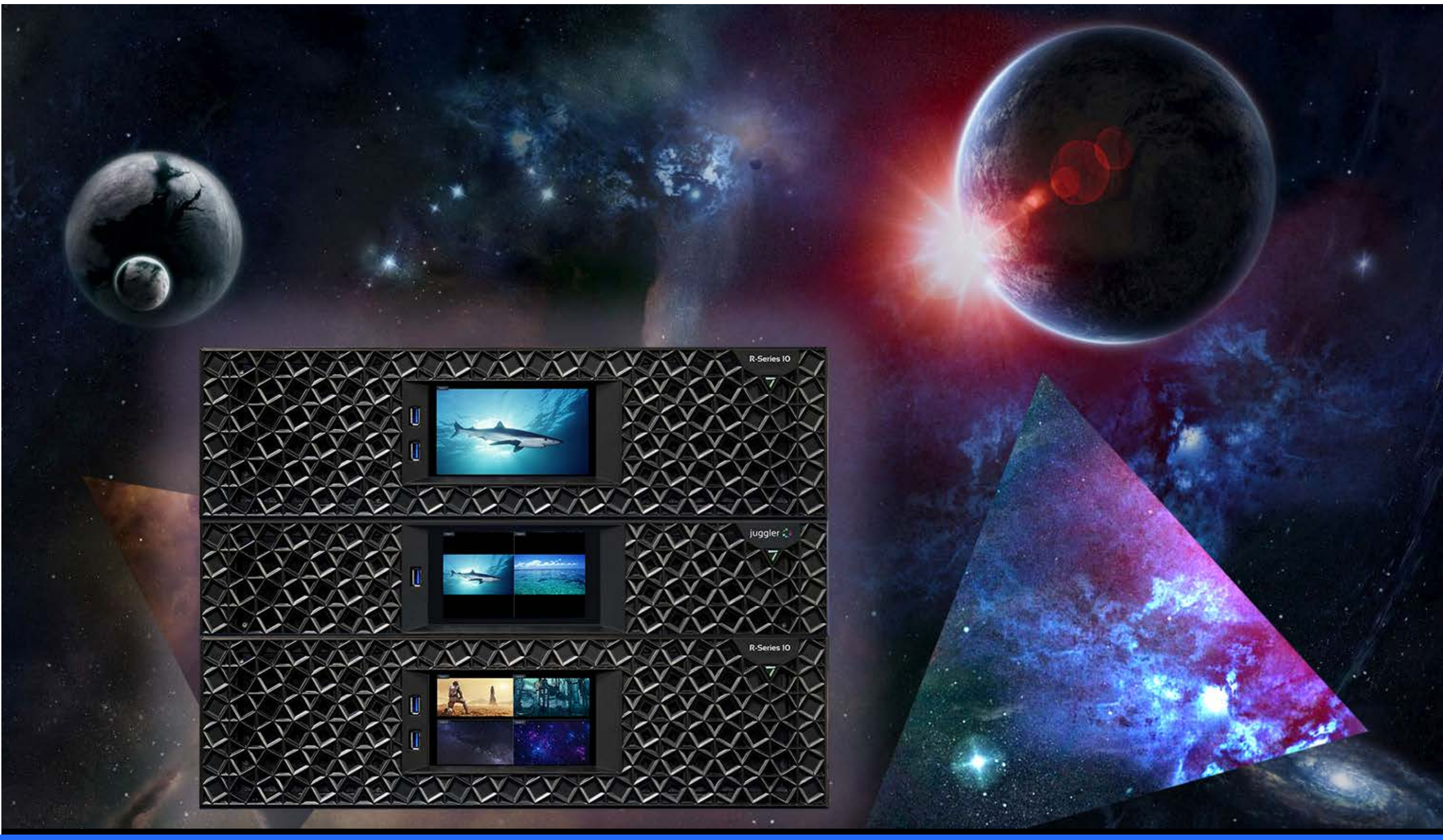
7thSense Media Servers

Synchronising Media Server Systems

User Guide



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7THSENSE

Synchronising Media Server Systems : User Guide

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Introduction to Timing

However accurate quartz system clocks are, they do remain individual and separate. This means that the precise duration of a second varies between them. The difference will be very small, but over a day, fractions of a second either way accumulate, and at 60 fps, drift between system elements can become apparent. This guide provides a basic overview to how the elements in a Delta Media Server show system can be synchronised, and when and why this matters.

Marking Time

DeltaServer synchronises frame display with the refresh clock of the server's output GPU(s). The first pixel is presented at the very start of the first line, every time. But when we have a number of servers, or multiple GPUs in each, many display devices, audio, and other parts of the system, show controllers and so on, how do we keep everything perfectly in sync?

Time, and Displaying Frames (Refresh)

Multiple graphical displays shared across several servers on the same display system will not be synchronous unless the graphical processing units (GPUs) in all servers themselves are fully synchronised. Display hardware must synchronise the screen refresh across all display devices, by using a common, repeating timing pulse to trigger the VSync signal in every display and synchronise the HSync. Absolute or elapsed time does not matter: but each new frame will be displayed simultaneously across all devices. A genlock input per server, and a simple house-sync pulse generator is all that is required for display synchronisation.

Matching Frame Delivery and Display

When frames are passed from DeltaServer to a graphics processor (GPU), the frame will be held until the VSync signal is ready. When in 'Auto' or 'Hardware Timed' mode, DeltaServer is locked to the GPU refresh clock, whether this is internal to the GPU, or drawn from an external sync reference. Frames must therefore be completely loaded before the VSync, otherwise a frame may be dropped. Delta pre-caches a configurable number of frames from disk to ensure this does not happen. Presenting frames from disk through to display requires adequate disk performance, graphics performance and processing capacity, so the higher the media resolution, and the more blending, warping or effects being applied, the more will be demanded from the server.

