides an NDI to HTML bridge allowing users to click on the 'TV Screen' icons next to modules connections and instantly preview the signal at that point in the chain in a pop out HTML window



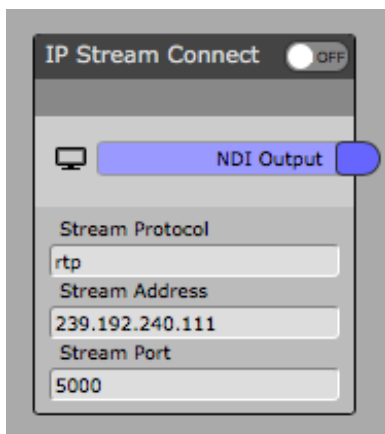
TS Encoder Pro

The ND Processing Engine has a number of different modules which output an NDI Source using traditional UDP transport stream (along with modules for other formats such as RTMP). The TS Encoder Pro combines the majority of common options in a single module, including codec, rates, and metadata.

This module includes an input frame sync to ensure a steady incoming stream to drive the transport stream encoder, and a scalar to normalise stream dimensions (nb. does not handle changing source dimensions during streaming). TS Options include the ability to set System B for DVB streams.

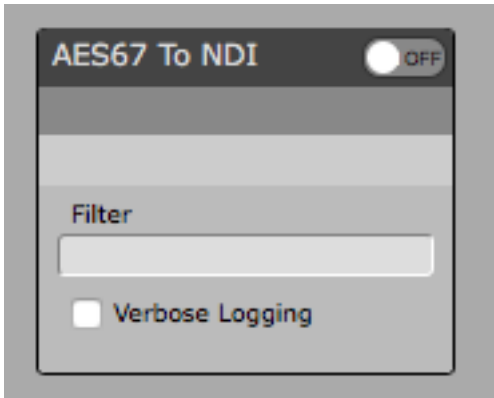
A variety of other “UDP Streamer” modules offer simpler preset configurations, also available as an RTP streamer.

If necessary, it's possible to create even more specific settings using a custom manifest.



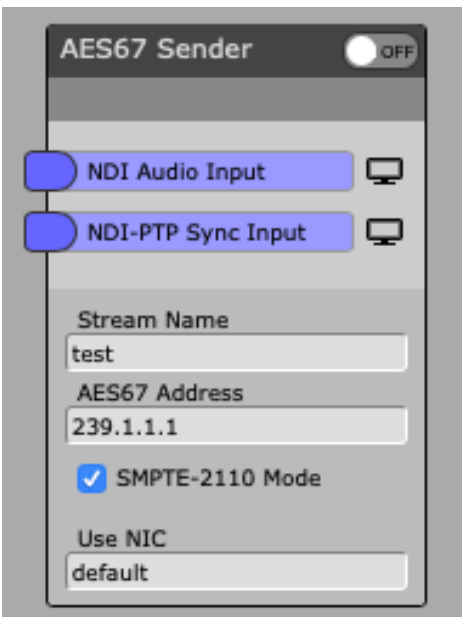
IP Stream Connect

The ND Processing Engine has a number of different modules to ingest IP Streams and convert into NDI for onward processing. A variety of formats including RTP, RTSP, RTMP, HLS, HTTP and UDP are supported. Other specific variants exist to support things like TeraDek receivers with timeout parameters. Also see UDP Stream Connect, IP Connect v2, and IP Connect v4



AES67 to NDI

A gateway module which automatically creates an NDI Audio stream for every AES67 Stream found via SAP announcements. An XML filter can restrict the sources to be converted.

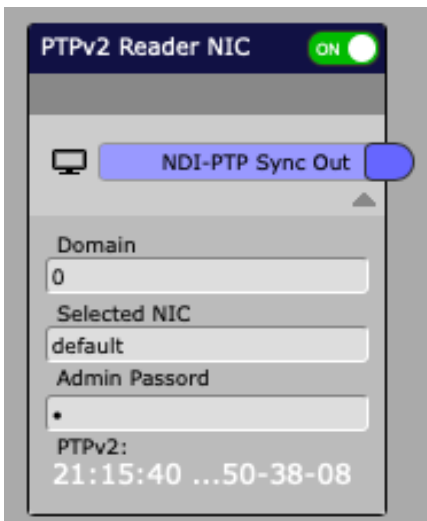


AES67 Sender

This module generates an AES67 stream for the connected NDI Source, using the multicast address and stream name. It also advertises the stream using an SAP announcement.

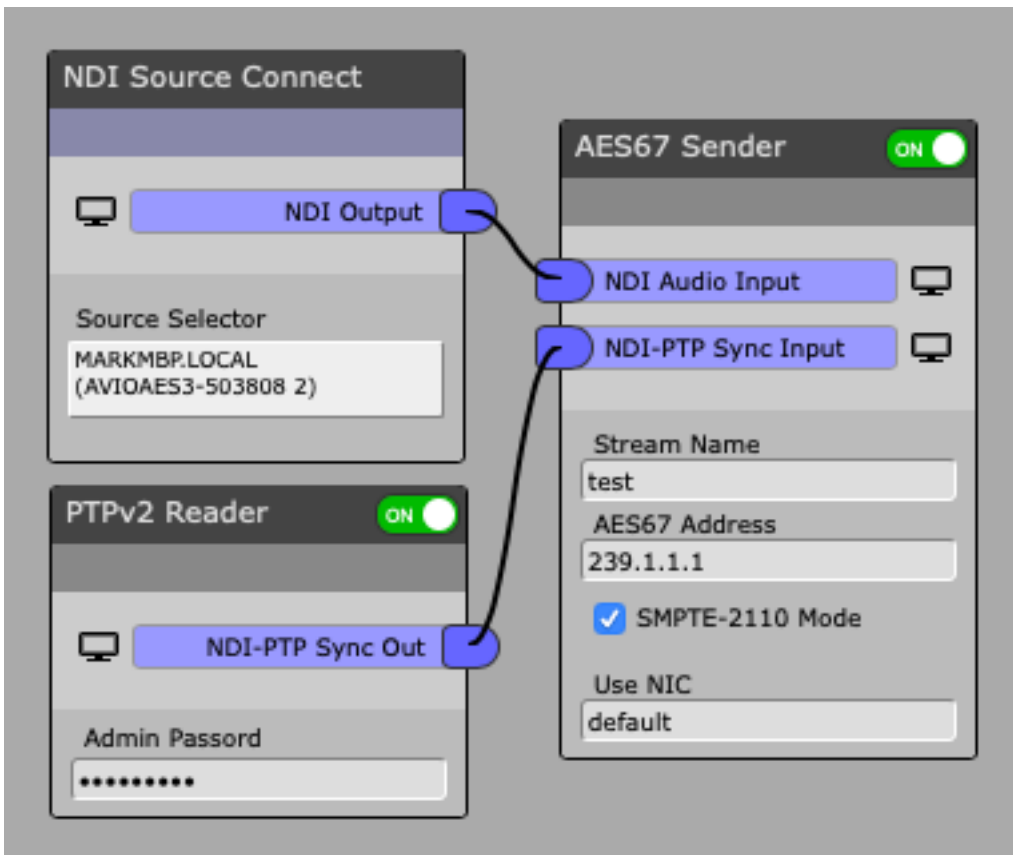
Important Note: The PTPv2 clock advertised by this module by default is “traceable” - ie. it does not reference a specific PTPv2 GMID. Many AES67 receivers will support this, some may require setting of the ‘Syntonous’ Mode.

NB: DANTE devices do NOT currently support traceable clock or syntonous mode, and so additional configuration is required send AES67 to Dante devices. It requires the use of the PTPv2 reader and a network GMID. See below



PTPv2 Reader

This module extracts PTPv2 time from the network and converts to NDI-PTP format which can be fed into AES67 Sender and other modules requiring PTPv2 GMID and Clock. It provides the GMID to label the clock, as well as a series of time messages which defined the clock itself. The current GMID and recent PTPv2 time is shown in the module.



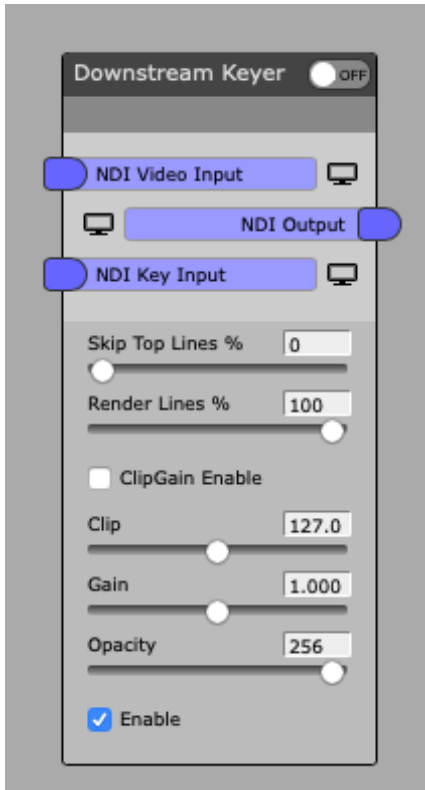
NDI to DANTE operations.

In order to send NDI to DANTE devices, there are several pre-requisites. Firstly the DANTE devices must be configured to support AES67 mode.

Next you must have an existing PTPv2 master clock source on the network.

Now, insert a PTPv2 Reader module and enter the system admin password, which is required since PTPv2 Reader must open a privileged UDP port to read PTPv2.

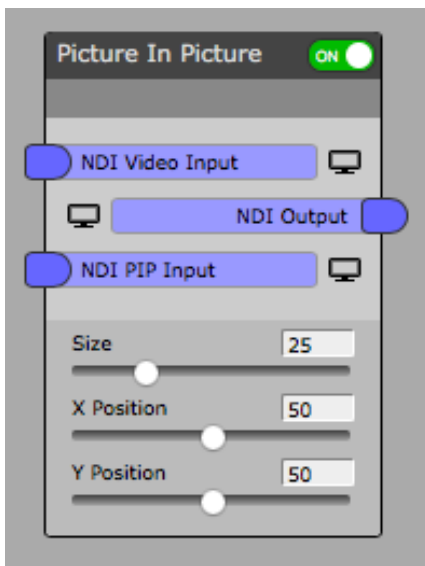
Connect up the NDI Source and the PTPv2 Reader Module as shown, and check SMPTE-2110 mode. Enter a name for the stream and turn it on. Now you should see that source appear after 10-20 seconds in Dante Controller as an AES67 stream you can route to your chosen DANTE hardware device.



Downstream Key

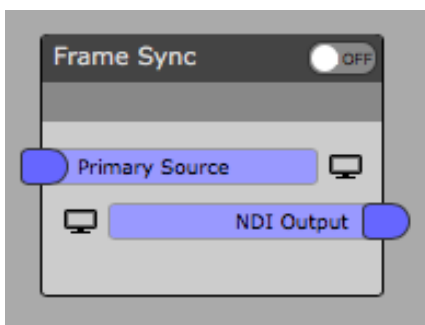
This module keys an NDI stream with alpha on top of another NDI Input, with opacity control and an on/off switch. It's also possible to skip the top percent of lines, and only render a percent of subsequent lines, for more efficient keying where only a lower third or a top strap or bug is required.

The ClipGain mode deviates from straight alpha to allow for modification of the keying maths.



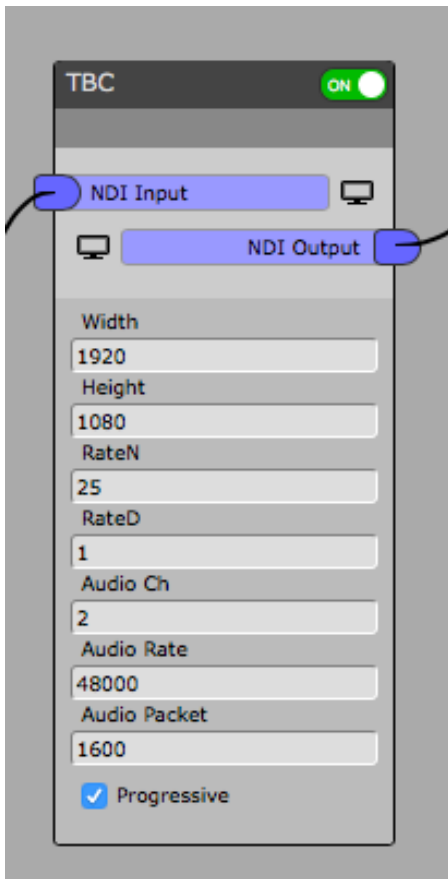
Picture in Picture

This module superimposes an NDI stream as a scalable and positionable picture in picture of another NDI Input.



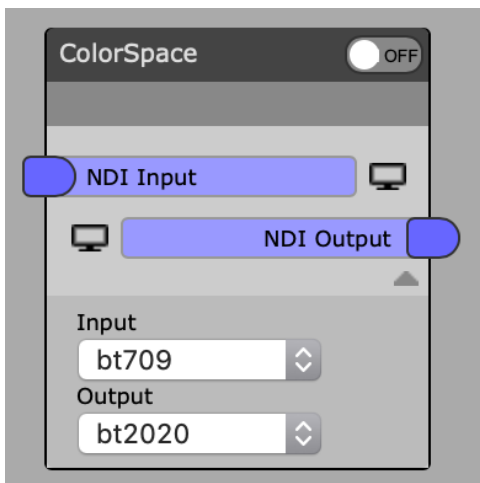
Frame Synchroniser

This module smooths out an incoming NDI stream, enforcing a jitter-free video, and continuous audio at the correct sample rate. Can be used to tidy up jittery NDI sources. For more serious format challenges, use the TimeBase Corrector.



TimeBase Corrector

This module smooths out an incoming NDI stream, enforcing a jitter-free video, and continuous audio at the specific rates and formats. Can be used to tidy up jittery NDI sources and enforce format. If the incoming source is the incorrect size, the TBC will output black at the correct size. Otherwise it will even out and conform incoming video and output a consistent format and rate regardless of incoming issues.



ColorSpace Converter

This module provides colourspace conversion between:

- bt470m
- bt470bg
- bt601-6-525
- bt601-6-625
- bt709
- smpte170m
- smpte240m
- bt2020

RTMP Tools

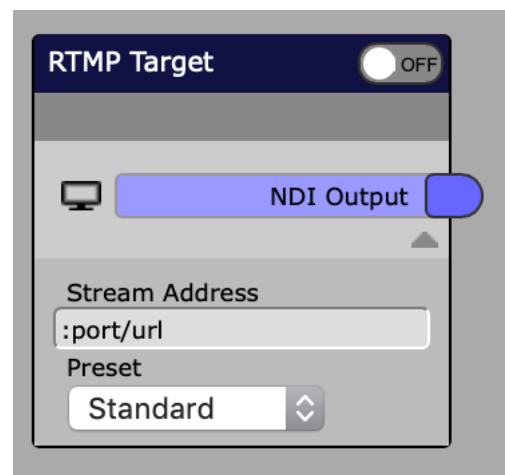
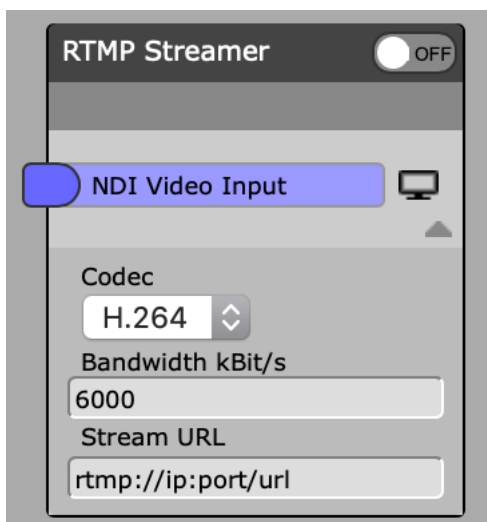
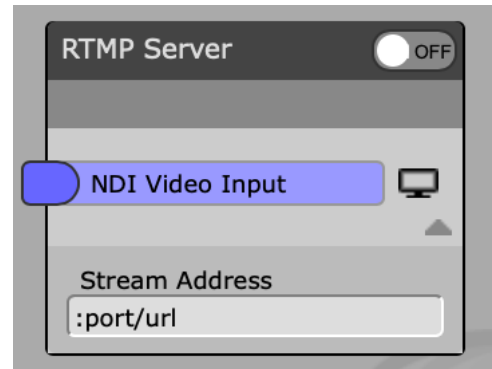
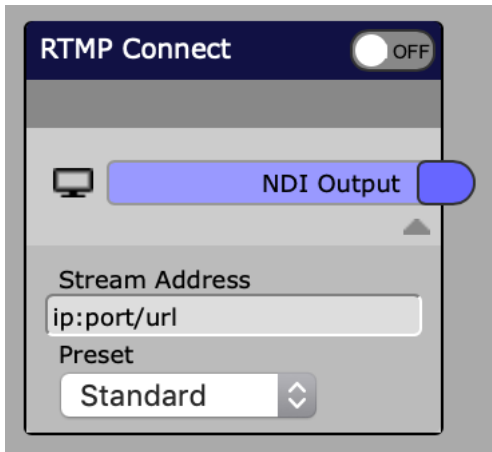
A Full range of RTMP clients and servers for all combinations of streams.

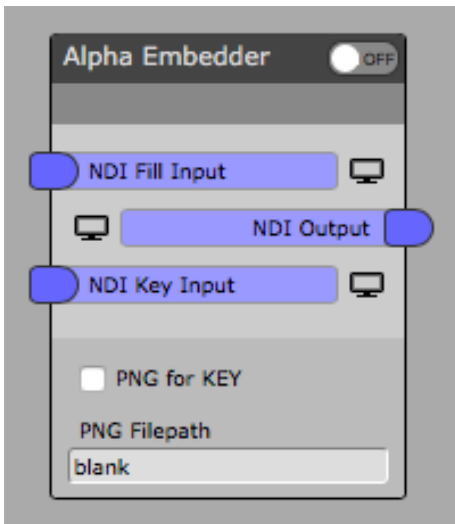
RTMP Connect will connect to a remote RTMP Server in a PULL method, outputting NDI.

RTMP Server provides an NDI Encoding service which a tool like RTMP Connect can pull from.

RTMP Streamer pushes an encoded NDI stream into a target system like YouTube

RTMP Target provides a push to server similar to YouTube, outputting NDI.

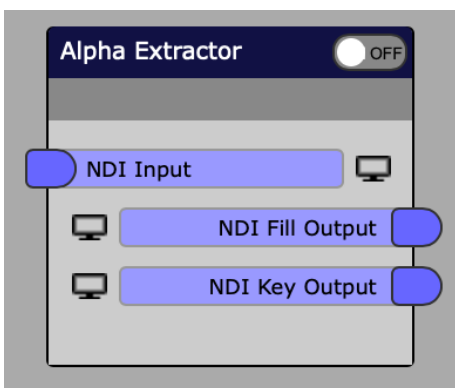




Alpha Embedder

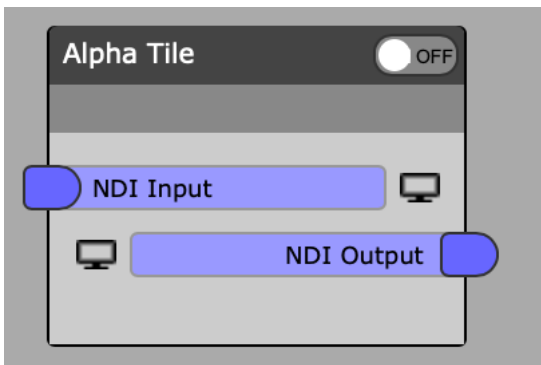
This module embeds an alpha channel into an NDI Stream, where the alpha channel comes as the Picture (not Alpha) - from either another NDI stream, or from the image data (not alpha) of a PNG file.

This is useful for combining Fill and Key from SDI Streams, or for creating masks on other NDI Sources.



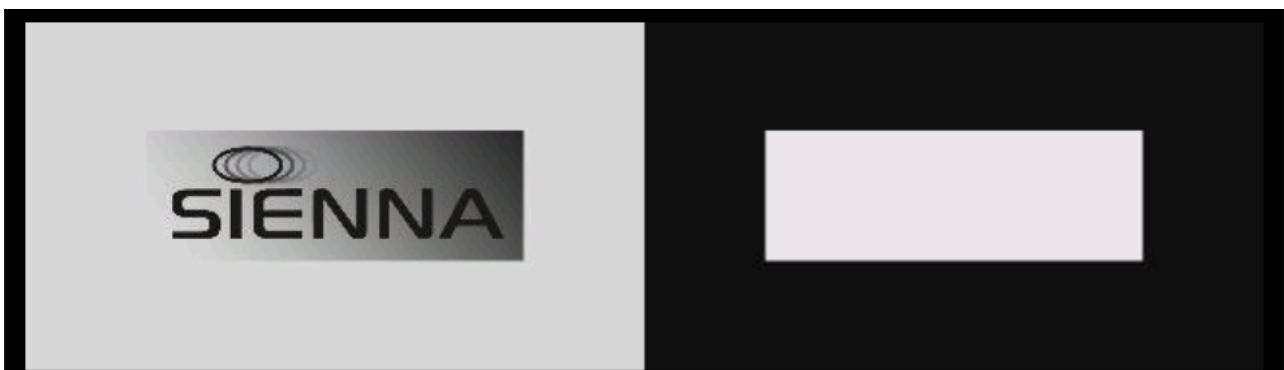
Alpha Extractor

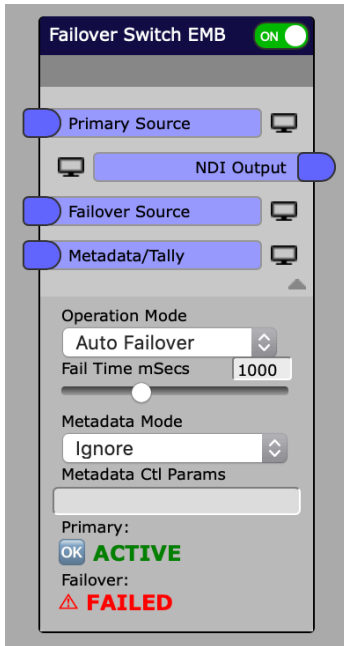
This module delivers a discreet NDI stream for the fill and key channels of the source, each as a standard non alpha stream.



Alpha Tile

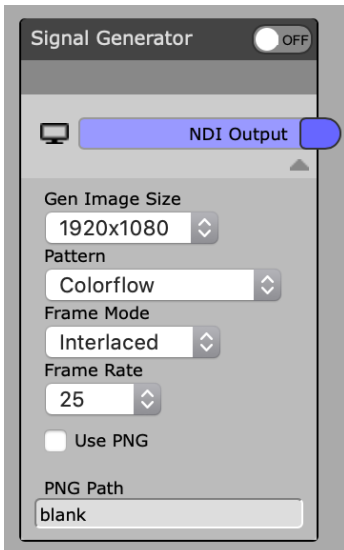
This module tiles Fill and Key into a monitoring output where you can easily view both streams alongside each other





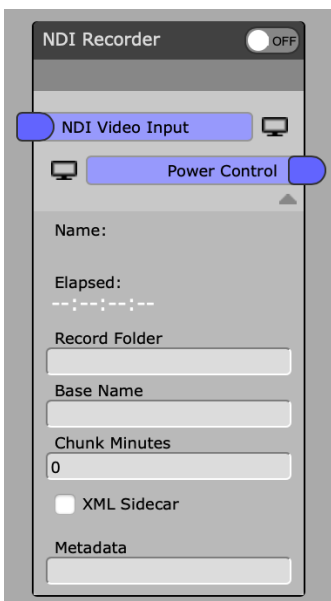
Failover Switch

This module passes through and monitors the primary NDI Source, and should it fail to present frames within a controllable fail time, it will switch output over to the failover NDI source. If the primary subsequently returns it will fail back again. You can also manually failover and link to another failover module for cross links, since it will emit failover status to drive secondary actions. The module can also be driven by NDI Metadata messages such as NDI:GPI



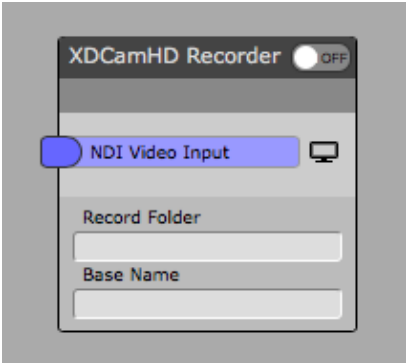
Signal Generator

This module generates a color flow test pattern in a wide range of sizes, frame rates and frame types. It also allows for rendering of a PNG file as an NDI Stream, with alpha channel if the PNG file includes one.



