System Design Template - Large Auditorium Audio and Video Distribution

This system design template describes how Tesira products can provide audio and 4K video distribution over a single network for a large auditorium. The system design assumes a large auditorium of greater than 2000 seats. The template contains audio and video distribution for the front of house, back of house, lobby and box office. In the past, performing arts spaces have generally been designed with disparate systems for audio and video. TesiraLUX, Tesira SERVER-IO, and Tesira AMP amplifiers running on AVB allow for a single system design, with all audio and video signals automatically kept in sync without any manual intervention required.

This template serves as a guide for a complex system that spans an entire building. It can easily be expanded to add automatic unattended mode, assisted listening systems, orchestra pit, paging, intercoms, network redundancy, additional cast and crew facilities, balconies, overflow or breakout function spaces, among many other possibilities.

Auditorium design

- Converged networked audio and video distribution
- Options for compressed or uncompressed video transport, up to 4K resolution
- Front of house and stage manager positions
- Main loudspeaker left and right arrays
- Auditorium delay ring
- 70V audio distribution for back of house, lobby areas and restroom areas
- Microphone inputs via a Dante console
- Stage monitors
- Confidence displays and audio monitors at front of house position
- Cameras for recording and Image Magnification (IMAG)
- Two side projectors and one large main rear projector
- Lectern with video inputs
- Two side projectors and one main rear projector
- Displays in the lobby and back of house
- Media players, signage players and video sources
- Recording and streaming

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• Stage aux video inputs and outputs
• Emergency alarm system mute interrupt and reset

Equipment list

- 1 - Tesira SERVER-IO Cards: 1x SNC-1, 2x DSP-2, 1x AVB-1, 1x DAN-1, 1x SOC-1
- 2 - Tesira AMP-4175R 175W x4 Channel
- 6 - Tesira AMP-4350R 350W x4 Channel
- 1 - Tesira AMP-4300R CV 300W x4 Channel 70V
- 15 - TesiraLUX IDH-1 Video encoder connected 10G
- 20 - TesiraLUX OH-1 Video decoder connected 10G

Example configuration file

The example template contains one audio partition and one 10G video partition. The file will require presets or control interfaces to change video and matrix mixer routing. Microphone left-right mixes and stage monitor feeds are received through the 6 channel Dante Input block. The embedded HDMI audio and stage auxiliary audio is also received in to the mixer block through partition connectors. The mix of inputs can be independently delivered to the front array, delay ring, stage monitors, lobby, back of house, front of house monitors and the recording mix. There is a fire alarm logic input to trigger a global mute of the matrix mixer via a preset. A logic output can power a LED to show the alarm state and include a reset button to restore audio.

The 10G video partition has all input and outputs connected to a single AV Router. Partition connectors are used to de-embed the HDMI audio to the audio partition. Audio mixes are returned to the video partition and re-embedded using the AV Combiner blocks. The analog aux audio is used to deliver stage auxiliary inputs and the front of house audio monitors.

Download Configuration File: Large Auditorium v1.tmf

Network details

The network can make use of converged control, AVB and Dante protocols running on shared network fabric to reduce the amount of switch hardware required. TesiraLUX supports 1G or 10G networking. AVB is able to seamlessly mix...
different port speeds. TesiraLUX will use 10G in this example for lowest possible latency with best video quality. The network will combine one 48-port 1000BASE-T copper switch and one 48-port 10GBASE-SR fiber switch uplinked together. Reference the Video Network Design Guide for information on building a high capacity AVB video network. See the List of AVB-capable Ethernet switches for compliant switch models.

Setup Requirements:

- 48-port 1G AVB enabled switch
- SERVER-IO DSP, AVB networked amps, Dante devices and control ports will be on the 1G switch
- 48-port 10G SPF+ AVB enabled switch
- TesiraLUX video end points will be on the 10G fiber switch
- 1G uplink between switches
- Enable AVB on the switches
- Configure VLANs for Dante and Control (AVB automatically VLANs.)
- Configure management IP addresses and DHCP

Audio setup

The main left and right arrays for auditorium sound reinforcement have a combined total of 7000W of power available from the networked amplifiers. The example in the template assumes a pair of bi-amped cabinets for each array with powered sub cabinets all configured in stereo. This is only one example of many other possible clustered designs that would best suit the particular acoustic space.

The loudspeaker processing custom blocks organize the DSP blocks for output to the networked amplifiers. The loudspeaker manufacturer recommended crossover, FIR filters and EQ values should be applied at the custom blocks. See Formatting FIR Filter Coefficient .csv Files for more information on importing FIR Filter data to Tesira Software. Level adjustments and peak limiter values are applied before the signals are delivered to the networked amplifiers. The Tesira AMPs contain hardware limiters but the Peak Limiter DSP block allows for fine grained control. The 16 band PEQ before the custom blocks is used for room coloring.

Tesira Software automatically handles synchronizing outputs during compilation using delay EQ groups. Dynamic delay EQ is used on the HDMI audio paths so the media remains time aligned with any changes in video processing. Delay EQ may also be used to synchronize all audio and video outputs if the system designer desires. See the Lip Sync and Delay Equalization in TesiraLUX article for further audio-video sync information. Different delay EQ groups can be configured for audiovisual isolated spaces. The delay ring in the auditorium requires the appropriate delay time value for the acoustic space. The 70V wired loudspeakers in the lobby and back of house may also have delay applied to align with the main auditorium or displays located outside.
HDMI audio will require adjustment during commissioning. Testing should include various types of user created and consumer media. The dynamic range can vary on different content types. Level controls, AGC and peak limiters can be used to compensate for large changes in the audio dynamic range of HDMI content.

Video setup

TesiraLUX supports 1G or 10G network connections for video streaming. In this example, all of the TesiraLUX video end points are configured for 10G fiber connection. The bandwidth mode is configured to 2160p60 with no compression. Scaling and compression are disabled to achieve end-to-end transit latencies near 16 ms, a critical factor for synchronization with live audio and image magnification. No compression allows large projected images to appear in maximum detail for the audience. See Video Bandwidth Controls in TesiraLUX and Video and Network Latency for more information.

HDMI audio de-embedded via the network and mixed on the DSP. HDMI audio can be mixed with mic audio and returned to the HDMI outputs to recording or streaming services. Dynamic Delay EQ within Tesira will preserve the audio-video time alignment throughout all of the DSP and video processing. Delay EQ can be used to time align signals from the networked amplifiers and the HDMI outputs if desired by the system designer.

EDID typically does not require any intervention and the EDID Preferred mode is sufficient. Each TesiraLUX end-point contains a broadcast quality scaler. EDID is managed automatically by each discrete end point.

Control

A large system expects that multiple users may be manipulating audio and video controls at the same time. Tesira can be controlled via an external touch screen system, software interface and through a series of recalled presets. Presets may contain blocks from both audio and video partitions. Presets and the instance tags of block objects are addressable by external systems through serial or IP communication. Tesira Canvas software can be used to connect meters, adjust levels or recall presets for the AV Router.

The fire alarm system mute can be connected to the GPIO ports of the SERVER-IO or TesiraLUX devices. GPIO can provide LED status indicators and an alarm reset switch. Logic is extendable to include an automatic operation mode, auto input port selection on the lectern or activation of standby mode for amplifiers, among a wide range of possibilities.

Further reading

- Auxiliary analog audio I/O in TesiraLUX

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• Formatting FIR Filter coefficient .csv files
• List of AVB-capable Ethernet switches
• Lip Sync and Delay Equalization in TesiraLUX
• Video and network latency
• Video bandwidth controls in TesiraLUX
• Video network design