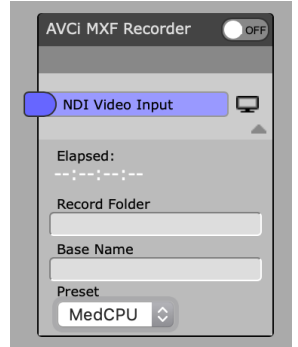
Native NDI 4 Recorder

This module uses NDI4 native recording to capture NDI Streams in their source essence (with no transcoding) into growing movie files which can be edited during capture with Adobe Premiere Pro. This module is *extremely* efficient and consumes no significant CPU power - allowing for very high scalability for recording. The Power Control output is to link to automation systems like the Sense Destination or Motion Detection modules.

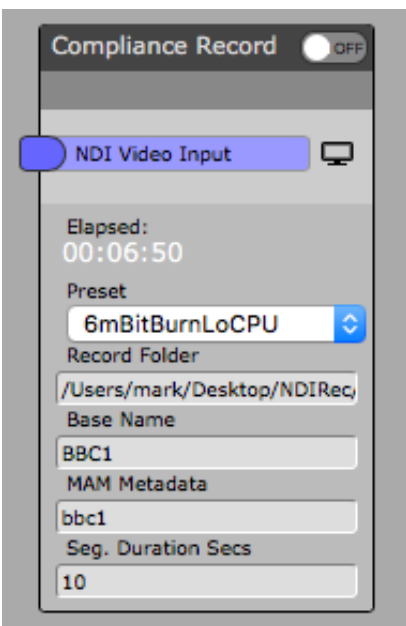


MXF Recorder

This module captures an NDI stream into a growing MXF File with XDCamHD 50 essence which can be used for edit-during-capture operations using NLE systems like Adobe Premiere Pro. A folder and base name are appended with Date and Time of recording.



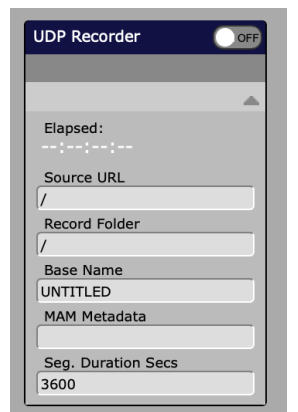
Other versions support AVCI and MPEG2 MXF recording as well as an XDCam HD recorder which breaks off in chunks.



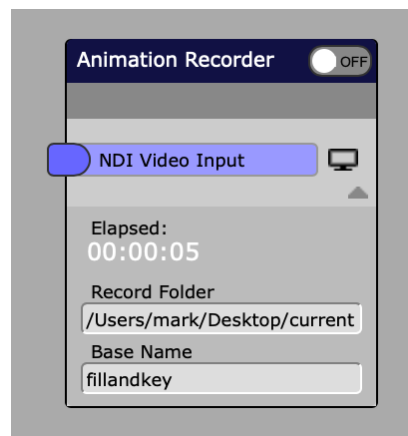
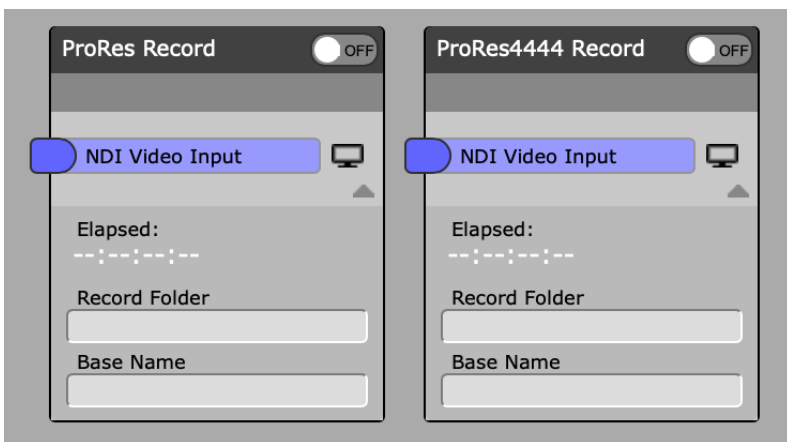
Compliance Recorder

This module captures an NDI stream into an MP4/AAC file, using chunked recording. Set the duration of each chunk segment, enter path and metadata, and pick from the list of format presets. Records 24/7 into files, with date time burn in and file naming, plus MAM checkin script.

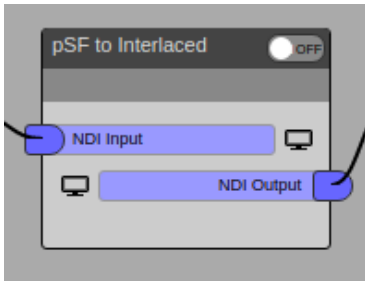
A second version of this module takes in a native UDP mpeg transport stream and performs the same functionality (without window burn option). The UDP version of the compliance recorder module performs native trans wrapping of the H.264 source media, and is hence



extremely CPU efficient.



Other QuickTime Movie recorders can capture into ProRes, including 4444 with alpha, or Animation codec with Alpha

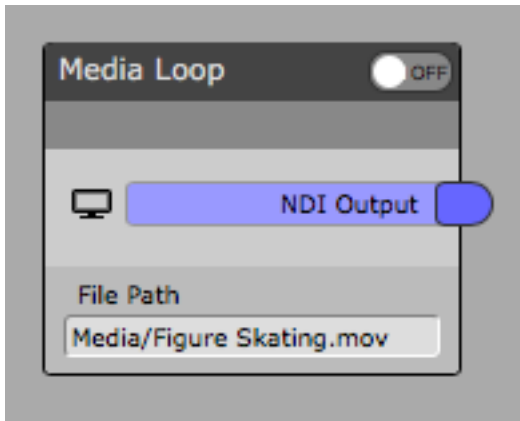
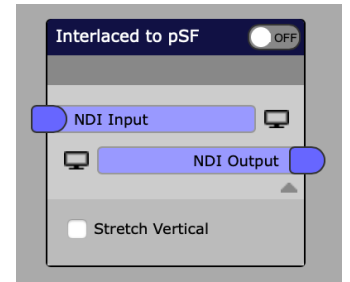


pSF to Interlaced

This module is designed to resolve issues commonly seen with HEVC workflows which do not natively support interlaced video. It takes a half-height, double rate image (eg 1920x540@50p), typically derived from a

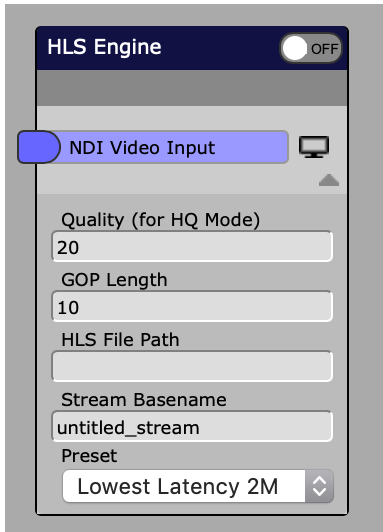
converted HEVC stream and converts it to a full height, interlaced stream (eg 1080/50i). Another module does the opposite.

A 3rd module. Progressive to Interlaced converts 1080p50 or p60 into 1080i50 or 1080i30 by taking alternate lines from alternative progressive frames to make interlaced fields. This preserves more of the motion between progressive frames compared to simply ignoring alternate progressive frames altogether.



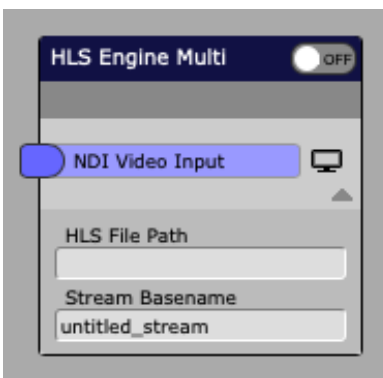
Media Players

Three modules plays a variety of standard media files as a looping NDI audio video source or a one-shot audio and video source or an audio only source.



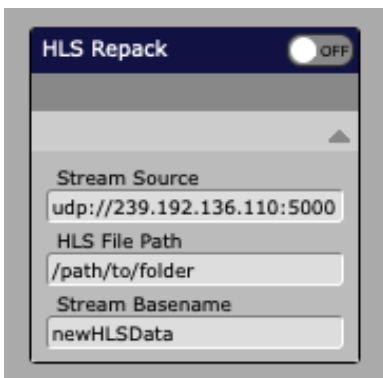
HLS Engine

This module creates a standard (10 second) or low latency (2-3 second) Apple HLS stream (HTTP Live Streaming) which is compatible with a wide range of viewers including most modern web browsers. The Engine dynamically creates the .ts segments and the dynamically updating live .m3u8 manifest, including chunk cleanup. These files are then served up to consumers with your choice of web server such as Apache or Nginx.



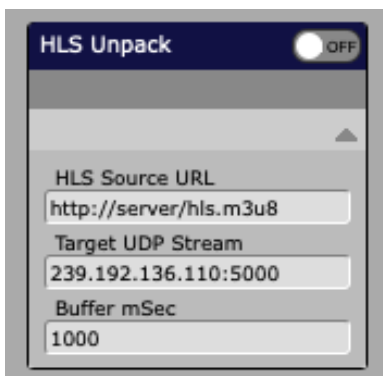
HLS Engine Multi

This module creates an HLS multi-resolution Stack using settings from the XML Manifest. It includes three different HLS resolutions / data rates which a downstream HLS viewer can automatically jump between based on network conditions



HLS Repack

This module takes an existing UDP TS and repack as HLS segments on storage for your web server to deliver to viewers. Since there is no re-encoding of the data, this is a very efficient module.



HLS Unpack

This module takes an existing HLS stream and unpacks it into a constant UDP MPEG Transport stream. Since there is no re-encoding of the data, this is a very efficient module

HLS Conversion

Several modules including IPConnect v2 and v4 can convert HLS to NDI

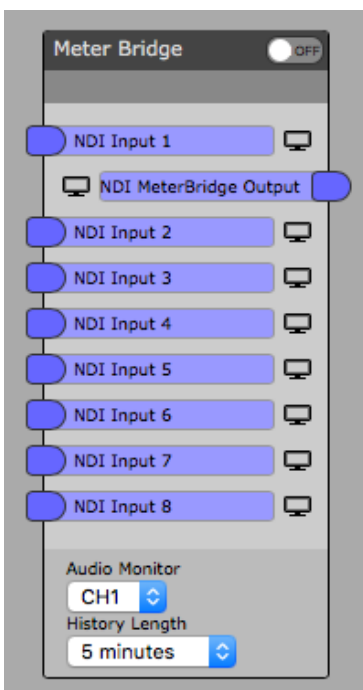
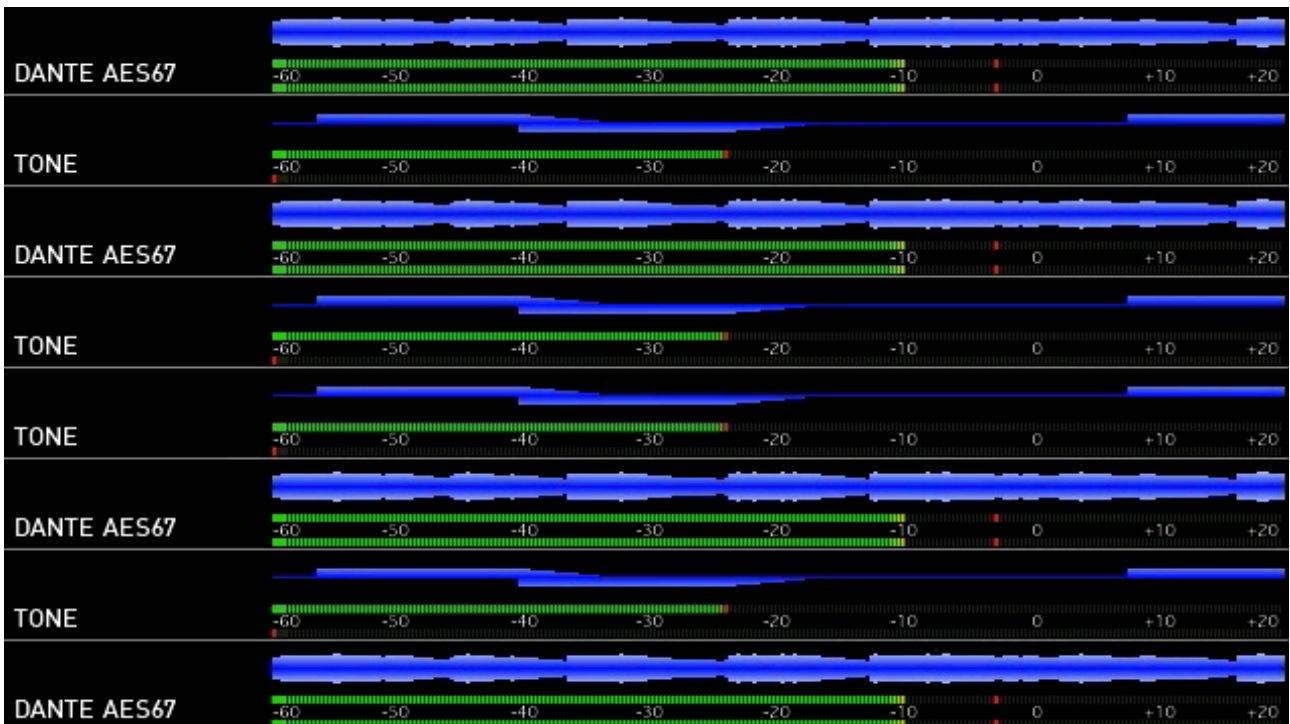
Multiviewers

The NDI Processing Engine offers 5 sizes of multiviewer module which can be combined to create larger multiviewers. The Pro versions include overlaid audio meters, tally indicators and under monitor labels. Each multiviewer outputs an NDI Stream, 1280x720 for 2x2 and 1920x1080 for the other sizes. For the 2x2, additional versions output FHD and UHD. An 18-way UHD multiviewer also has a section for status and tally driven by another module. Multiviewer labels can be driven by TSL_UMD messages, and other NDI metadata such as contribution metadata from UNITE. Multiviewers also respond to video / audio freeze alarm conditions with overlays

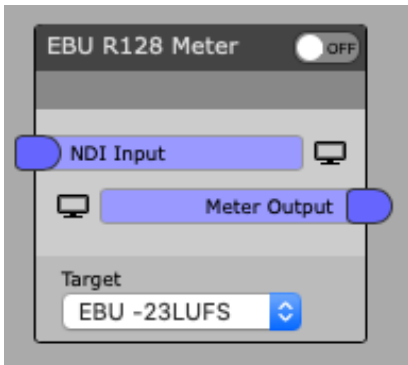


MeterBridge

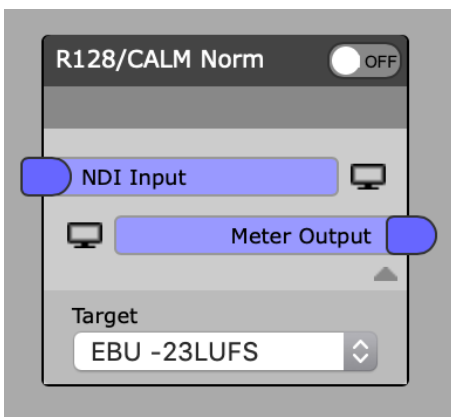
The Audio Meterbridge module offers 8 channels of stereo audio monitoring in a single NDI output (640x360) which can be merged into larger Multiviewer displays. Apart from highly responsive PPM audio meters (SMPTE dBVu) the meterbridge offers a unique level 'history' trace which provides at-a-glance indication of audio activity over time, without watching meters constantly. Each channel can be labelled.



EBU R128 / CALM Loudness Meter

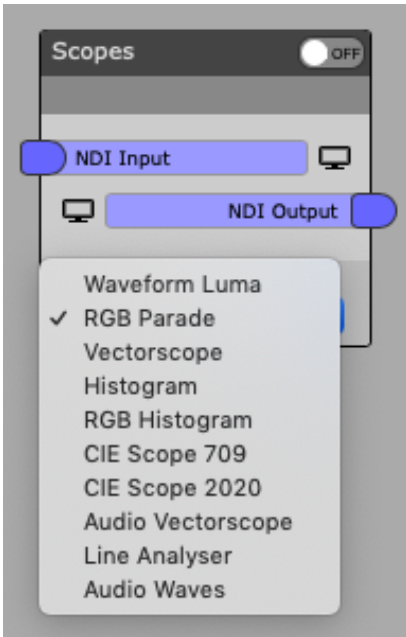


This module provides time based monitoring of audio level using the EBU R128 standard. EBU Level -23 LUFS or Online Level -16 LUFS can be selected as the target for the metering. This could possibly also be used for US CALM monitoring with -24 LUFS



EBU R128 / CALM Normaliser

This module imposes gentle normalisation on streams to enforce R128 / CALM levels.

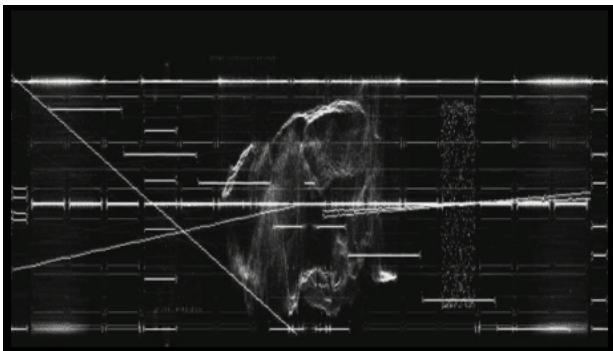
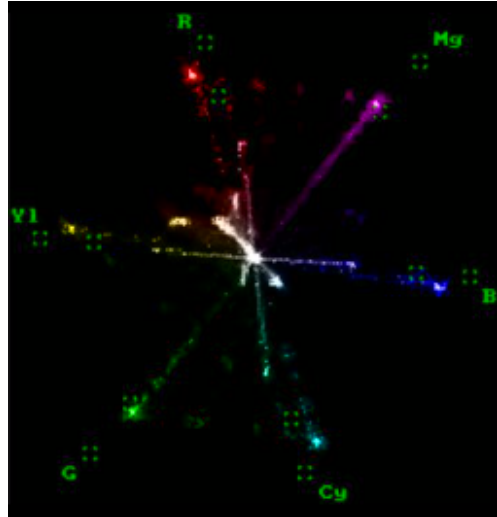


Scopes

This module provides a number of test analysis displays. These can be combined with a multiviewer.

Vectorscope

is a traditional color vector scope for evaluating chroma.

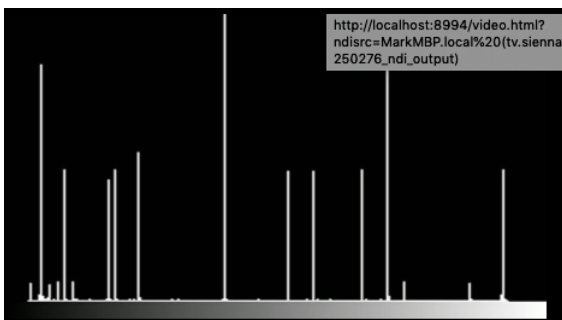
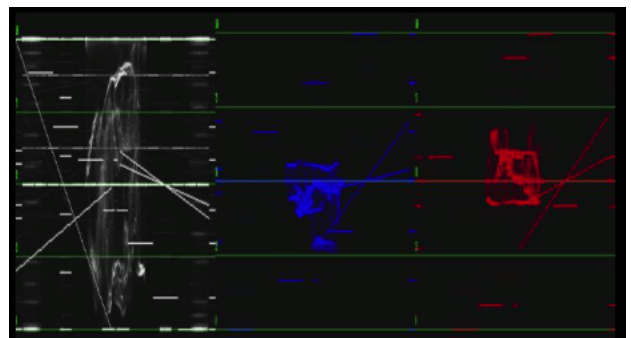


Waveform Luma

This module is a traditional Luma scan analyser

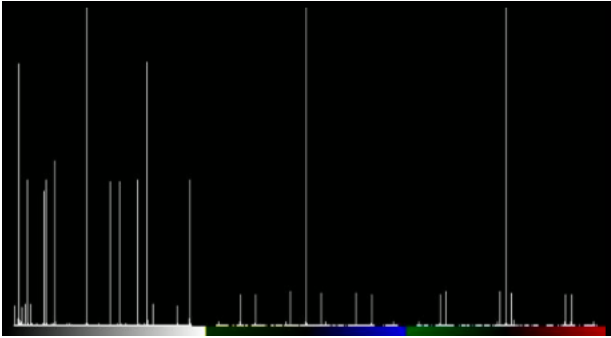
RGB Parade

This module is a traditional RGB Parade display



Histogram

A traditional Luma Histogram



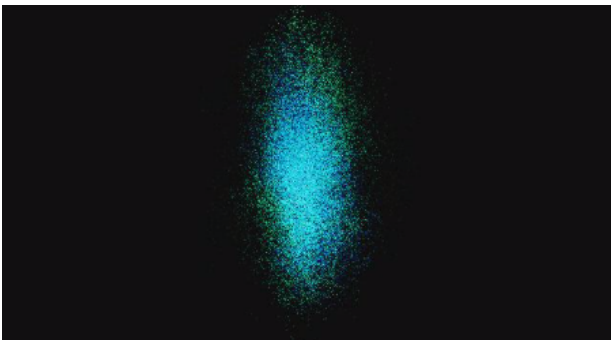
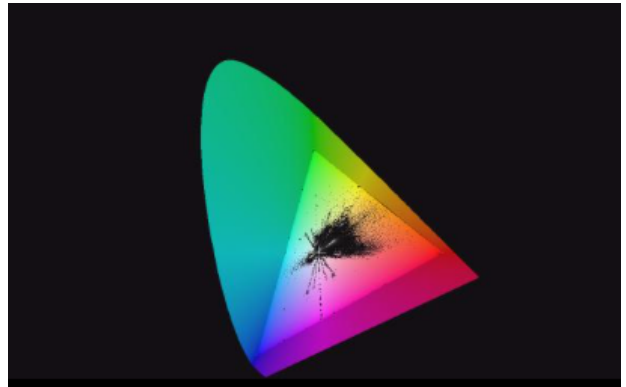
RGB Histogram

An RGB Histogram

CIE Scope

A representation of color spread.

Two versions are available to support 709 and 2020 color spaces.

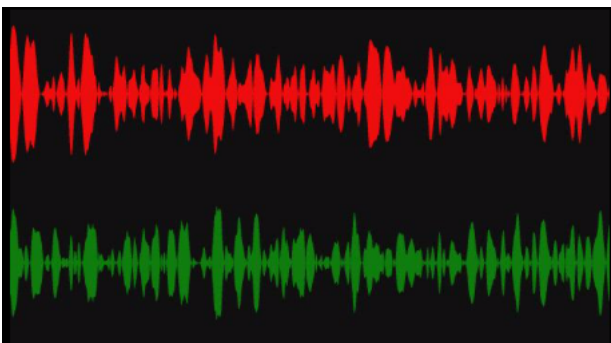


Audio Vectorscope

Displays phase and channel energy

Line Analyser

Displays signal levels across a single line through the middle of the picture.



Audio Waveform

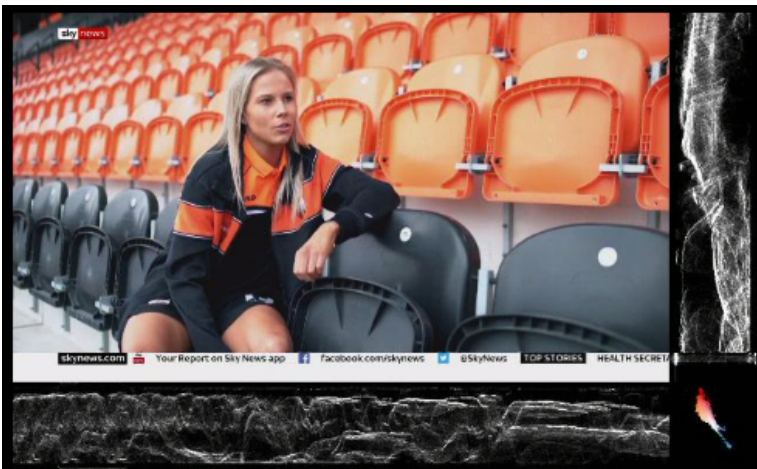
Multichannel audio oscilloscope type display.



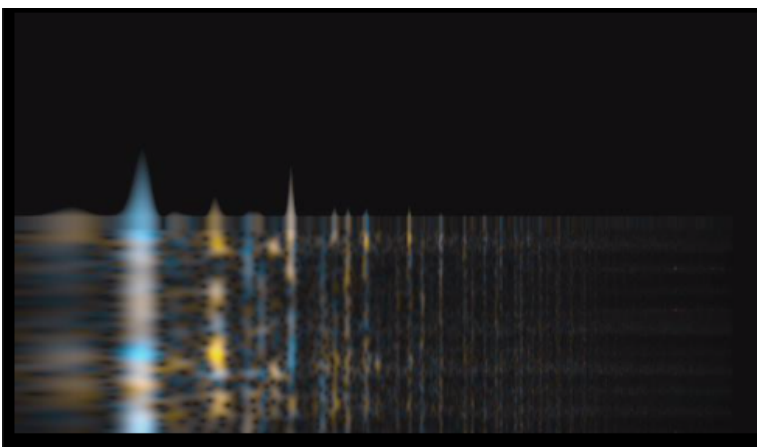
RGB Quad



Histogram Combo



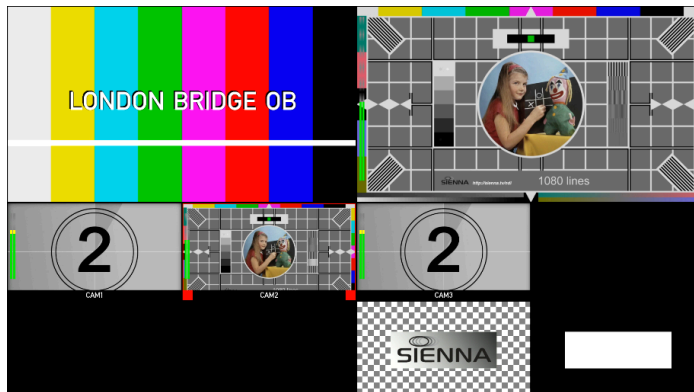
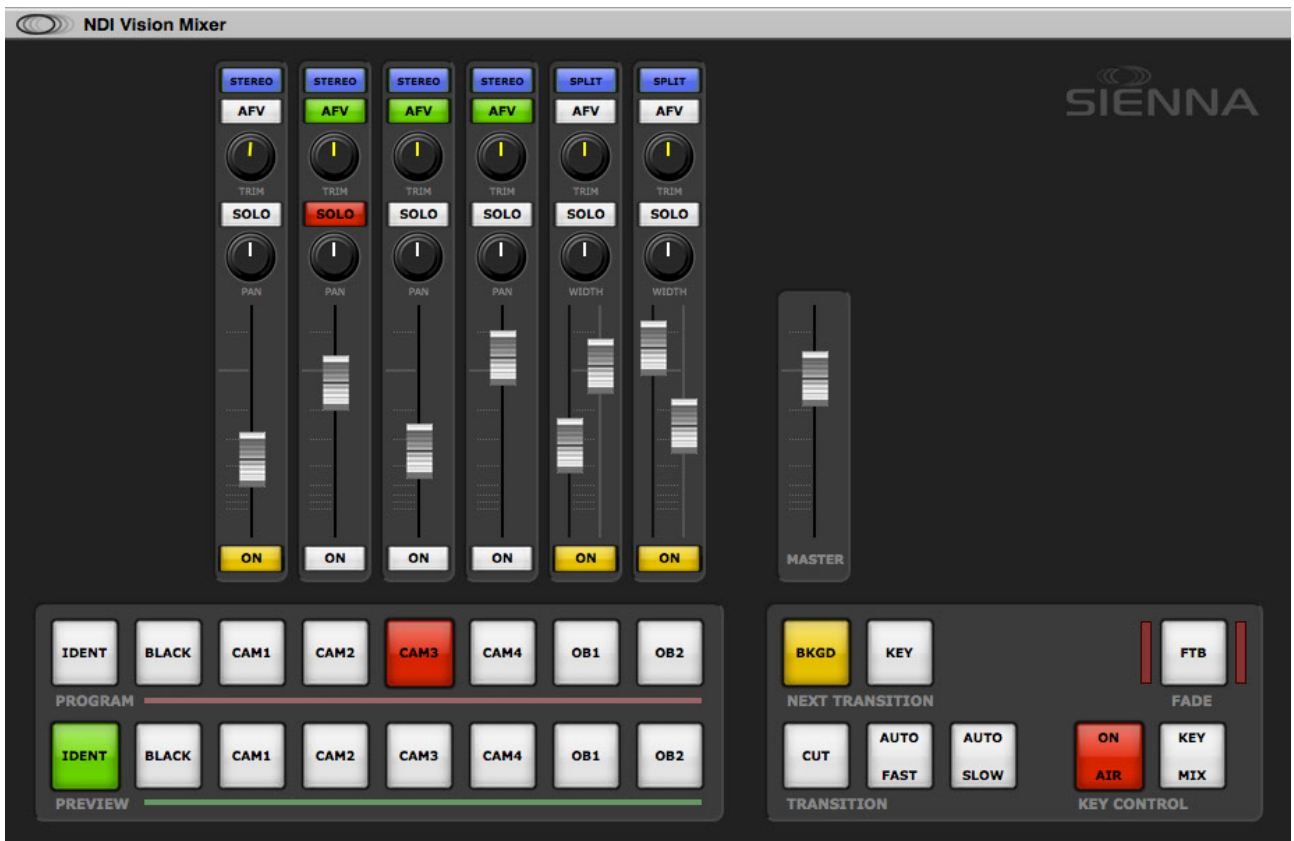
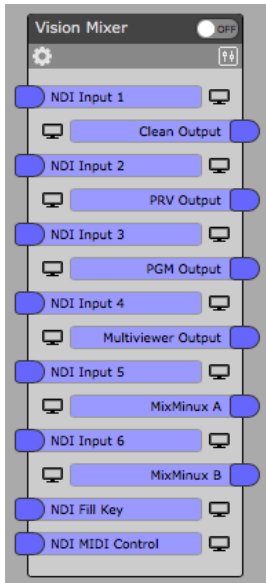
VectorScope Combo



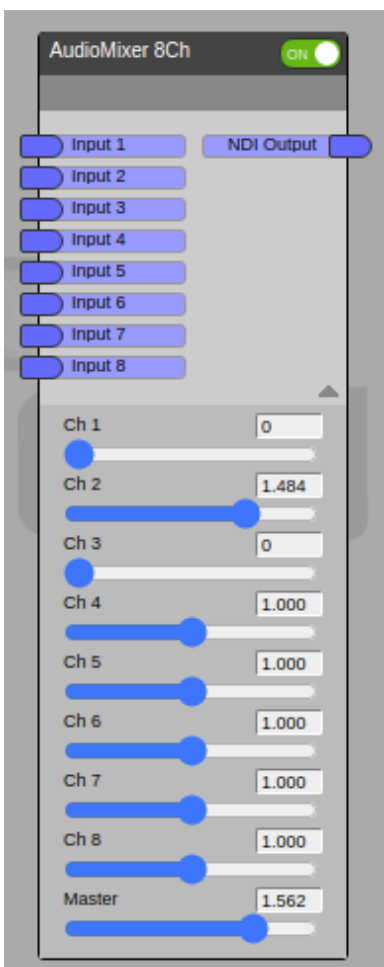
Sonogram

Vision Mixer

The NDI Vision Mixer Module provides a compact but fully functional vision mixer which can be run locally or in the cloud. It has 6 main NDI inputs plus one NDI Fill and Key input for DSK overlay. It also has a multiviewer with audio meters, labels and tally, and a flexible audio mixer with AFV, Solo (PFL) and Mix Minus. it can also generate an Ident slate with user defined text. Supports external control surfaces local or remote, including JLCooper ION and Behringer X-Touch Mini, X-Touch Extender / MackieControl. Also supports NDI MIDI Control. The latest version includes audio metering in each channel strip.

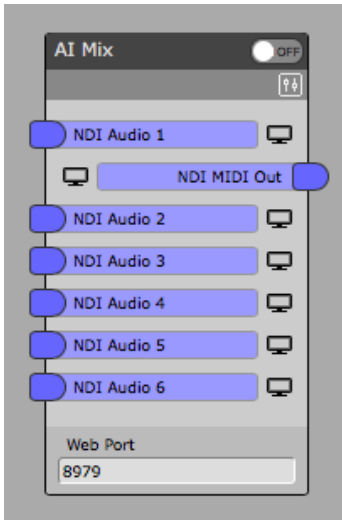


Audio Mixers



There are 2 types of Audio Mixer Modules, one is derived from the Vision Mixer, with a rich Web Based display, Panning, PFL metering etc, and with control options including Behringer XTouch Extender. This module provides 6 source channels.

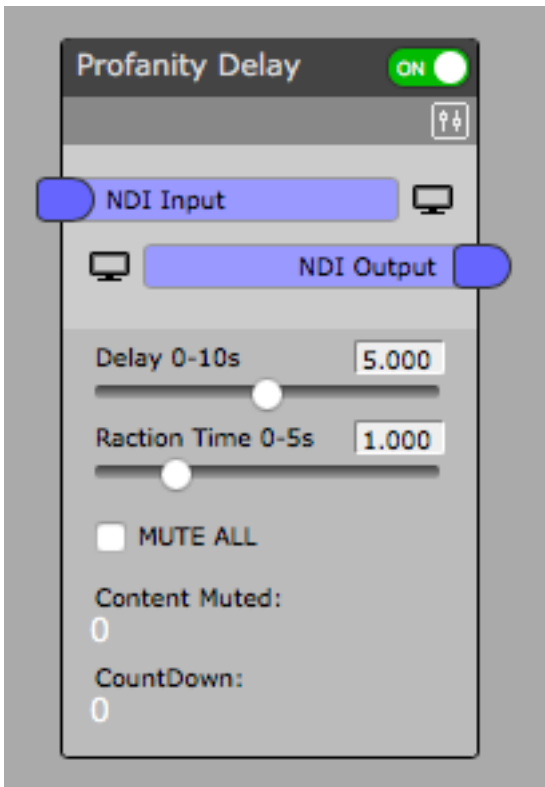
The other module is simpler with an on screen slider for each audio level and a master. This simpler engine could be expanded to support mode channels in the future if required.



AI Mix

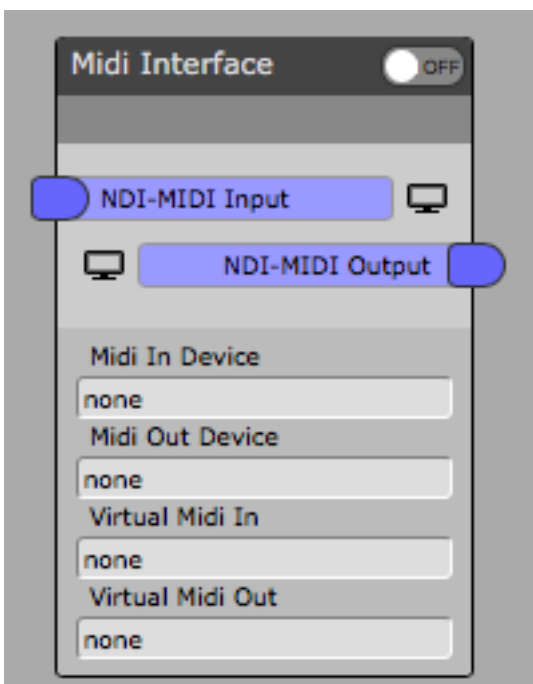
This powerful module provides automated “Video Follows Audio” control to drive the NDI Vision Mixer module (or other devices). It uses artificial intelligence and user defined rules to analyse up to 6 audio sources and use their level activity to make vision mixing decisions, output as NDI MIDI.





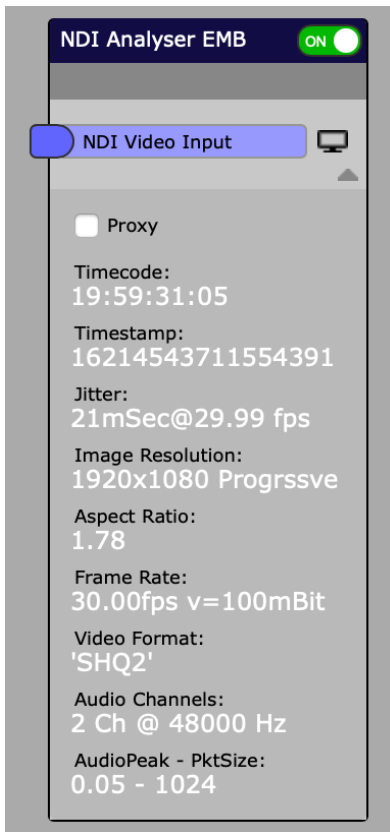
Profanity Delay

The Profanity Delay module allows for reaction-compensated muting of audio and video on a delay. This module also has a mini HTML web interface which provides a 'big button' experience and can also be easily customised. When hitting the MUTE button, that time is compensated by the reaction time parameter, and muting of the output is scheduled. A countdown timer provides clear indication of what will happen and when. Once the 'moment' has passed, the operator releases the MUTE button and once again the video unmutes after the appropriate countdown.



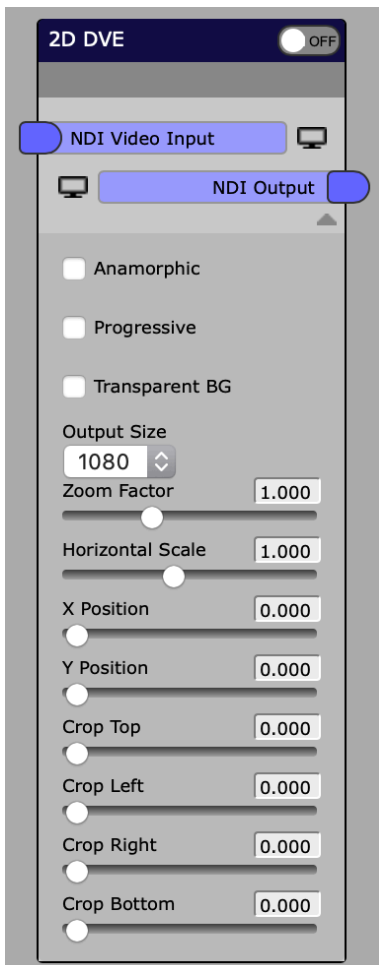
Midi Interface

The Midi Interface module implements the NDI-MIDI standard to read from a local MIDI device and embed the Midi data into NDI Metadata. It also does the reverse. The NDI-MIDI Output can also feed MIDI back to the module midi out. NDI-MIDI can be fed to compatible processing modules, or out to the Midi Out Module. The NDI intermediate signal can also run via Sienna.Cloud. Real and Virtual MIDI input and output ports are supported.



NDI Analyser

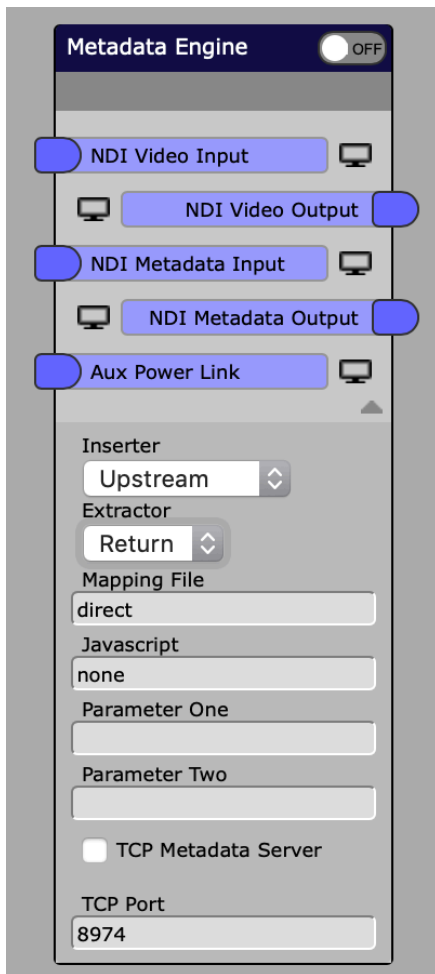
This module provides status information for the NDI stream connected into it. Information such as timecode, image geometry and audio format is displayed, along with analysis of NDI network jitter. The EMB version of the NDI Analyser also displays the actual compressed NDI Data rate



2D DVE

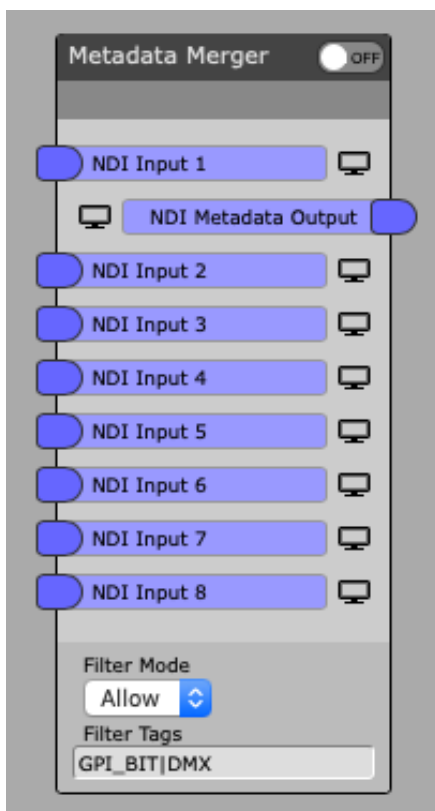
This module provides scaling and positioning options to create a cropped picture box which has been scaled and positioned, and which outputs the remainder of the screen as an alpha key. You can use the output of this module with a down stream keyer to superimpose one video on top of another. This output can also go to a 3rd party vision mixer.

Note that an alternative to this is the Picture in Picture module which does a similar task in one more efficient module but does not have the same flexibility for cropping and stretching.



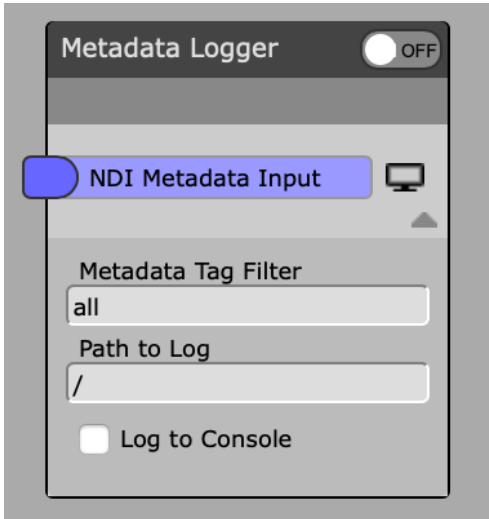
Metadata Engine

This flexible module adds various options for inserting, extracting and translating NDI Metadata within streams. It can be used, for example to insert PTZ control or NDI Vision mixer control - triggered from NDI Midi or other metadata. Translations can include macro functionality from one message to several using the Mapping file, or it can use sophisticated javascript to process / convert metadata. The Metadata Engine can also pass NDI Metadata to and from TCP connected systems like NODE:RED.



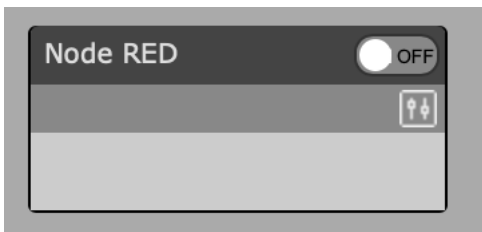
Metadata Merger

This module can merge the NDI Metadata flowing from up to 8 NDI Sources. You can optionally filter the NDI Metadata tags you want to include or exclude from the merging. This module can be used in conjunction with multiple instances of the Tally Engine if you need to merge tally from lots of NDI Sources.



Metadata Logger

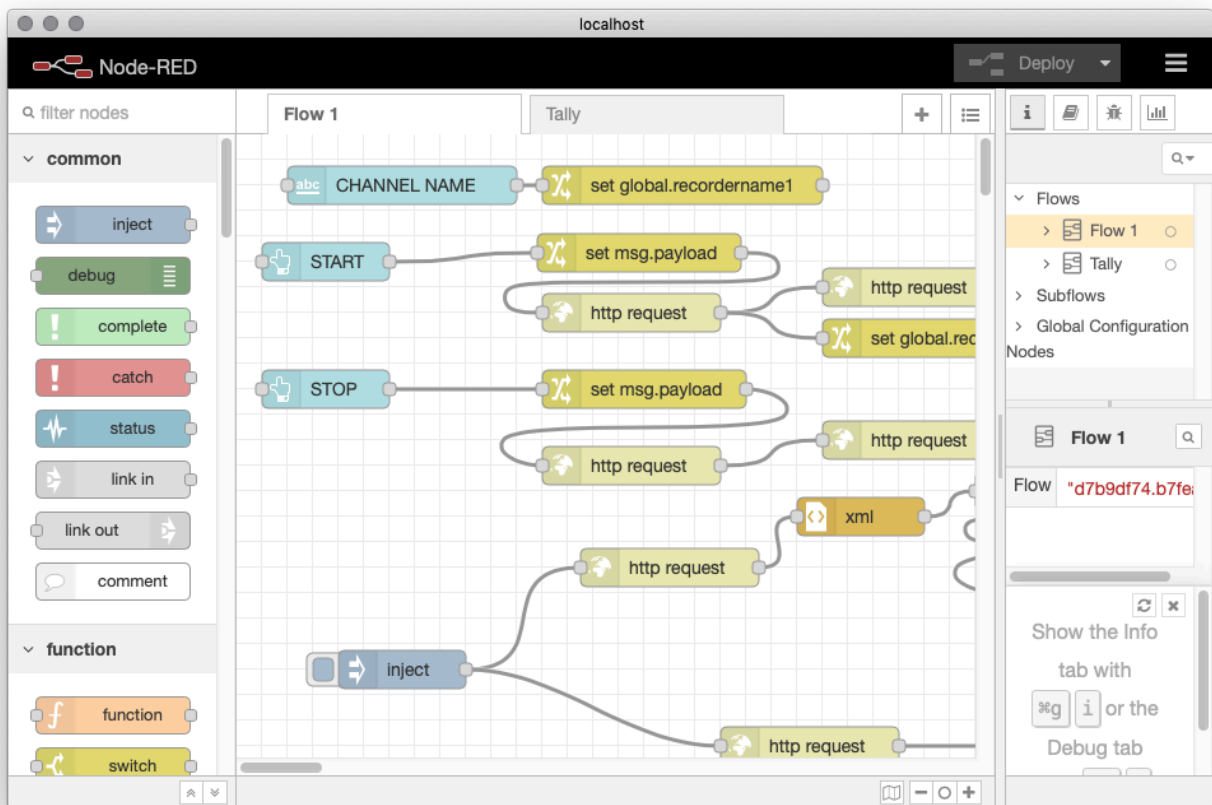
This module logs incoming NDI Metadata to a file and can also display it in the NDI Processing Engine log.

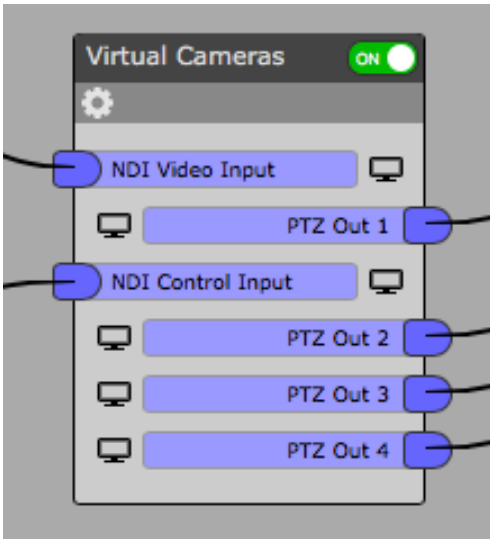


Node RED

This module interfaces with the IBM Developed Node RED engine, which provides no-code drag and drop message processing using a node-based engine. In addition to HTTP Rest calls from Node Red to the

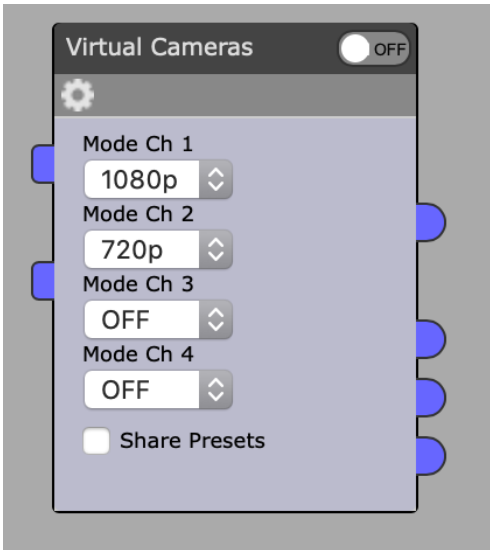
processing engine you can use the Metadata Engine to pass TCP messages in both directions containing native NDI Metadata messages





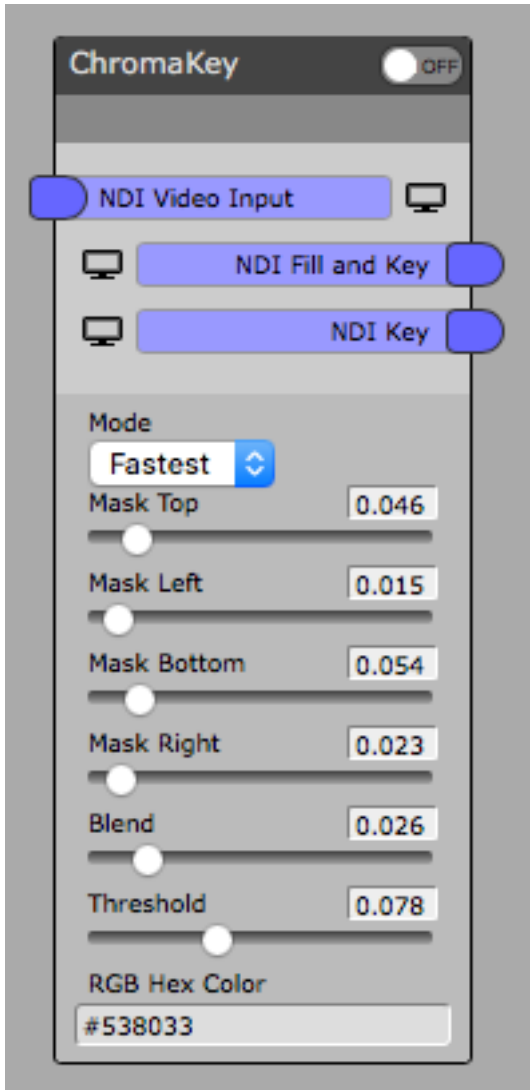
Virtual Camera Crew

This module can generate up to 4 Virtual PTZ cameras from a single high resolution NDI Input. Typical applications would be to feed in a UHD wide shot, and derive 4 HD tight shots for switching an event with a single locked off wide camera shot. Input supported up to 4320p and outputs can be 1080 or 720.



NDI PTZ Joystick

This popup window contains an NDI Joystick for controlling NDI PTZ devices such as cameras, (local or via NDI.Cloud), and also for the Virtual Camera Crew virtual PTZ system.

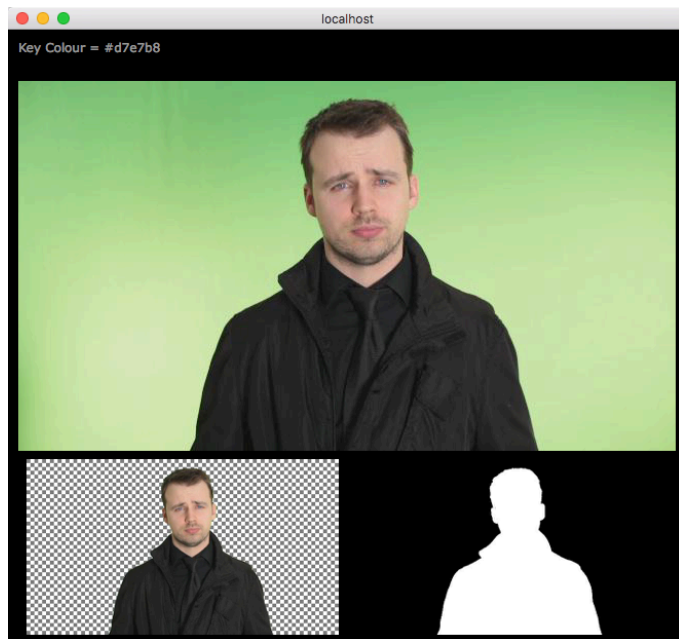


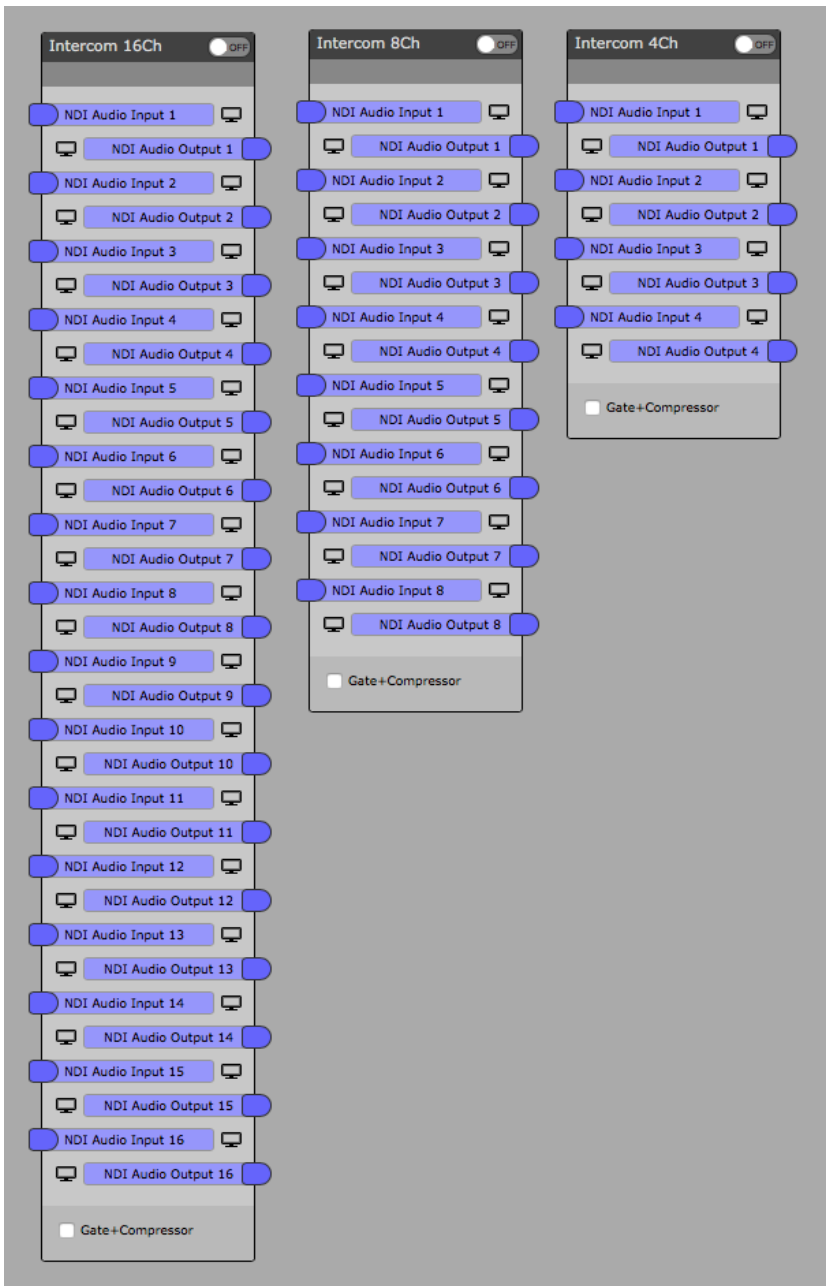
ChromaKey

This module provides chromakey functionality which includes edge cropping, and 3 modes to balance between CPU intensive keying with 9 pixel adjacent cell analysis and faster single pixel analysis.

The incoming video stream has a new alpha channel embedded, and this alpha is also output as black and white video on the key output.

A popup web interface provides point and click key colour selection along with preview of key and results.



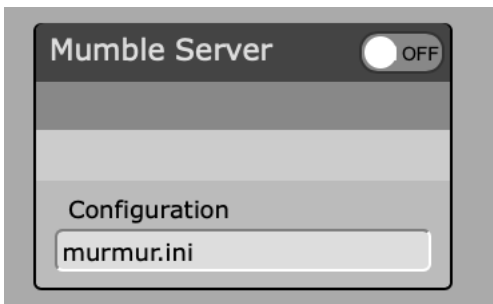


NDI Intercom Server

These modules (4, 8 and 16 Channel) provide a 'party-line' native NDI intercom server where each mono input is mixed and delivered (mix minus) at each of the outputs. An aggressive Gate+Compressor option provides very even high level on the output for intelligible speech even when input levels are low, or are variable. Feed in streams from the NDIntercom app for iPhone, regular NDI streams from PGM or other sources, AES67 streams via conversion from AES67/Dante intercom Beltpacks, or analog / digital audio feeds via Audio In module. Same selection of connections for the output. A simple Intercom server with universal format connectivity. Can also be used for large scale Mix-Minus generation.

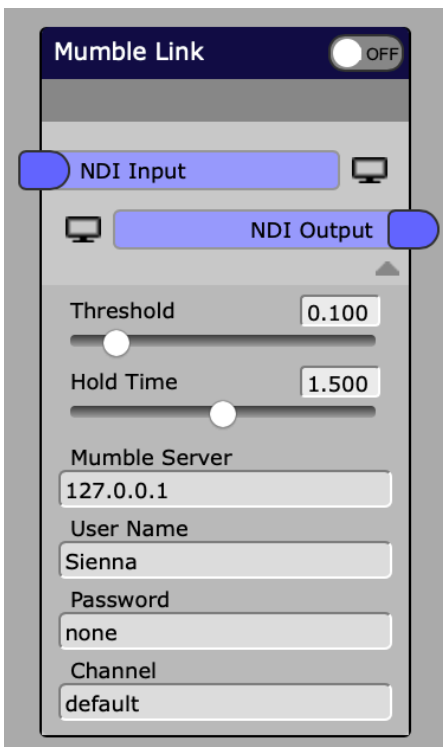
Mumble Intercom Server

Mumble is an open source intercom useful for local and wide area network communications. Client mumble intercom applications are available for mac, windows, linux, ios, android and raspberry Pi. The murmur.ini file in the modules folder allows for configuration of the server, including adding a password. You can make multiple .ini files and run several servers. Open ports 64738 UDP+TCP to access the default mumble server (and use other ports in .ini file for multiple servers). Mumble provides good quality mono audio with very low bit rates.



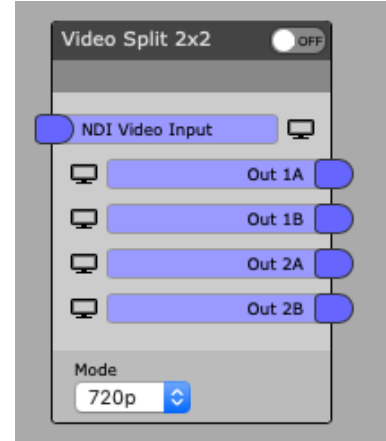
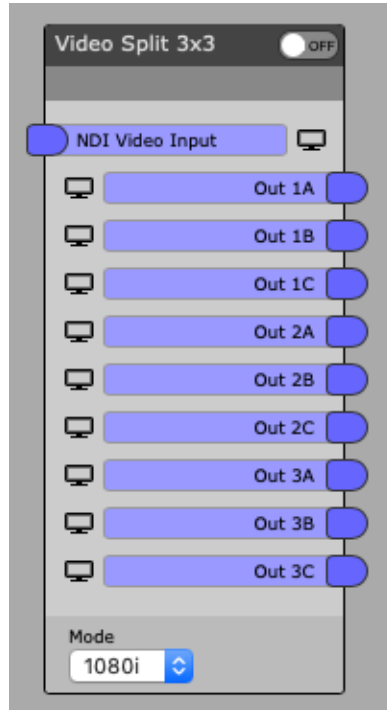
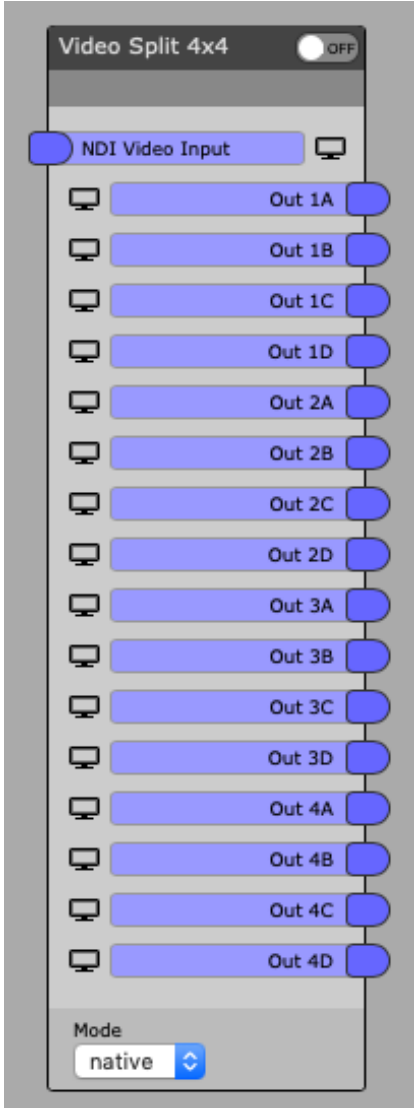
Mumble Link

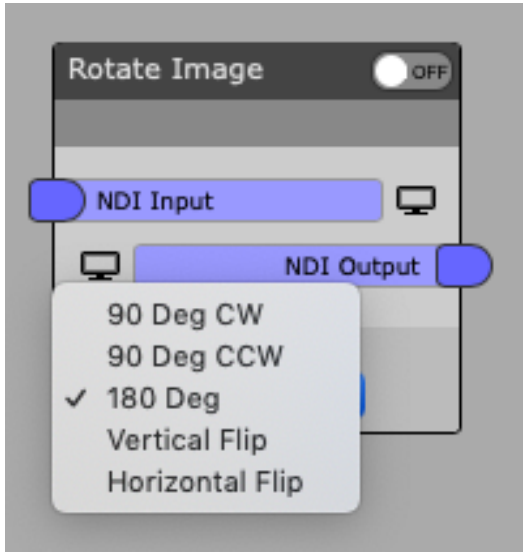
This module allows you to interface NDI audio with a mumble intercom server, for example to feed your program audio into intercom, or to extract a call-in user to use for production.



Video Wall Splitters

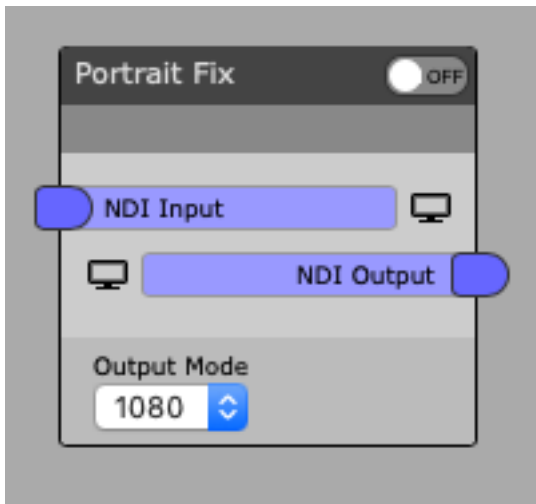
These modules (4, 9 and 16 Channel output) provide efficient splitting of NDI Video signals to tile across video wall modules. They can output a pixel perfect 1:1 resolution - most efficient, or scale to 720 or 1080 resolutions.





Rotate Image

This module provides common image transforms, rotate, and flip. In the 90 degree rotation, the aspect ratio of the NDI Stream is also transposed for downstream processing.



Portrait Fix

This module is a useful tool to transform portrait mode cellphone video into 16x9 content for display in regular video.

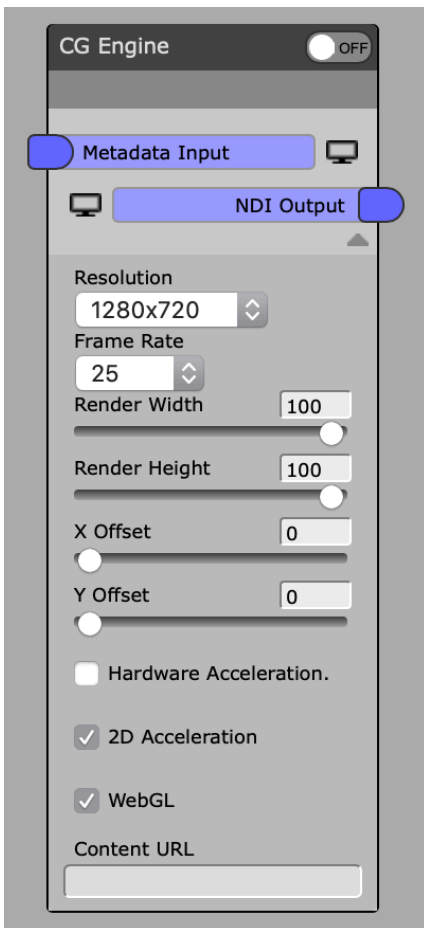
It blurs the sides of the image whilst centering the portrait content.



HTML5 CG Engine.

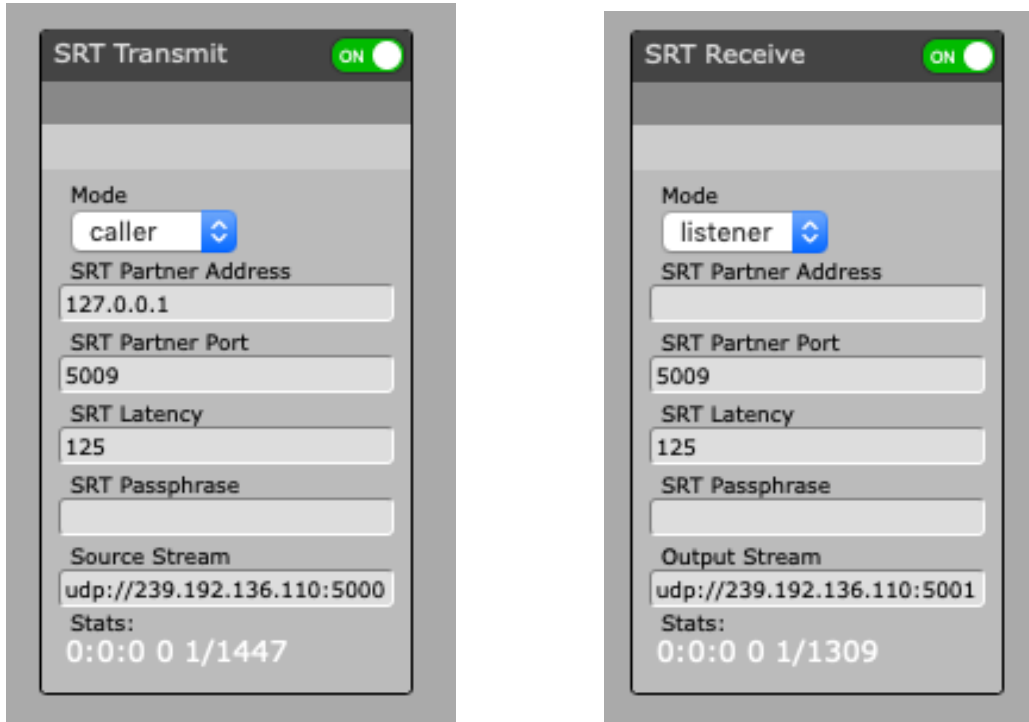
This module is a WebKit2 based HTML5 Renderer, for use with HTML5 based CG systems such as Singular.Live, and many others. It renders a URL (which is being animated by a back end system) and outputs NDI Pixels, fill and Key ready to key on top of your sources.

You can use full raster HTML5 pages designed for Full HD full coverage, etc (for example an L Shaped Graphic for Sports or Financial News or you can render a smaller 'widget' and position it anywhere in the screen. Note that when used with the Singular Live service, this requires Ubuntu 20.04LTS. An NDI Metadata input feeds NDI Metadata messages to a special javascript callback in your HTML page so you can make render changes based on incoming metadata messages from data sources, alarms etc.



SRT Transport for MPEG Transport Streams

These 2 modules provide the ability to send and receive SRT Protocol feeds which wrap MPEG Transport streams in UDP (or other Protocols).

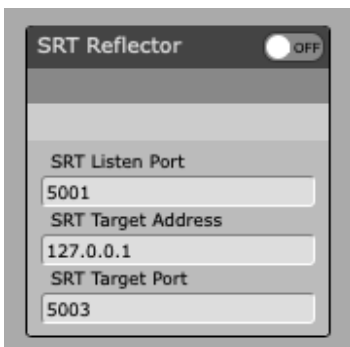


In order to survive a hop across the internet, or any other network connection which drops packets, wrapping the UDP transport streams in the SRT Protocol adds a reliability layer to prevent image breakup due to packet loss.

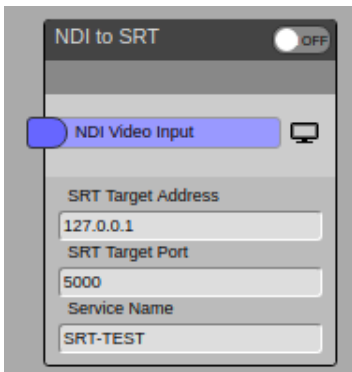
This differs from the approach used in Sienna.Cloud for NDI which sends native NDI Streams from location to location, along with NDI Metadata, Tally, PTZ control etc.

For very basic situations where the most efficient workflow is to simply protect existing MPEG transport streams across a WAN, the SRT Transmit and Receive can be useful tools.

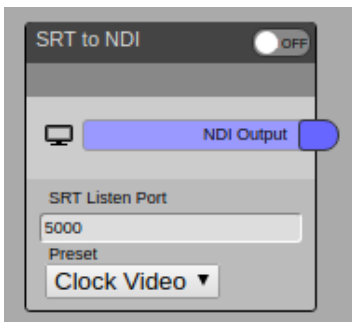
Stats: [dropped][recovered][***unrecovered***] [rtt time] [data rate/link speed]



For some workflows, simply reflecting the SRT Stream may be useful - for example to work around firewalls. This has been used for example to reflect data between cloud based instances from the same ISP outside and inside of China in order to pass through the Chinese state firewall efficiently - necessary to ensure good enough performance for live video.



Finally, a pair of modules allow for direct conversion between NDI and MPEGTS-SRT, offering integration with any sort of wide area network workflow.



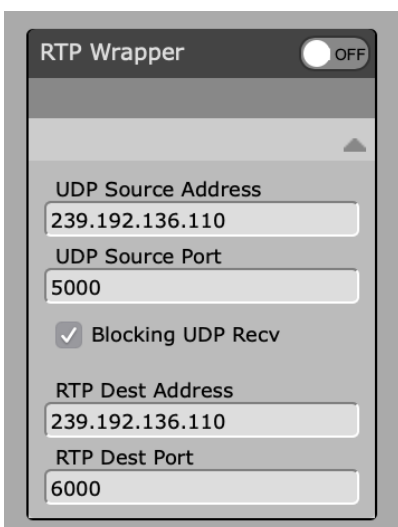
In general its much better to use the SRT Receive module followed by UDP Stream Connect instead of SRT to NDI module, and use UDP Streamer Custom followed by SRT Transmit instead of NDI to SRT module - since the module pair combination is better performance and more reliable - particularly if there will be connection breaks.

One exception to this rule is if the video format in the SRT stream is likely to change on subsequent connections - in this case do use the SRT to NDI module, and implement an auto restart term in the manifest. This will allow for automatic reset of the UDP

Decoder stage on each connection (to handle changes in format).

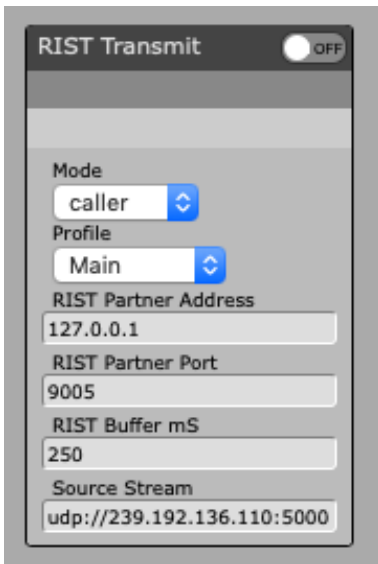
Note that Sienna.Cloud for NDI is a better choice than SRT for a native NDI end to end workflow and SiennaLink is a better choice for super low latency remote monitoring.

SRT is most useful for integration with 3rd party hardware and software.



RTP Wrapper

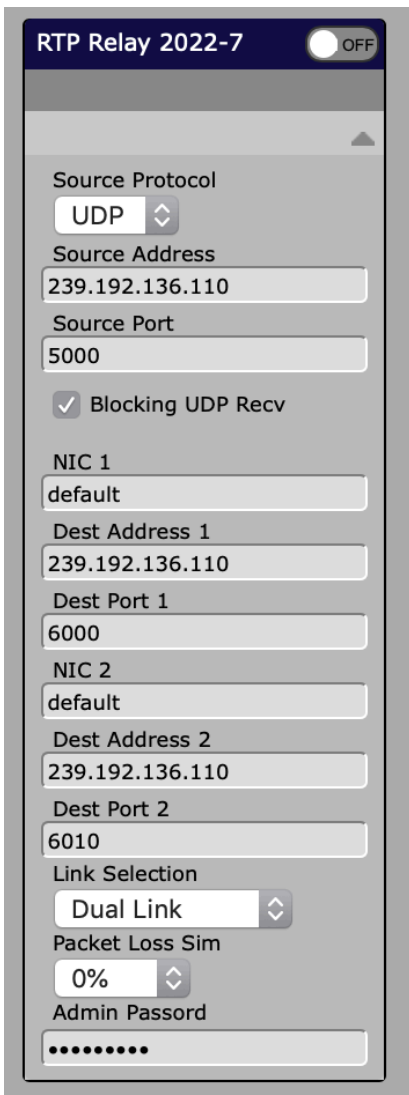
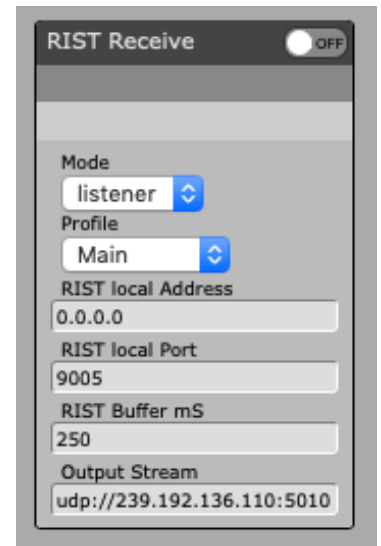
This module can take a properly formed UDP stream from a module like the TS Encoder Pro and add RTP headers to the stream.



RIST Transport for MPEG Transport Streams

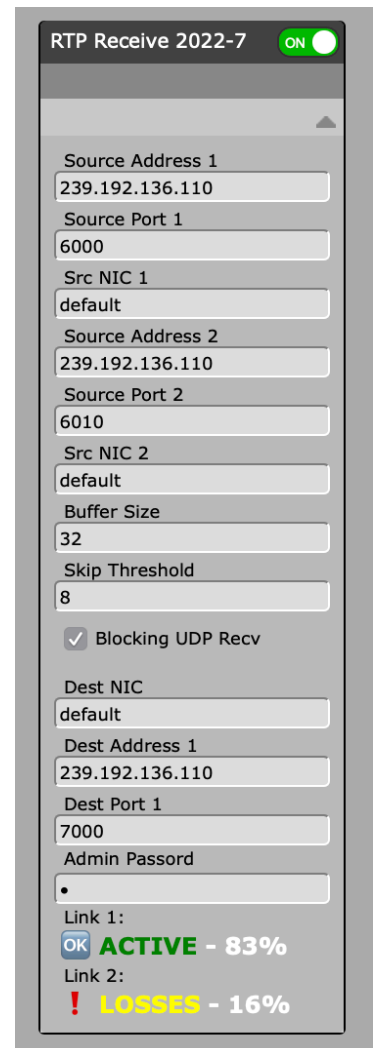
Using the same concept as the SRT modules on the previous page, these 2 modules will wrap and unwrap RIST streams containing MPEG TS essence.

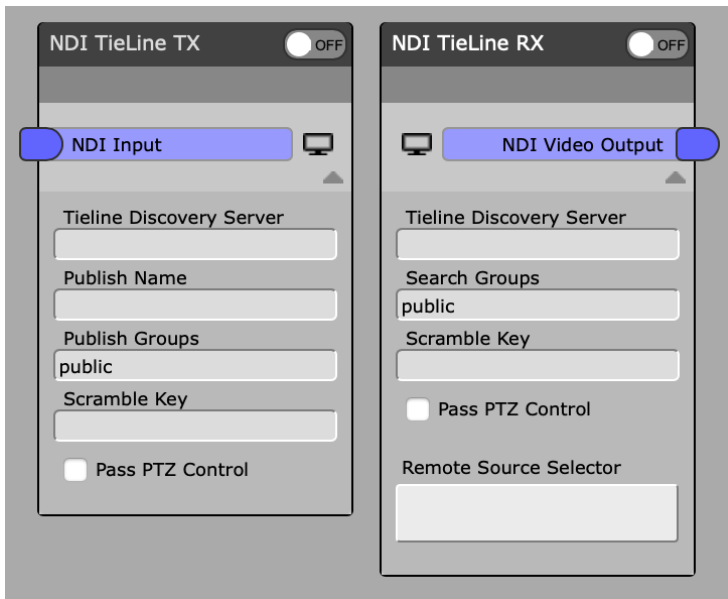
Like the SRT modules you should combine this with UDP MPEG TS Stream encoder and decoder modules.



RTP SMPTE 2022-7 Diversity Pair

This pair of modules provides support for the 2022-7 hitless failover mechanism for RTP streams. A UDP or RTP origin stream is fed across an associated pair of RTP feeds to a remote receiver with 2022-7 recombining capability. If an RTP packet is lost on one stream, it will be seamlessly taken from the other, allowing redundant operation of standard UDP or RTP streams over an unreliable connection. The sender allows for packet loss simulation to test the mechanism and there receiver shows statistics.

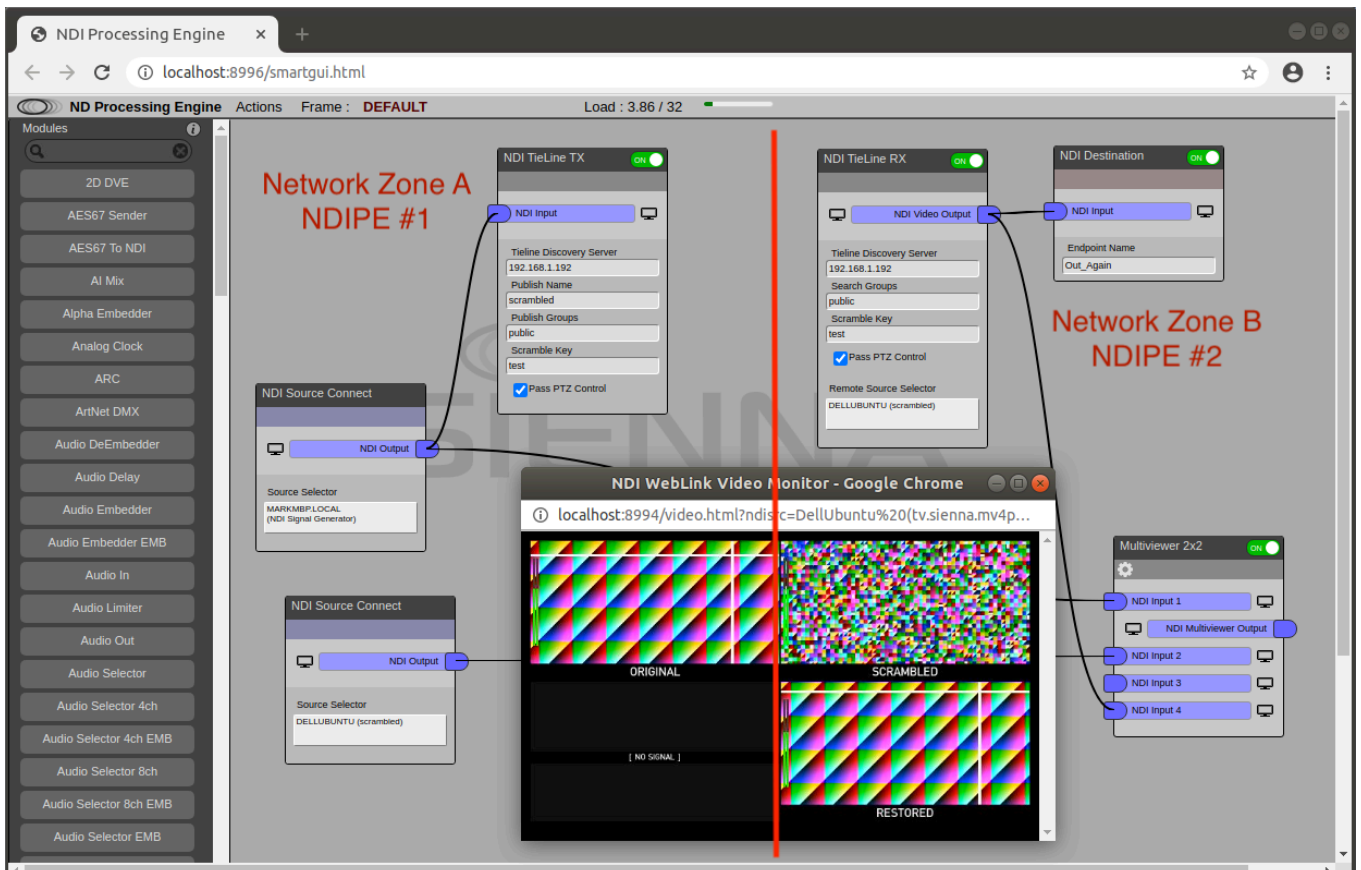




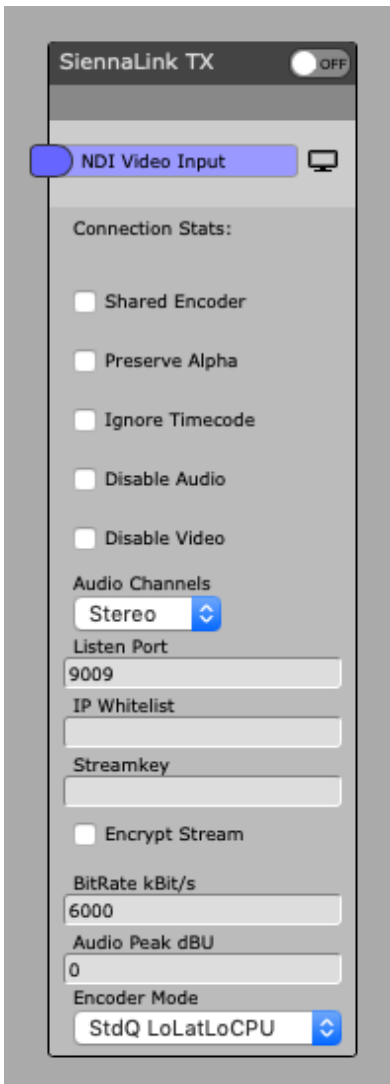
NDI TieLines

This pair of modules provides a tie-line / firewall mechanism to bridge NDI streams between Processing Engines in different network segments where there is deliberately no general discovery / sharing by default. Bridging between different NDI Discovery servers on each side, these modules allow for general network isolation but allowing a specific stream to flow, using techniques like dual NICS where the second NIC is

completely isolated from the primary network, and the Tie Line module relays the NDI stream between the NICs like a traffic router. The Tie line pair can also use encrypted macroblock scrambling for the journey between modules without affecting the unscrambled image, and where the NDI stream is natively preserved with no processing.



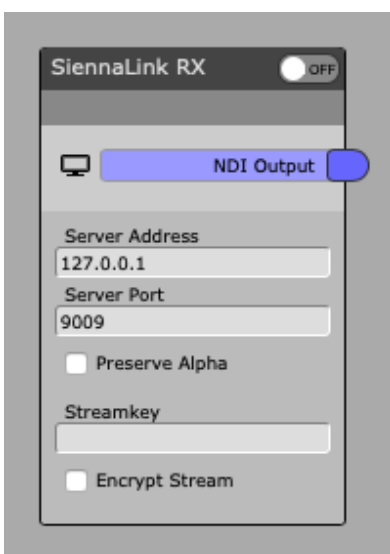
SiennaLink Transport for NDI Streams



These 2 modules allow easy, super low latency connectivity of NDI via the SiennaLink protocol across wide area networks. SiennaLink TX recompresses NDI with H.264 long-GOP and sends it using SRT transport to a SiennaLink RX receiver in another location. SiennaLink is simple, reliable and low latency. SiennaLink TX can also send streams to the free SiennaLink Remote Monitor applications which exist for macOS, Windows 10, Ubuntu Linux, Apple iOS and Apple TV platforms - to provide flexible remote monitoring of sources.

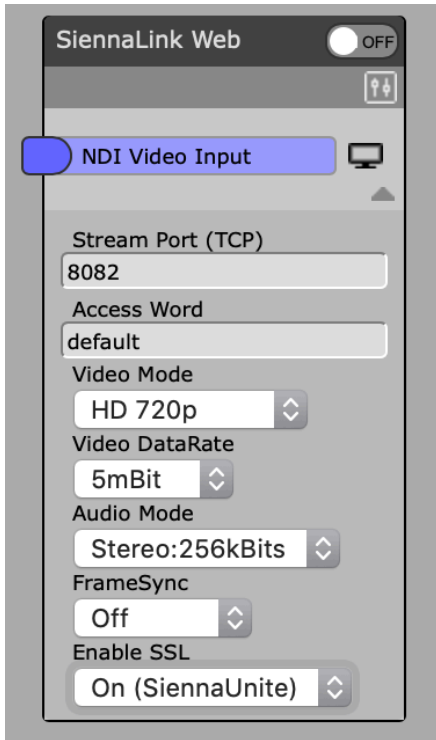
Shared Encoder mode allows multiple connected clients sharing a single H.264 encoding pipeline, which can manage multi-client load, although be careful to avoid mixing end clients with different levels of remote connectivity since one poor receiver will throttle data for all others sharing a single shared encoder.

Preserve Alpha mode will carry NDI Fill and Key between SiennaLink TX and RX modules (alpha not supported to the free desktop client apps). Streamkey manages basic connection authentication, and if Encrypt Stream also checked, it will be used as the encryption key. Works up to UHD.



Since SiennaLink will 'freewheel' if sources are 'parked' for example in an NLE, source timecode is monitored for changes before sending frames. If the source has static timecode by default you can ignore timecode monitoring.

Multichannel audio can be carried between TX and RX, and free desktop clients can pick 2 channels from 'up to 8' sent with the stream.

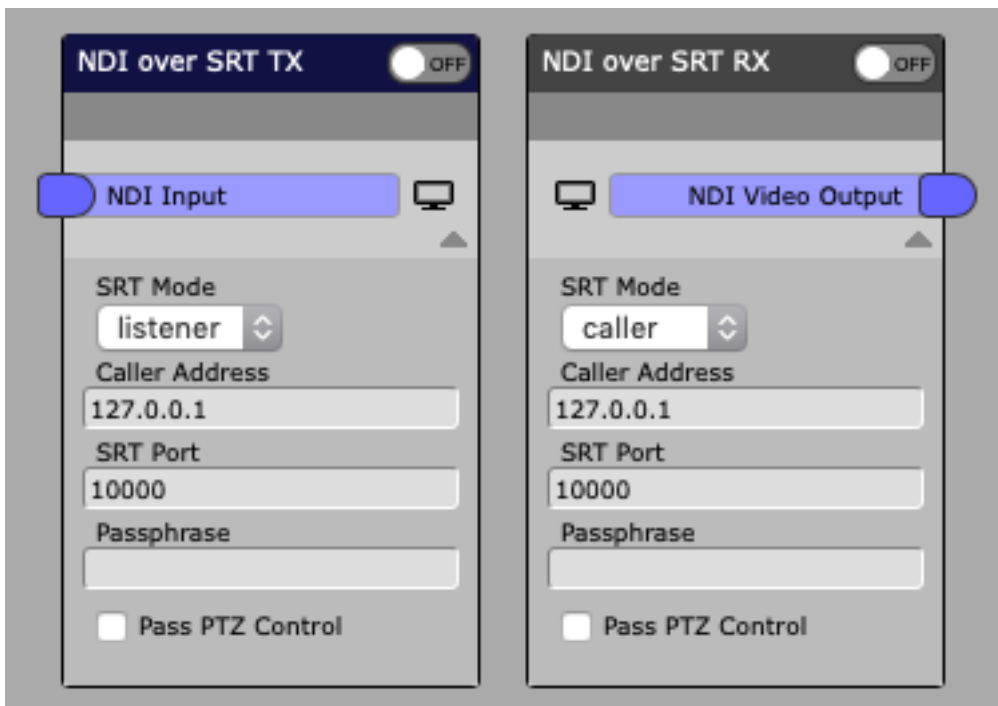


SiennaLink Web

This module offers a 'lowest common denominator' mechanism for distributing a low latency stream to a remote viewer, since it does not require any special software at the receiving end. A common web browser is all that is required to receive an HD video and audio stream from an NDI Source, with the same super low latency found in the SiennaLink TX system with its dedicated viewer app.

SiennaLink Web is also used as the return feed for the UNITE workflow which is described elsewhere in this paper.

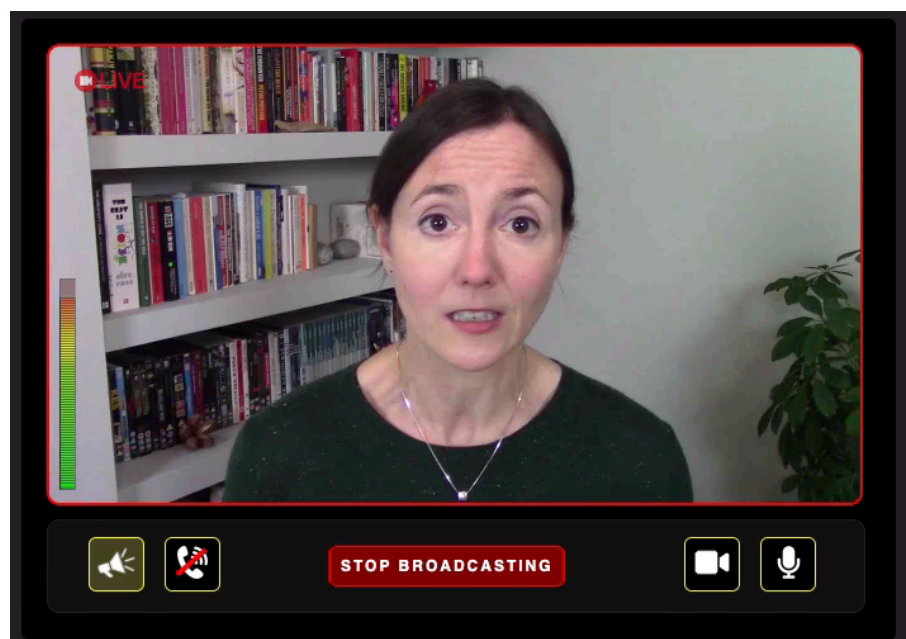
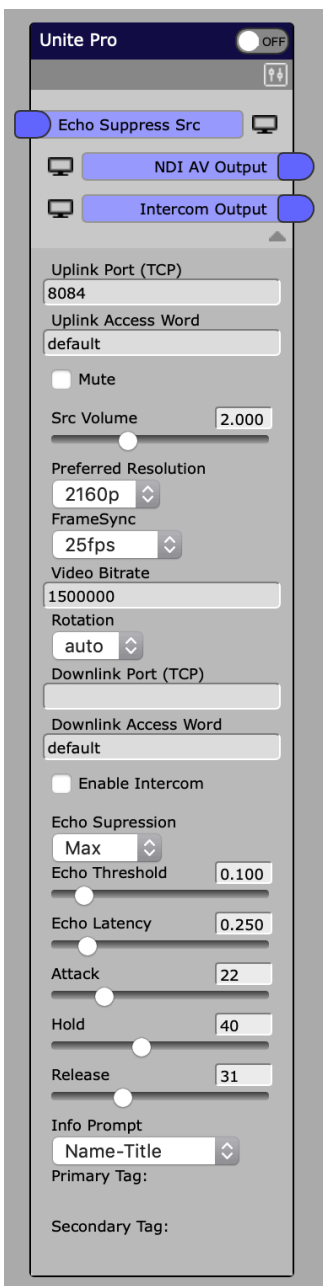
NDI over SRT



This pair of modules allows you to carry an NDI Stream natively across an SRT transport link, without transcoding. Allows for firewall traversal, encryption and wide area network carriage of native full bandwidth NDI essence including PTZ Control.

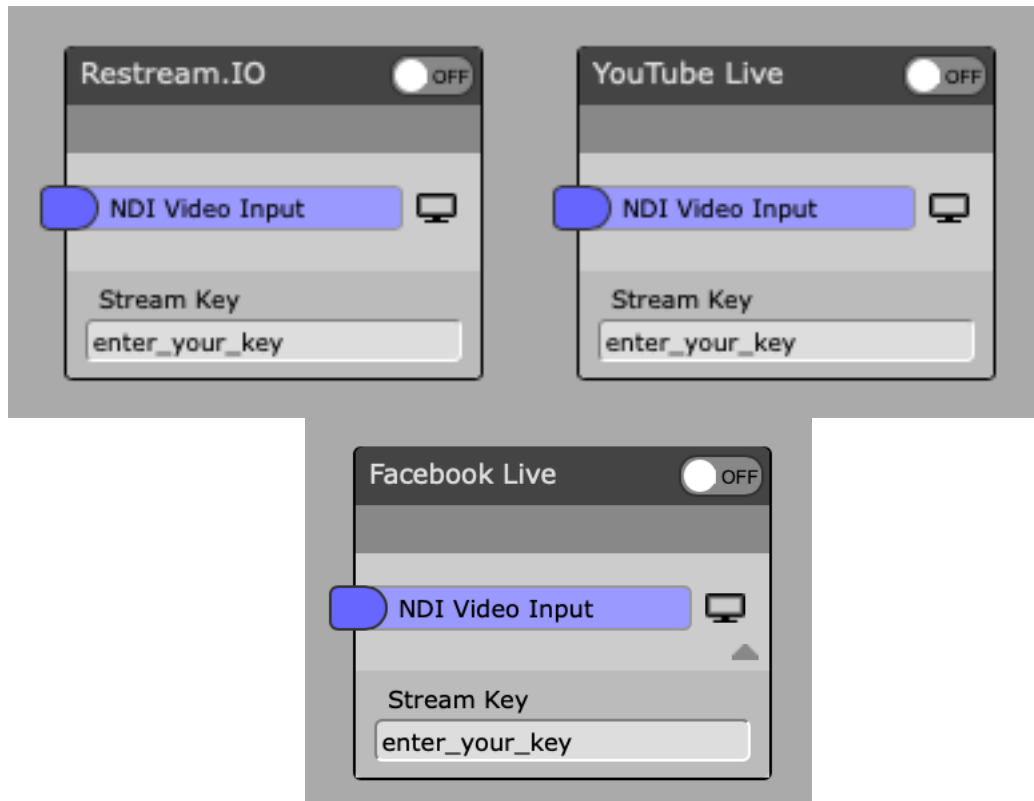
Sienna UNITE™

Unite is a revolutionary protocol for remote contribution from web browsers using a webcam. Providing a super reliable, stable and high quality feed with Native, discrete NDI output for any number of remote contributors, Unite includes all the professional tools you need to interact with contributors, including intercom and return video feed. Server side echo suppression, automatic rotation for portrait feeds, remote metadata entry and support all the way up to UHD differentiate Unite from products from other vendors which simply use WebRTC. Unite does NOT use WebRTC, and instead uses the much less complicated and hence much more reliable Unite™ protocol developed by Sienna.

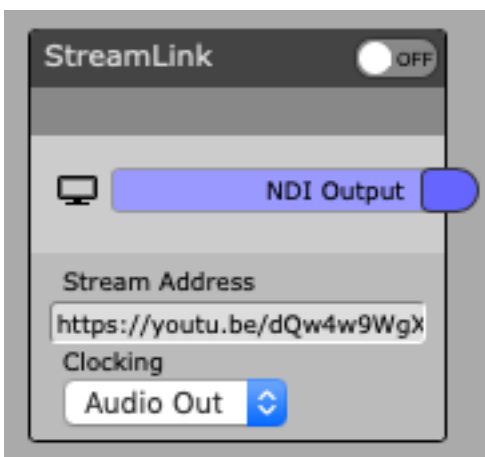


Social Media Publishing

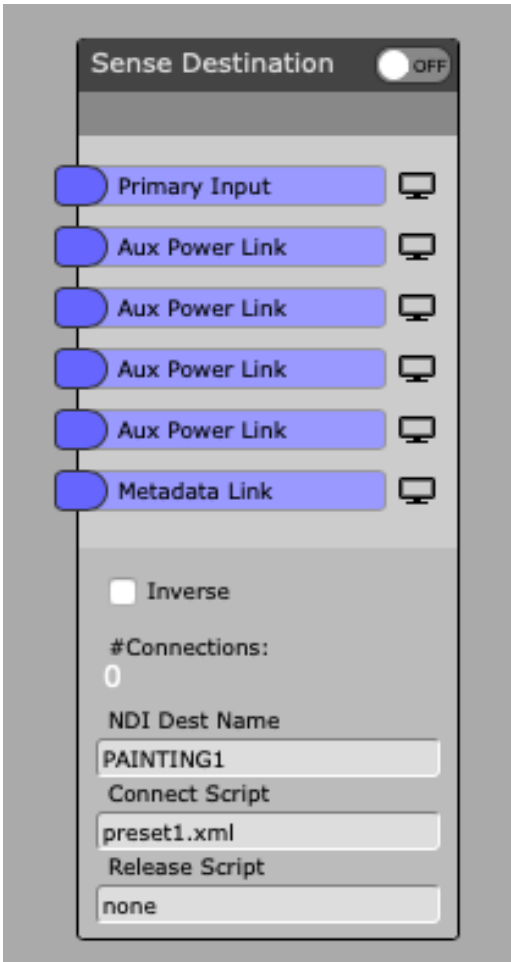
These 2 modules (YouTube Live and Restream.IO use RTMP publishing to push live streams into social media live video workflows. In both cases all that is required is the Stream Key for the account in order to publish NDI Sources direct to these social media CDN engines. Restream is particularly useful since the Restream service can forward your stream to a wide range of Social Media platforms simultaneously including FaceBook, YouTube and others.



Social Media Stream Capture : StreamLink

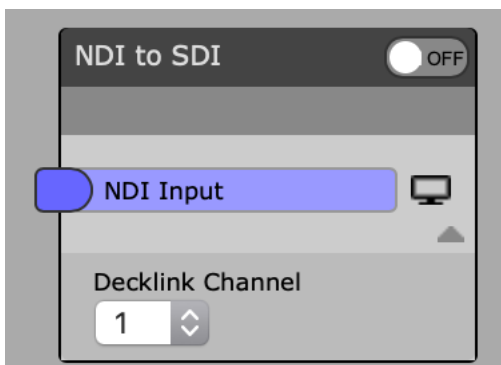


The StreamLink module allows you to enter URLs from various social media video platforms to capture content into NDI Streams. YouTube live stream share URLs for example, and even non-live video URLs can be entered (video marked as 'protected' in YouTube will NOT work). Also supported are Vimeo, Daily Motion and other platform URLs. Each type of stream may require a different NDI Clocking mode, so be prepared to experiment with the Clocking setting for best results.



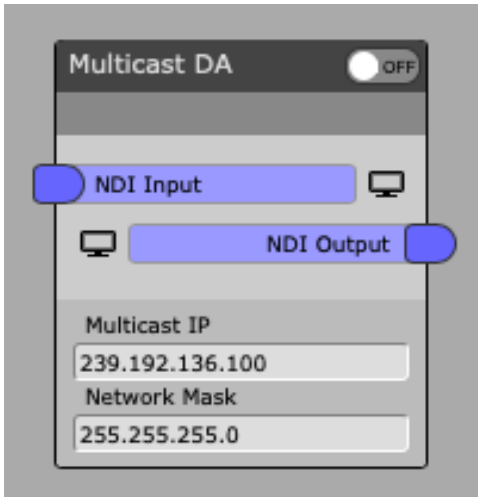
Sense Destination

This module acts in a similar way to the standard NDI Destination Module, in that it presents a virtual NDI Named endpoint for the outside world to connect to. However, in addition to that function, this module automatically senses the 'load' on the destination, and can perform functions based on whether there is anything connected to the destination (ie. is anything viewing the output). The 2 functions which can be performed are a) Control of Module Power for up to 4 other modules connected to the Aux Power Link connections, and b) Sending of 1 or 2 NDI Metadata messages via the Metadata Link connector when the end point is either viewed (active) or not viewed by an external NDI Receiver. This module can be used for a variety of infrastructure-on-demand mechanisms, and for some types of failover / redundancy workflows.



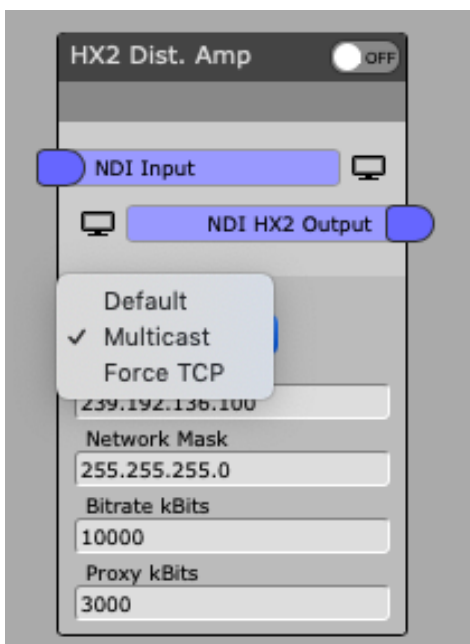
NDI to SDI

This module outputs an NDI Stream via a BlackMagic Design SDI interface. For more sophisticated NDI to SDI functionality, use the Sienna NDI Outlet Multi Server.



Multicast DA

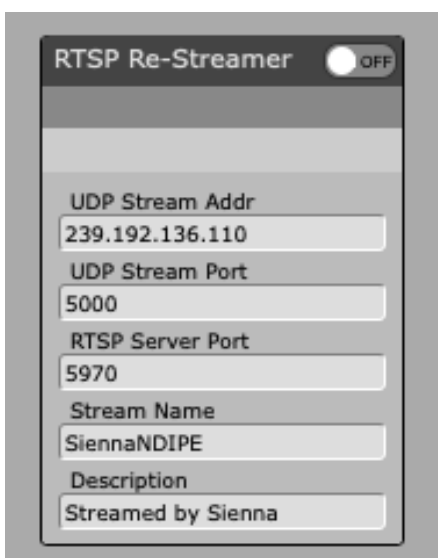
This module provides a simple way to take any source from a unicast configured device and convert it to a Multicast NDI Source. This allows selective Multicast, where only sources which are aimed at a very large number of receivers may be sent multicast, whilst all other NDI traffic stays in the default unicast state.



NDI HX2 DA

This module allows you to take any full bandwidth NDI Signal and create an NDI HX2 stream of that source. HX2 is H.264 with significantly reduced network bandwidth, suitable for distribution - particularly if the multicast option is enabled. HX2 requires NDI4 based receivers - older NDI versions cannot receive NDI HX2 streams.

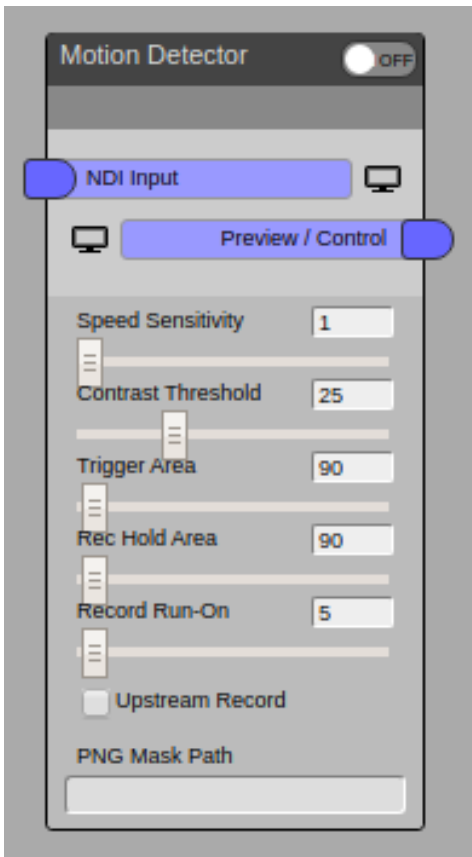
The Force TCP mode ensures this module will only allow traditional TCP (not multi-tcp, or UDP) connections to receivers, which can simplify firewall for cloud operations (just open TCP 5960 upwards for the number of required streams).



RTSP Re-Streamer

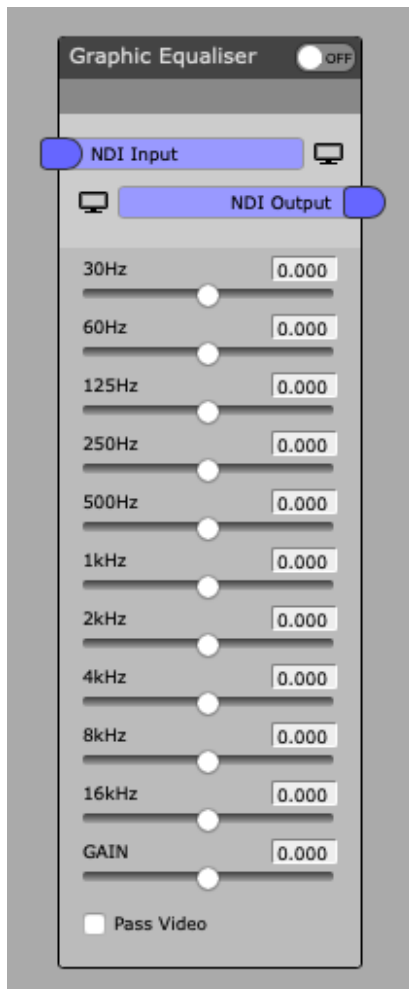
This module takes an existing UDP MPEG Transport Stream and presents it (and distributes it) over an RTSP server. Remote clients can call into this stream and connect via TCP. The Stream address takes the form `rtsp://thismachineip:rtsp_port/stream_name`.

Note that if you turn this module off with connected clients you may need to wait 4 minutes for the connection to clear before you can successfully restart this module.



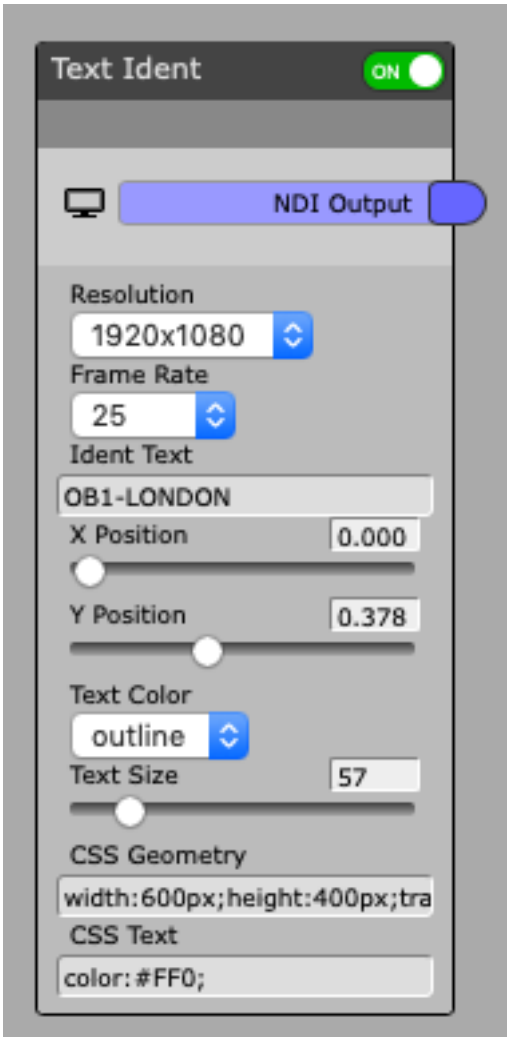
Motion Detector

This module provides a powerful motion detection engine based on openCV. It uses an algorithm based on changed content in localised areas, between frames, or over a longer period. You can specify a png mask to ignore areas from detection. It can send NDI record commands upstream to a PTZ Camera or encoder with on board recording, and it also outputs Midi over NDI MMC record commands to control external devices like the NDI Native Recorder module. When combined in a workflow with the Sync delay module, this allows for pre-record type workflow where the recording will capture video before the trigger event.



Graphic Equaliser

This module provides a 10 band audio ‘graphic’ equaliser. You can also control overall gain, and control whether the module passes video through or ignores it. With Pass Video turned off, this module features a super-low CPU load.



Text Ident

This module allows you to quickly create a simple text IDENT for overlay on picture using the downstream keyer or vision mixer. It uses the CG Engine module to render HTML text based on the template "ident1.html" stored in the top level webpages folder. This module allows dynamic changes to some of the parameters.

You can optionally override the CSS for the text block itself, plus the node which contains the text box.

Example CSS for the Geometry wrapper:

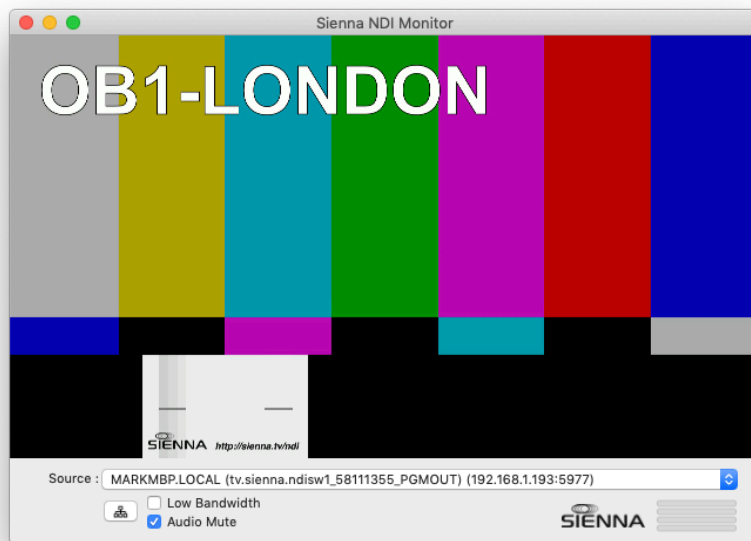
```
width:600px;height:400px;transform: rotate(90deg);
```

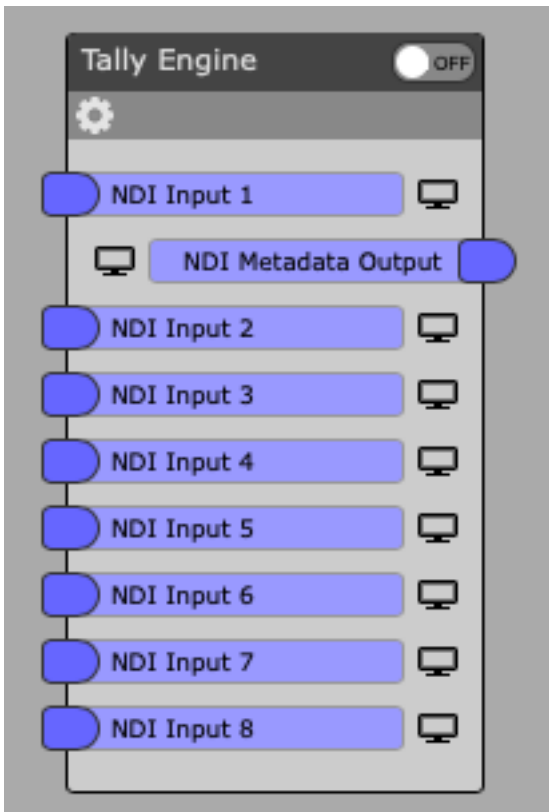
This rotates by 90 degrees, and also corrects the position.

Example CSS for the Text:

```
font-family:times;color:#FF0;
```

This sets the text to yellow, and the font to times





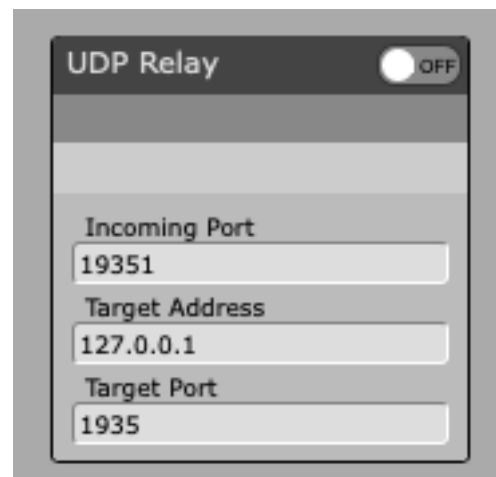
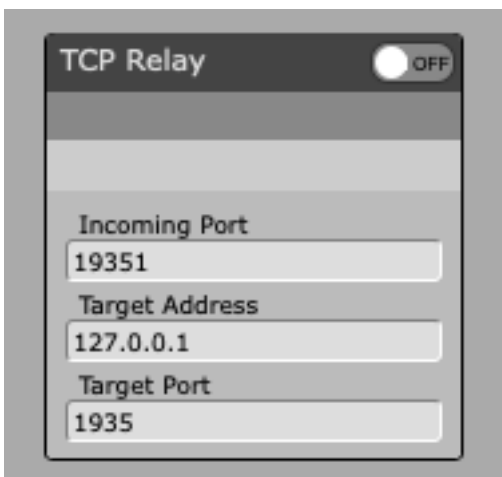
Tally Engine

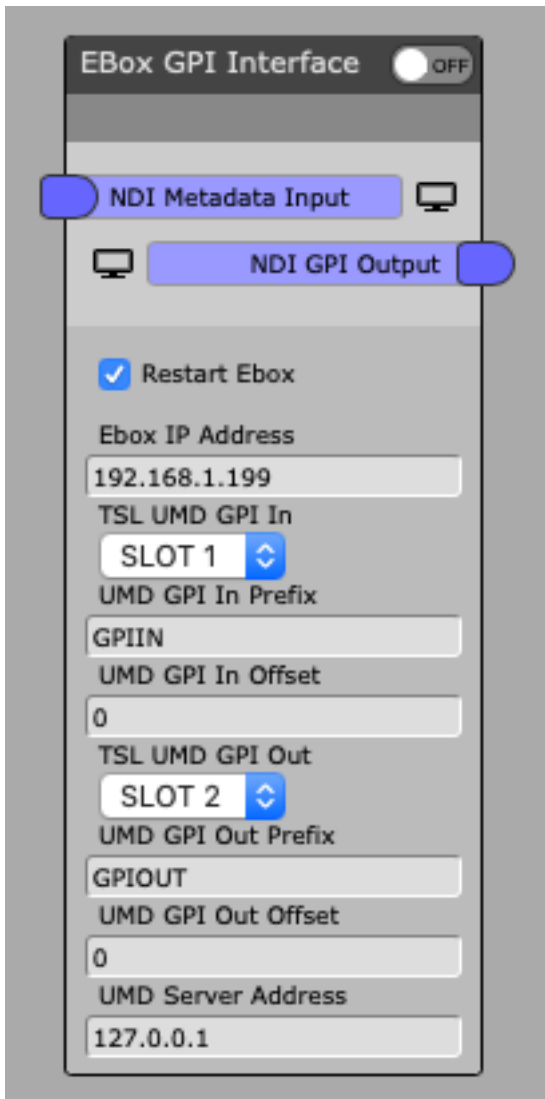
This module monitors the NDI tally state for up to 8 sources, and allows for conversion into TSL_UMD tally messages, as well as outputting NDI:GPI format NDI Metadata messages for downstream process automation.

You can specify an offset for the channel index as well as entering names for each channel which are emitted along with the tally status.

TCP / UDP Relay

These 2 modules provide simple relay of TCP or UDP traffic allowing for port and host redirection of traffic. You can use UDP Relay to receive unicast and resend as Multicast for example





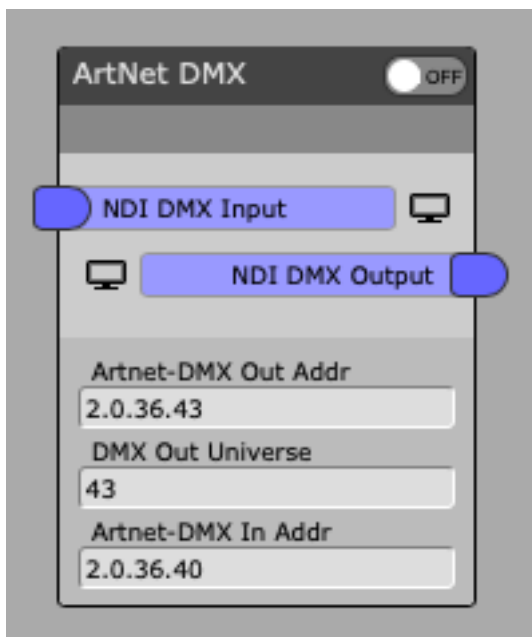
GPI to NDI Interface

This module works with the JLCooper Ebox GPI interface device, to provide 24 GPI in and 24 GPI out interfaced seamlessly with NDI Metadata, using the NDI:GPI metadata protocol.

<http://www.sienna-tv.com/ndi/gpioverndi.html>

This can be combined with the NDI Metadata Engine to drive higher level NDI workflows for example controlling PTZ Cameras, Tallies, vision mixer control etc. It also sends TSL_UMD v3.1 messages for incoming GPI closures, and also NDI:GPI messages being sent to set GPI outputs.

For in and out you can disable UMD, select which UMD slot to publish, as well as a prefix (to which the GPI index+1 will be added) and an optional offset to the GPI Index. By default you can send UMD to the Processing Engine itself on localhost (127.0.0.1) and this will then be available via HTTP calls to the engine, for use in other modules, such as the Multiviewer Information CG Renderer.



DMX to NDI Interface

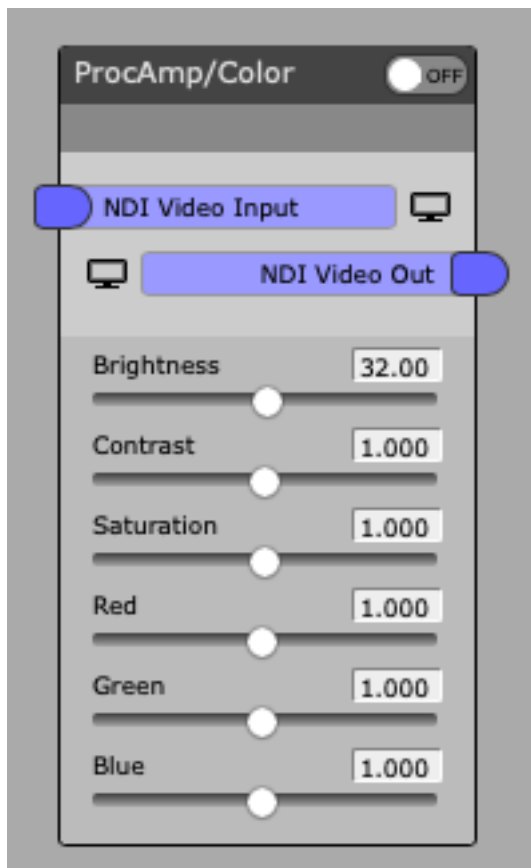
This module works with Artnet to DMX devices such as the LTEC Artnet-DMX-1 to allow bidirectional conversion between DMX control data and NDI-DMX metadata protocol.

<http://www.sienna-tv.com/ndi/dmxoverndi.html>



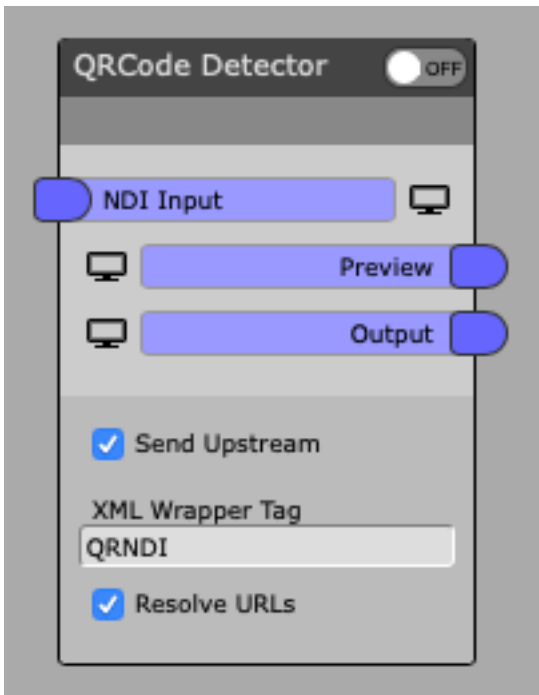
ProcAmp

This module provides the basic image controls for Brightness, Contrast and Saturation.



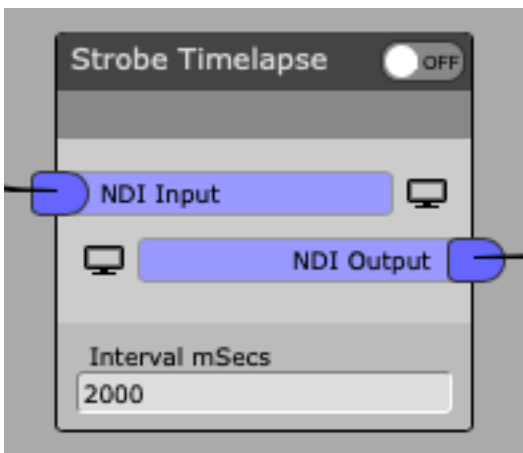
ProcAmp with Color Corrector

This module provides the basic image control for Brightness, Contrast, Saturation as well as color shift for red, green and blue



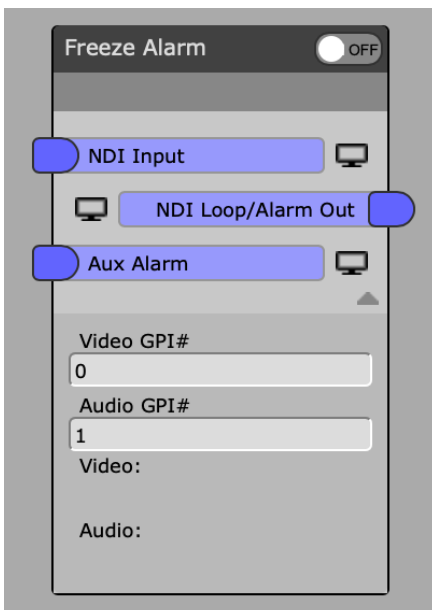
QRCode Detector

This module analyses the image looking for a QRCode. This code is then optionally resolved (if its an http URL) and the resulting QRCode metadata content is embedded into the output streams, and optionally back upstream. The Preview output displays QRCode detection information whilst the main output embeds metadata with the incoming stream.



Timelapse Strobe

This module strobes the incoming NDI stream and emits only one frame for every specified interval - also altering the NDI Metadata to represent this frame rate. The output of this module can be captured with the NDI Recorder, then sped up in Adobe Premiere for a time-lapse effect.



Freeze Alarm

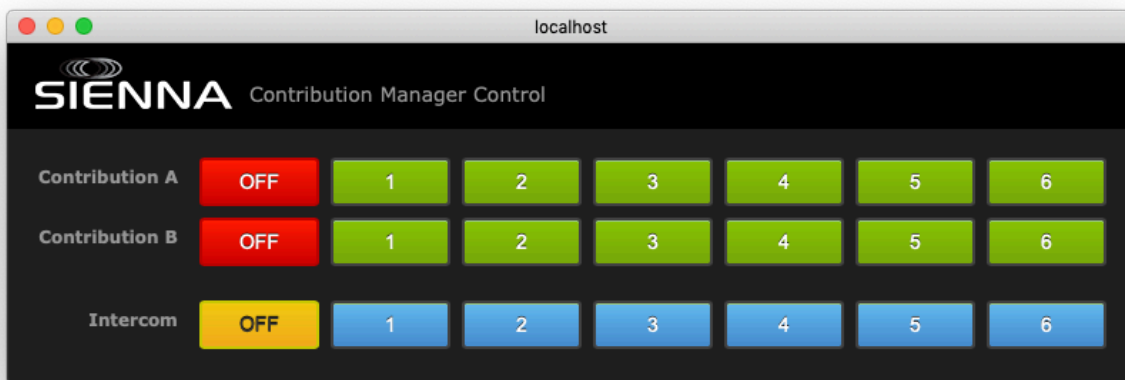
This module analyses picture to look for pixels which are stuck between frames, and which indicate a frozen picture (with NDI packet data still flowing). It also detects mute sound. In both cases real time metadata is embedded into the stream for downstream processing. The NDI Multiviewers, for example will use this metadata to apply alarms overlaid in the viewer,

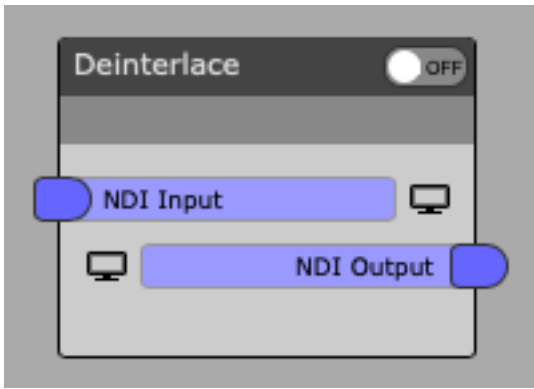


Contribution Manager

These modules provide a complete system for managing incoming contributors, such as Skype TX callers, or outside broadcast field journalists.

The modules has a very simple to use web interface to manage which of many incoming feeds is presented to the vision mixer as a 'next contributor' - whilst providing appropriate return to the feed, as Program or Mix minus for example. Finally the module interfaces with the intercom system to allow you to break into the stream / return to communicate with the feed.



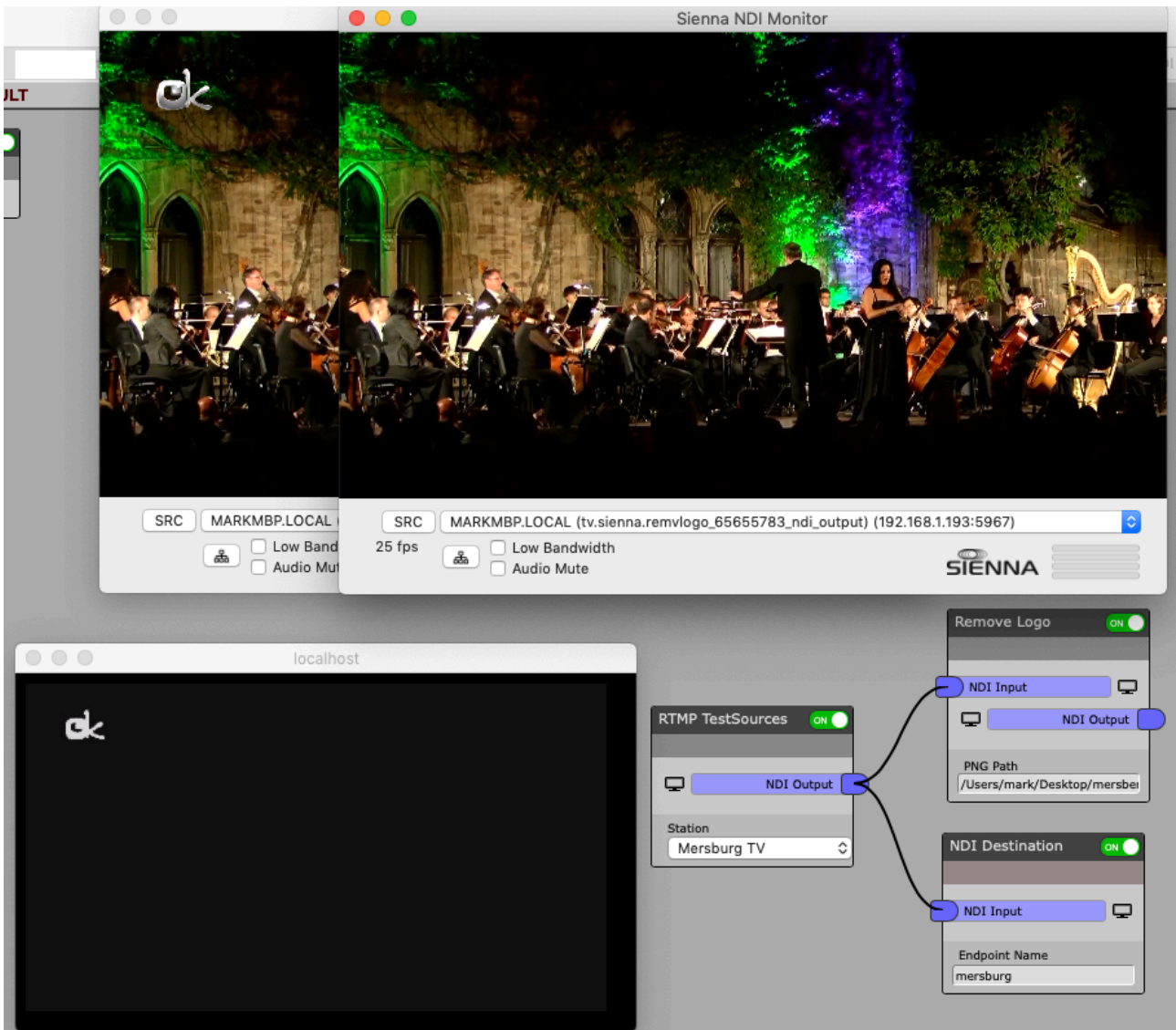


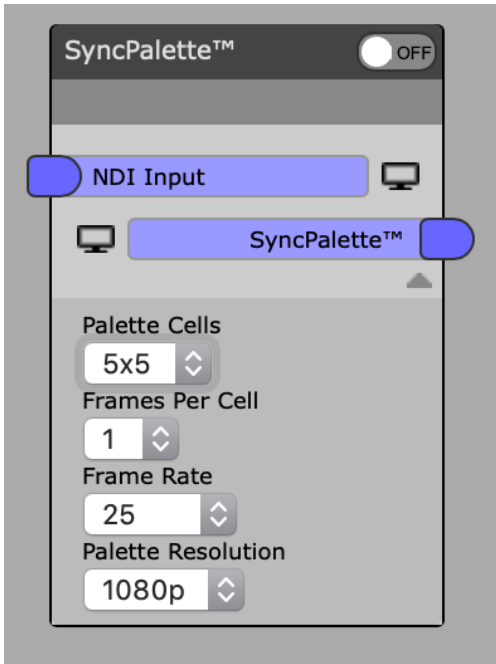
DeInterlace

Weston 3 (BBC) algorithm smart DeInterlacing filter

Logo Remover

Using a PNG Mask, identify areas of logo to remove by gathering surrounding pixel values.

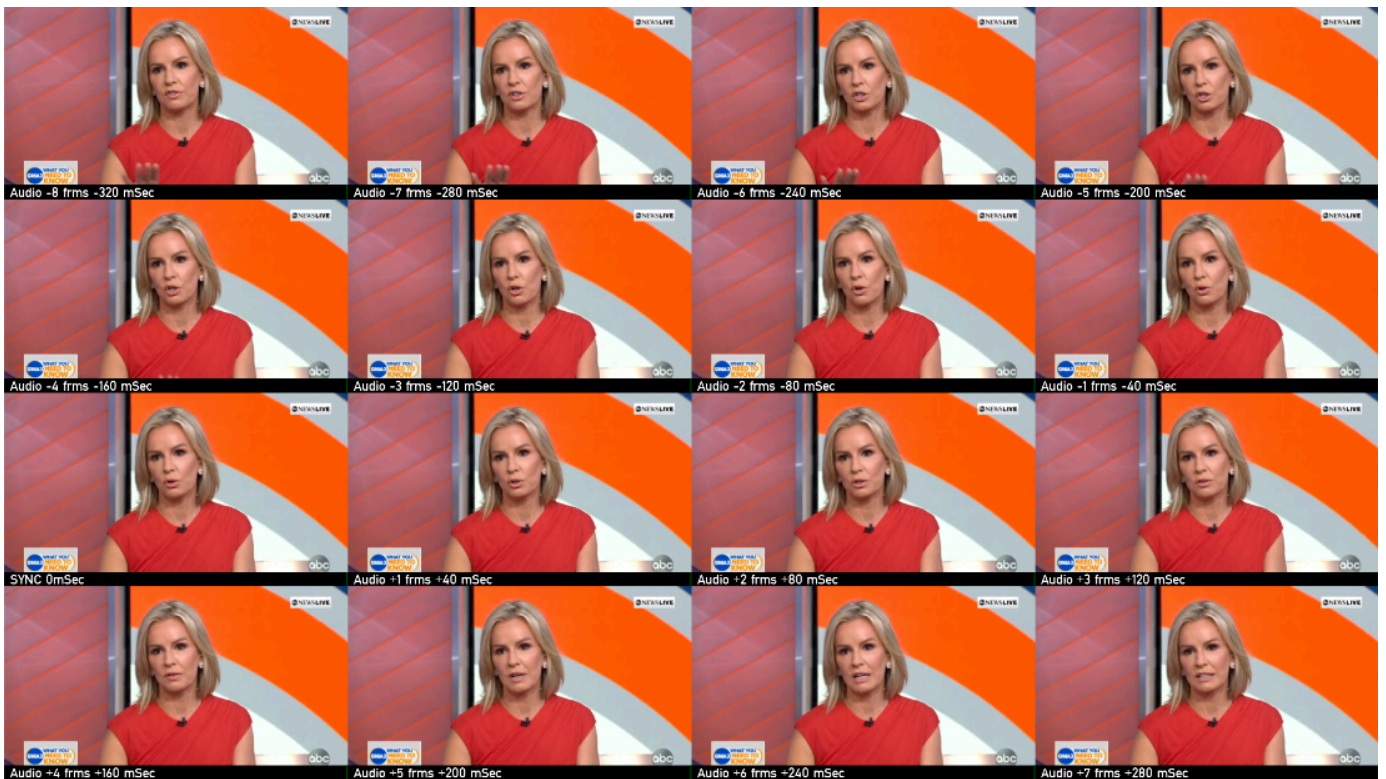


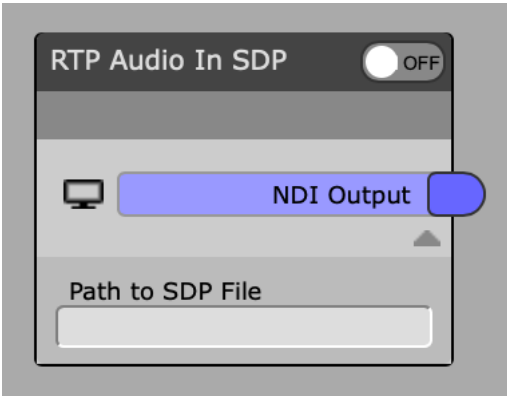


SyncPalette

A unique tool for instantly evaluating the lip-sync error for streams, in order to quickly apply offset correction.

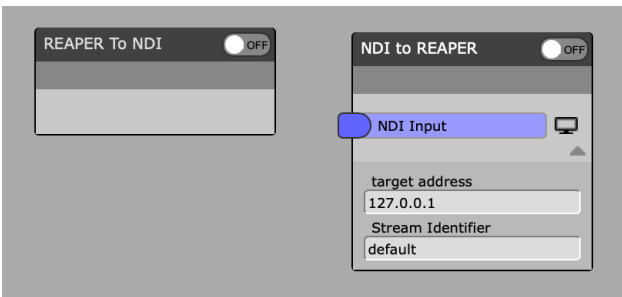
Each cell shows the stream with a 1 frame offset compared to its neighbour, with the audio from the central cell. Simply find the cell with the closest lipsync, and read off the required audio lip-sync correction for entry into the Sync Delay Module





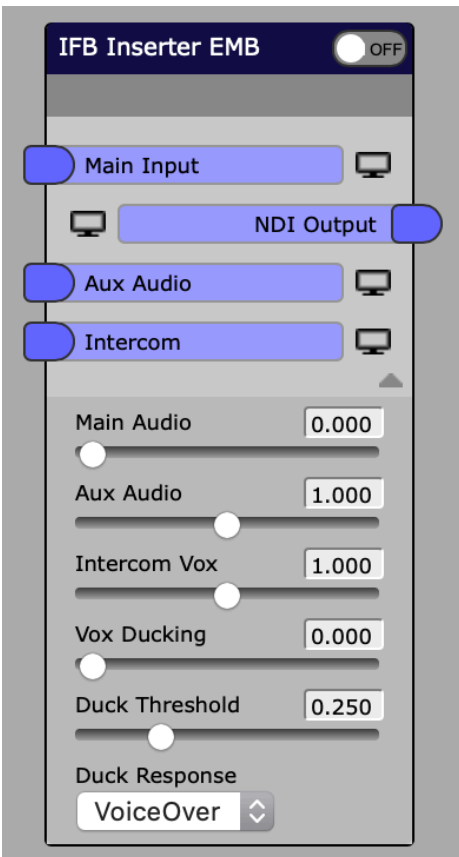
RTP Audio Receiver

Connect to an audio stream described with an SDP file. Useful where SAP discovery is not possible.



Reaper ReaStream Integration

Create 1-8 channel audio IP streams between Sienna and Reaper (or other VST compatible DAWs) using the Reaper ReaStream unicast UDP protocol. Essential for cloud based workflows where AES67 and DANTE are not possible.



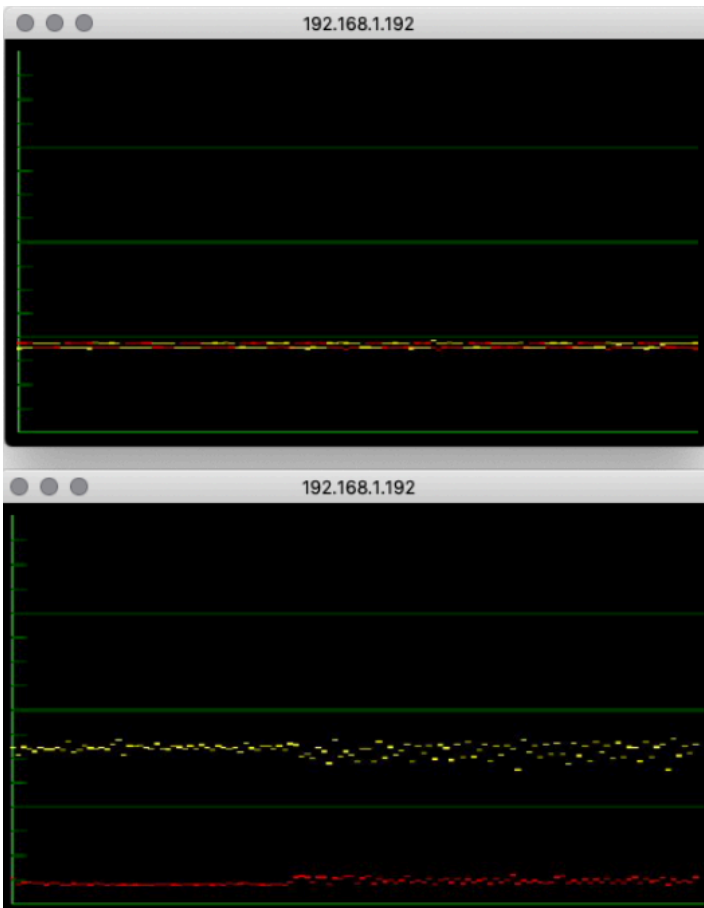
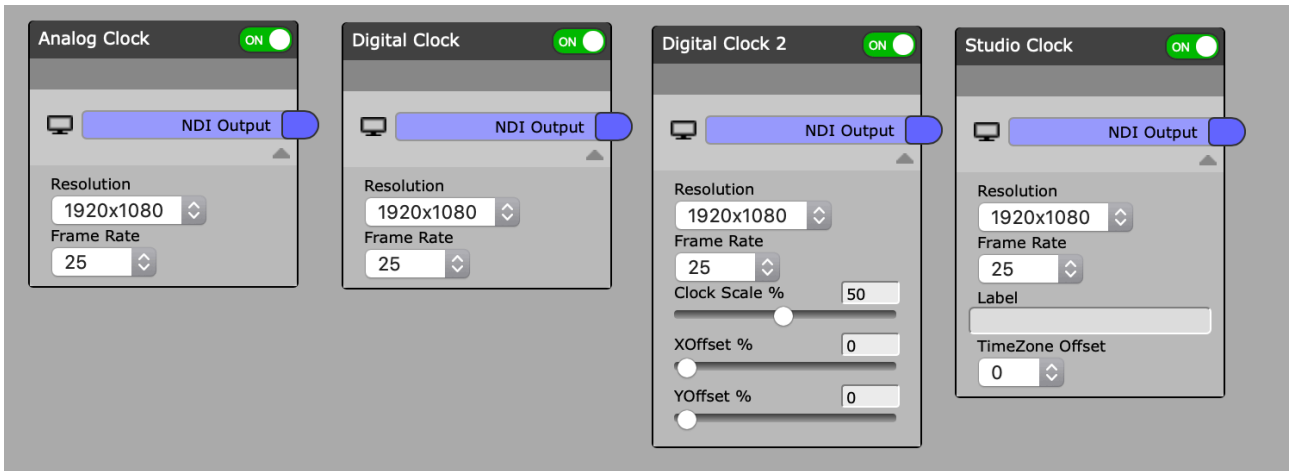
IFB Inserter

This essential module provides a host of tools for preparing return feed audio for contributors - allowing an easy mix of primary AV source with an auxiliary audio source, as well as an intercom IFB Interrupt mechanism to feed director instructions to a live contributor.

This IFB mechanism can also be used for traditional audio ducking for tasks like foreign language translation.

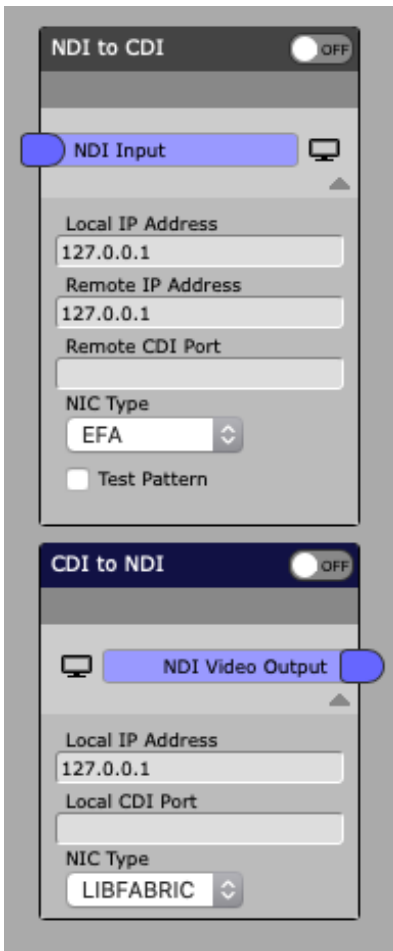
Clocks

A Range of NDI clocks for multiviewers, overlays etc.



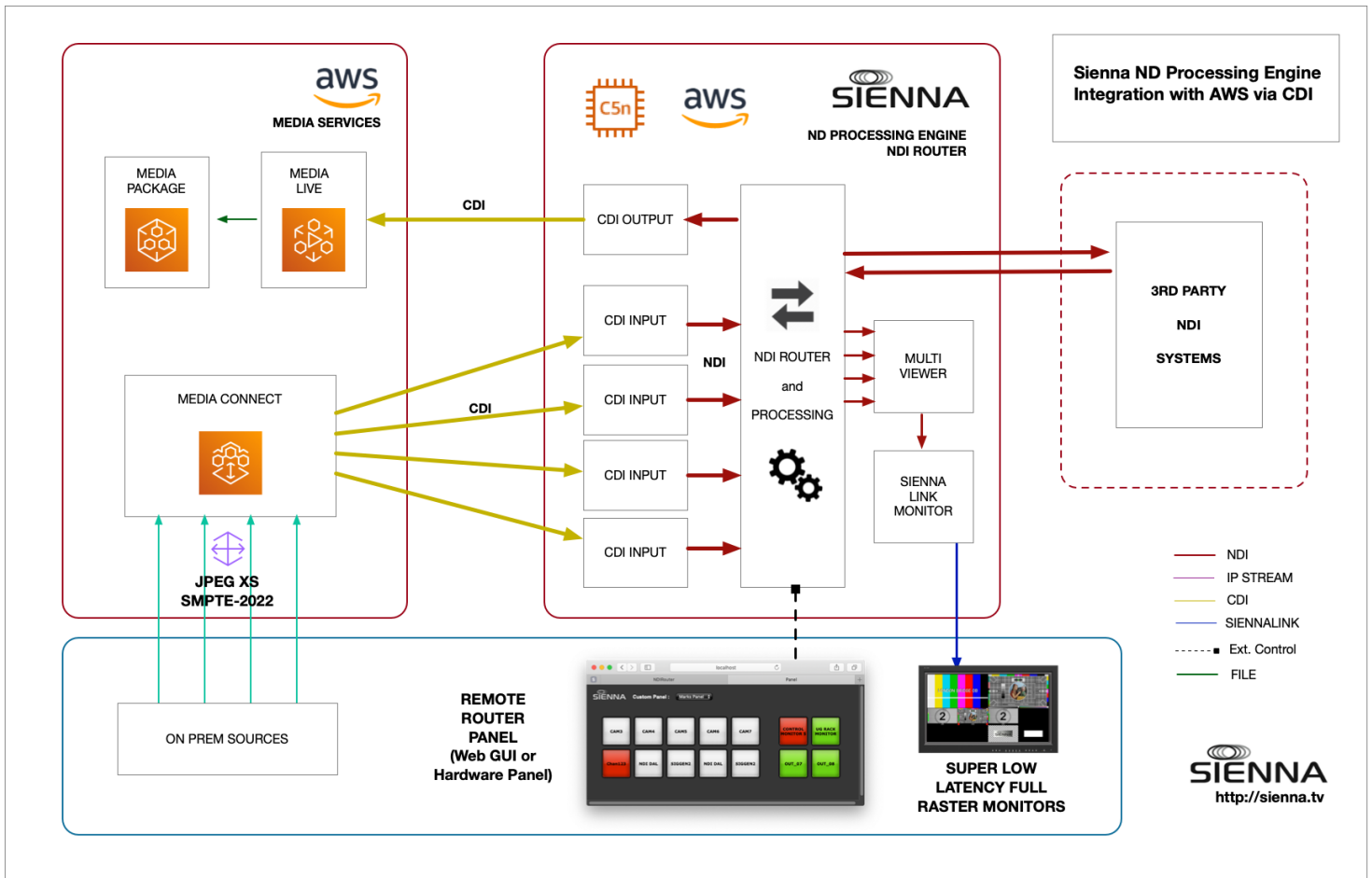
NDI Jitter Scope

A unique tool for characterising NDI field and frame jitter with a real time visualisation. Allows engineers to detect improper field timing (as shown at the bottom) in contrast to perfect pacing (top). It also allows engineers to monitoring increasing jitter which happens naturally when scaling up as software based systems start to hit the CPU or other hardware limits of the platform. Visualisation of jitter is an essential tool to know when a platform capability limit has been reached.

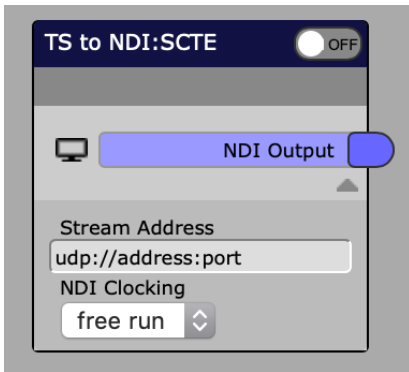


CDI Integration

The CDI Protocol, developed by Amazon Web Services is a pragmatic answer to SMPTE 2110 in the cloud. It combines the SRD reliable transport with 2110 style media essence to allow for low latency, fully uncompressed reliable exchange of video, audio and metadata between cloud based instances. This pair of modules allows for seamless interchange between NDI and CDI for integration with 3rd party systems like AWS MediaServices, and other CDI compatible systems. The underlying SRD layer provides stream protection for imperfect network connections, making the CDI protocol more reliable than traditional SMPTE 2110 connections which use raw unprotected RTP messages. The Sienna modules support the AWS EFA (Elastic Fabric Adaptor) for highest QOS in AWS, but can also use regular network adaptors in AWS or other cloud platforms, or on prem.



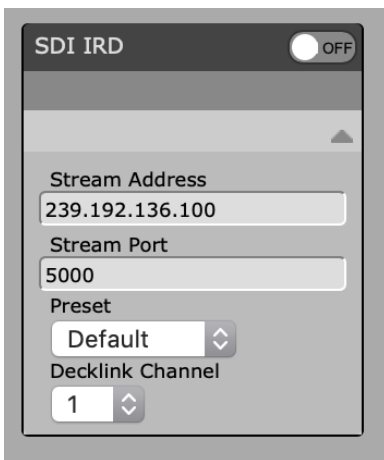
SCTE-35 Utilities



SCTE-35 extractor from MPEG TS

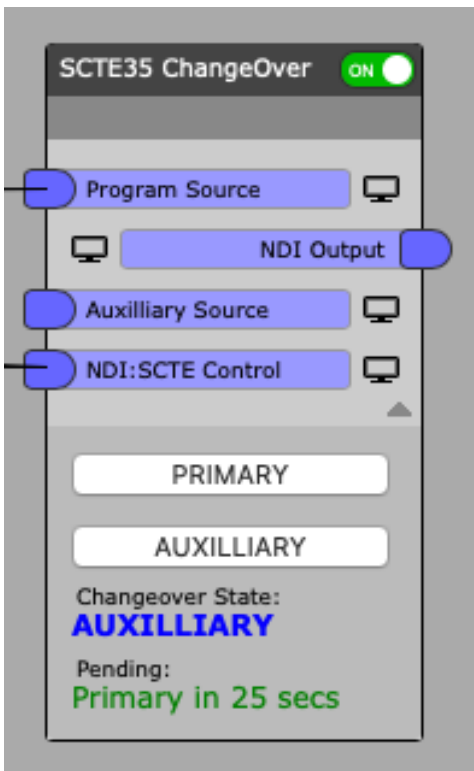
This module decodes an MPEG transport stream which includes SCTE-35 triggers into an NDI Audio Video stream with embedded NDI:SCTE35 metadata.

This can be used by downstream systems for automatic splicing and other advanced functionality.



SDI IRD (inc SCTE / CC)

This module outputs to SDI from an MPEG Transport stream. If the stream contains SCTE-35 it will convert to SCTE-104 in the SDI, and if the stream contains C708 closed captions these will also be inserted in the SDI VANC. Supports BlackMagic Design SDI interfaces.



NDI:SCTE-35 ChangeOver

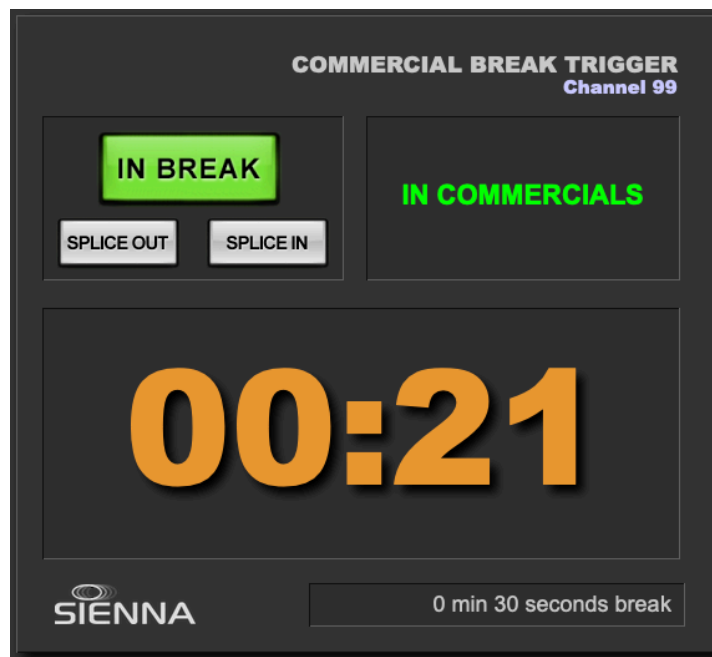
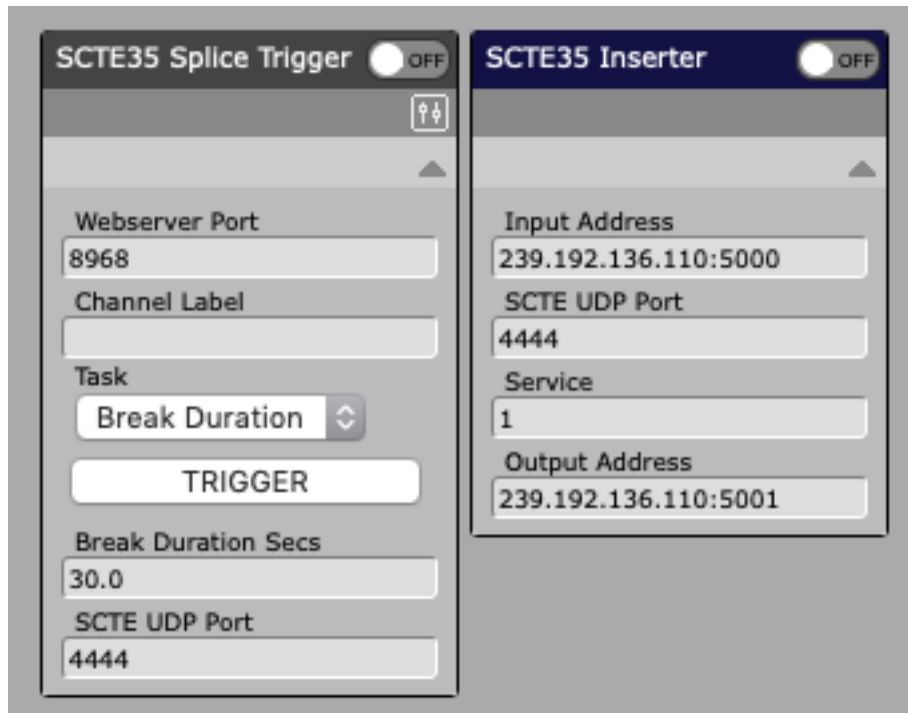
This module performs automated clean-switch changeover between a Program Source and an Auxilliary Source (eg Advertising Server feed), under the control of NDI:SCTE-35 messages embedded in the Control Stream.

This can perform SCTE-35 driven changeover from upstream received MPEG Transport Streams. or from SCTE35 triggers generated inside the NDI Processing Engine environment. On screen information shows the status of the changeover, including pending actions driven by SCTE-35 timed messages.

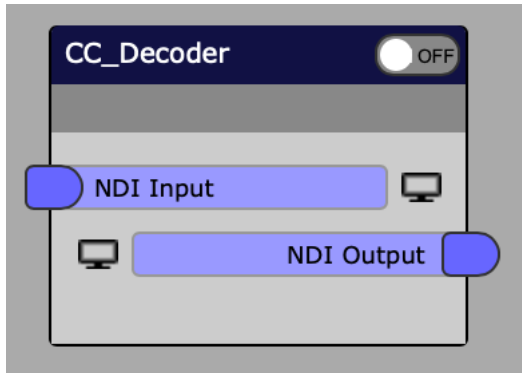
SCTE-35 Trigger / Inserter

This pair of modules provides a mechanism to originate, SCTE-35 Splice Insert messages and then insert them into an existing MPEG Transport stream for downstream action.

The Splice Trigger module has a Web Interface for triggering commercial breaks and includes on screen status information, countdown etc as well as spoken voice notifications which can be patched into your intercom system to alert production to start of break and count down back to live.

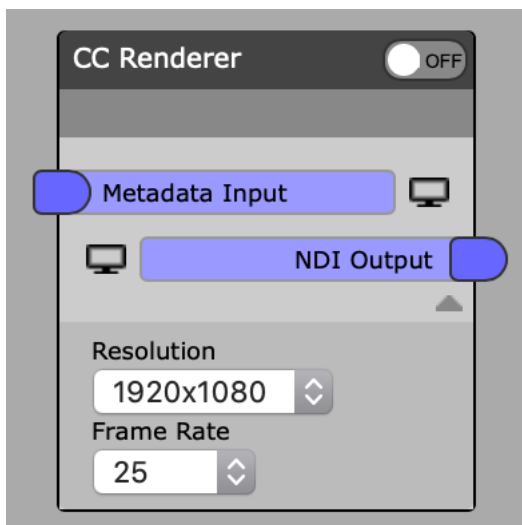


CC-708 Closed Caption Utilities



CC Decoder

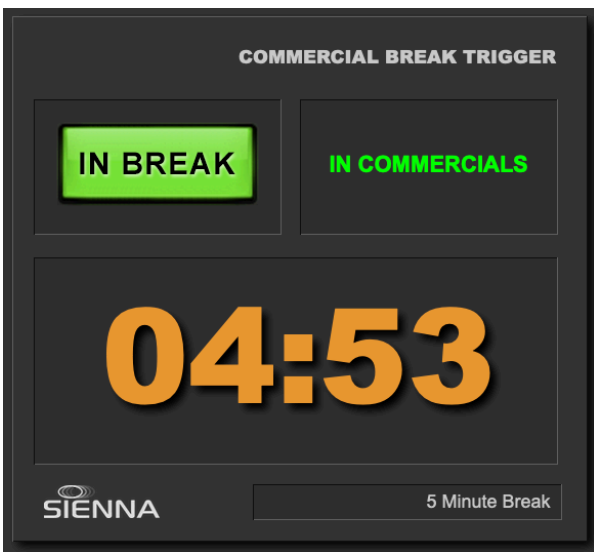
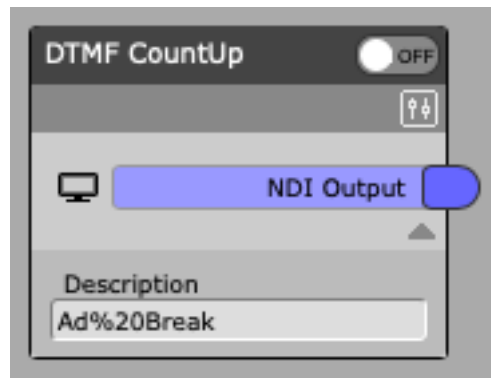
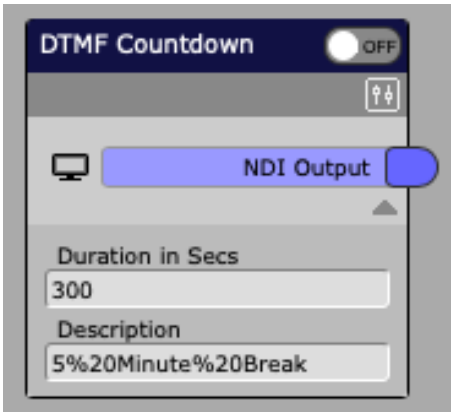
This module translates raw NDI:C708 metadata from Sienna NDI Source Maxi into NDI:UCF format universal caption metadata.



CC Renderer

This module renders NDI:UCF universal caption format metadata as burned in captions as a fill and key NDI stream for overlay.

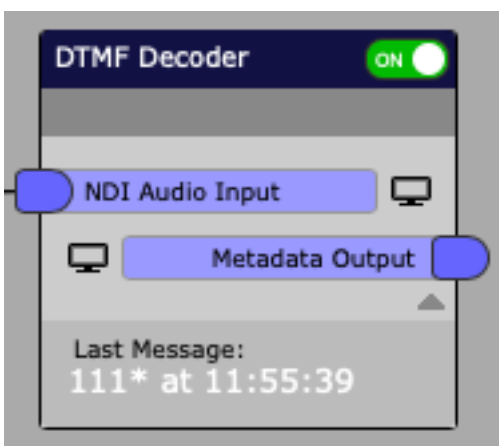
DTMF Tools



DTMF CountDown / CountUp

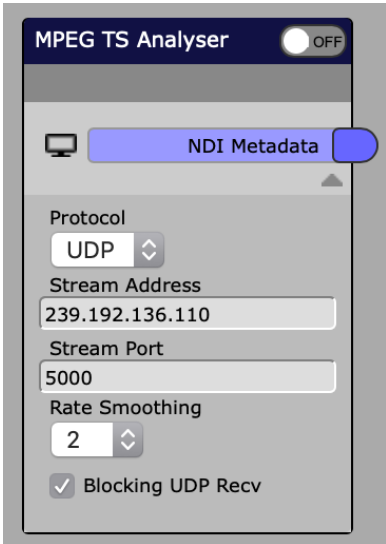
This pair of modules provides a more traditional method of triggering ad-breaks, using DTMF signalling in audio. A web interface allows the operator to trigger a break which is emitted as NDI Audio with DTMF tones, and includes on screen status information, countdown etc as well as spoken voice notifications which can be patched into your intercom system to alert production to start of break and count down back to live. An NDI Audio Embedder can add

extra channels to your existing program stream to carry DTMF messaging alongside your program audio



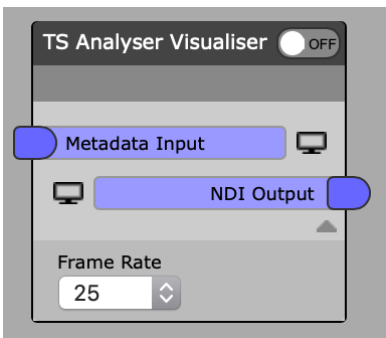
DTMF Decoder

This module decoded DTMF messages in the incoming NDI Audio stream. Once decoded the data is shown in the module status, and also emitted as NDI Metadata using the NDI:DTMF protocol which can be processed downstream by the NDI Metadata Engine, or passed to NODE:RED.



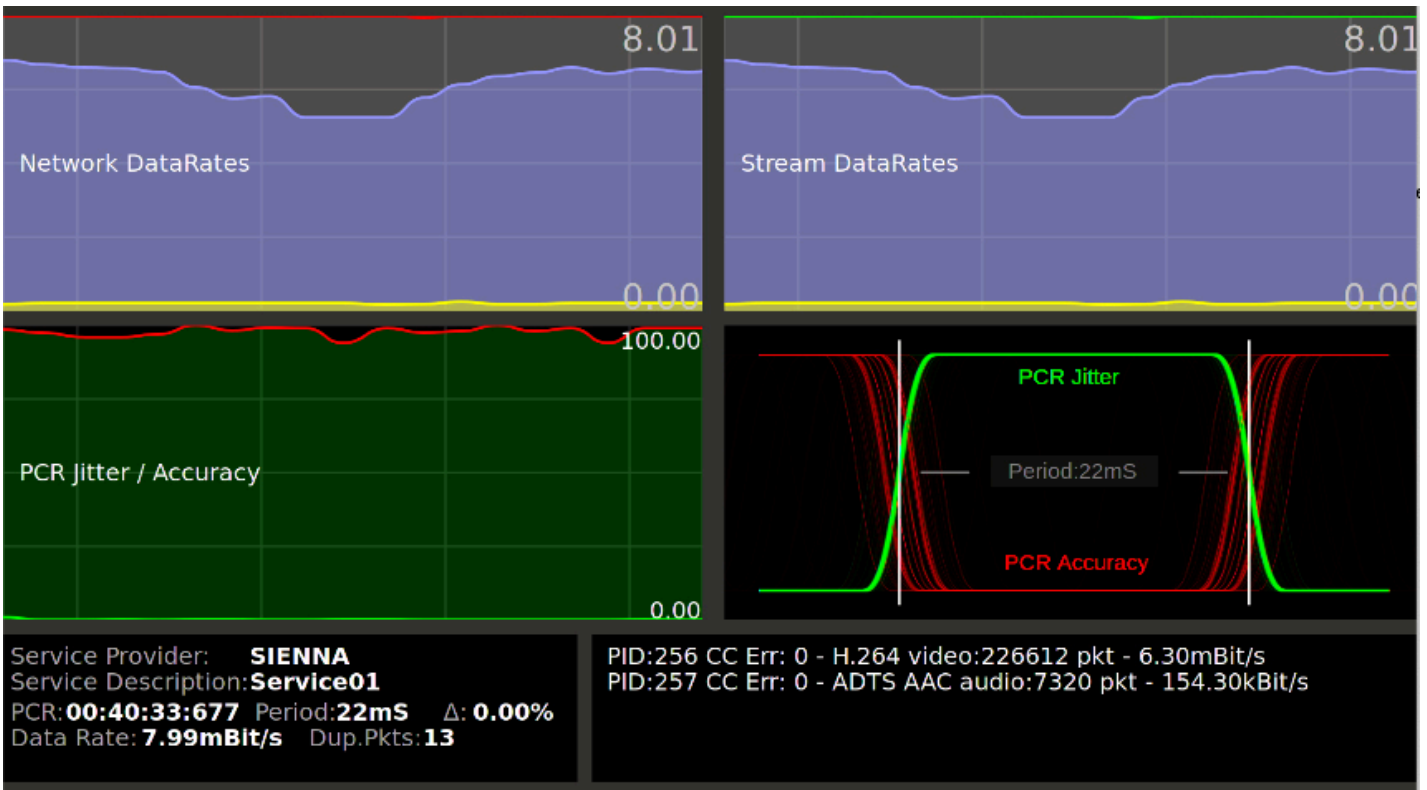
MPEG TS Analyser

This essential module performs packet level inspection of UDP or RTP MPEG Transport streams and creates a real time metadata output with metrics such as PCR jitter and accuracy, CC and RTP error and other useful data. This metadata can be fed to the visualiser below or to other systems such as alarm generators in case of stream issues.



TS Analyser Visualiser

This module visualises the metadata from the MPEG TS Analyser as shown below. It features a re-imagination of the classic SDI eye pattern as a mechanism for visualising PCR jitter and accuracy.



The User Experience

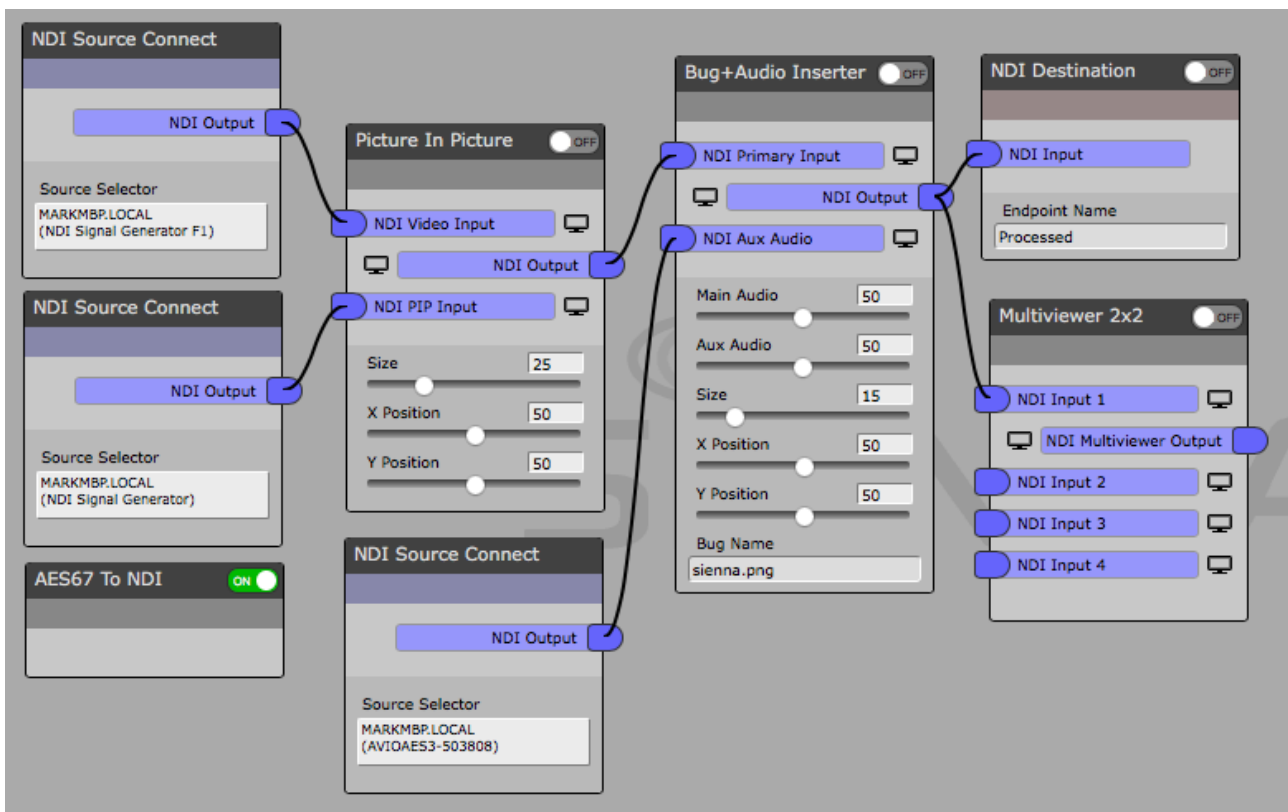
Central configuration via Web Interface

The Sienna N

DI Processing Engine has a web based interface for constructing and monitoring processing chains using the various modules available.

NDI Sources and Virtual Destinations are presented in a graphical interface where users can drag modules into a canvas, then drag connections between inputs, modules and outputs.

Complete 'patches' of connectivity can be constructed and saved in templates for instant recall later on when required.



Development Status and Roadmap

This document provides an outline of the requirements anticipated by broadcasters, and proposed functionality to deliver solutions.

Sienna NDI Processing Engine

The NDI Processing engine and all the modules shown in this document are complete and shipping Ubuntu 20.04LTS. Further modules are in development, and Sienna is accepting commissions for custom modules, workflow consultancy design and implementation.

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