Movie Time

Sequential movies are always in frames, so the framerate is defined in its format. Delta allows the application of framerate compensation, so that media of different framerates can be played on the same timeline. This can be smoothed by choosing interpolation.

Audio Time

LTC audio tracks carry embedded SMPTE timecode, which enables multiple servers to synchronise their playheads to an external LTC timecode. This code is essentially time reference meta data. If the server is not genlocked to the LTC source, this can cause drift between audio and video, showing up easily in lip-synced media, although not obvious with ambient or soundtrack audio.

Matching Movie and Audio Tracks

For ‘pure playback’ on DeltaServer systems, playback rates must be coordinated properly from top to bottom. From production to media render to Delta timeline settings, to desktop/EDID settings or SDI format settings and house sync, to signal transmission path, display – everything should be designed and purposed to work in the same refresh (or multiple of the same refresh). However, DeltaServer copes with a degree of tolerance even when not everything is perfect.

By placing audio and movie resources on a timeline, we lock them together in time. In limited scenarios, a movie frame rate can be compensated for by giving it more or less real time in display, using the Playspeed adjustment. If an audio track is frame-adjusted it may discernibly change pitch and go out of tune in relation to other tracks or sound sources, depending on the amount of adjustment, though DeltaServer can compensate for this with its own pitch correction. The best solution is to design the media playback to a consistent framerate.

We can sync timelines between servers, and even better, genlocked to an external timing source. But what happens when media do not all start at a frame reference of zero? Or when loudspeakers at a large outdoor projection are a significant distance from viewers? Any individual resource can be repositioned on a timeline to provide positive or negative time adjustment, and additionally all audio on a server can be offset in DeltaServer Configuration Defaults by a given number of frames (plus or minus).

Delta Time

Delta time is based on movie time: i.e. the smallest unit of time is the frame, according to frame rate.

In smaller systems, and for shorter show lengths, Delta servers can simply be placed in the same Timing Group, so that their timelines are internally synced. A Leader Delta server will broadcast its timeline position as a series of binary timing packet to Follower servers in the group, so that the playheads of every timeline in every server are synchronised. However, without a common genlock source, servers may drift *between each other* over a longer continuous play time. We may want all devices to refer to a central clock and a central timecode instead.

Communications Integrity

Delta Leader-Follower communication is carried out over the network. For analogue timing sync connections, long runs of unshielded or unbalanced cable can cause signal loss and noise in timing signals, so RCA/phono, BNC or mini-XLR connectors and coax or balanced cable should be used.

Genlock: Synchronizing Devices

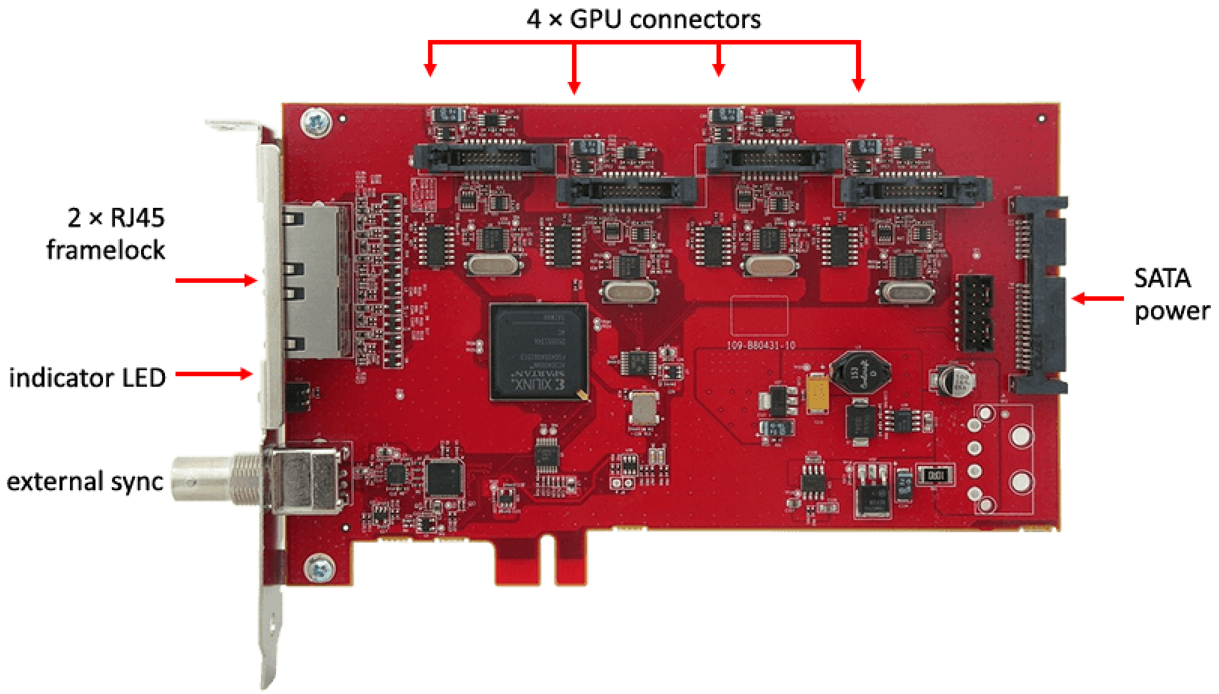
GPU Graphics Cards

Within a media server, multiple GPUs and displays must be synchronized. This is called output locking, and ensures that all displays refresh and scan together, using a sync module (card) designed for the GPUs in use.

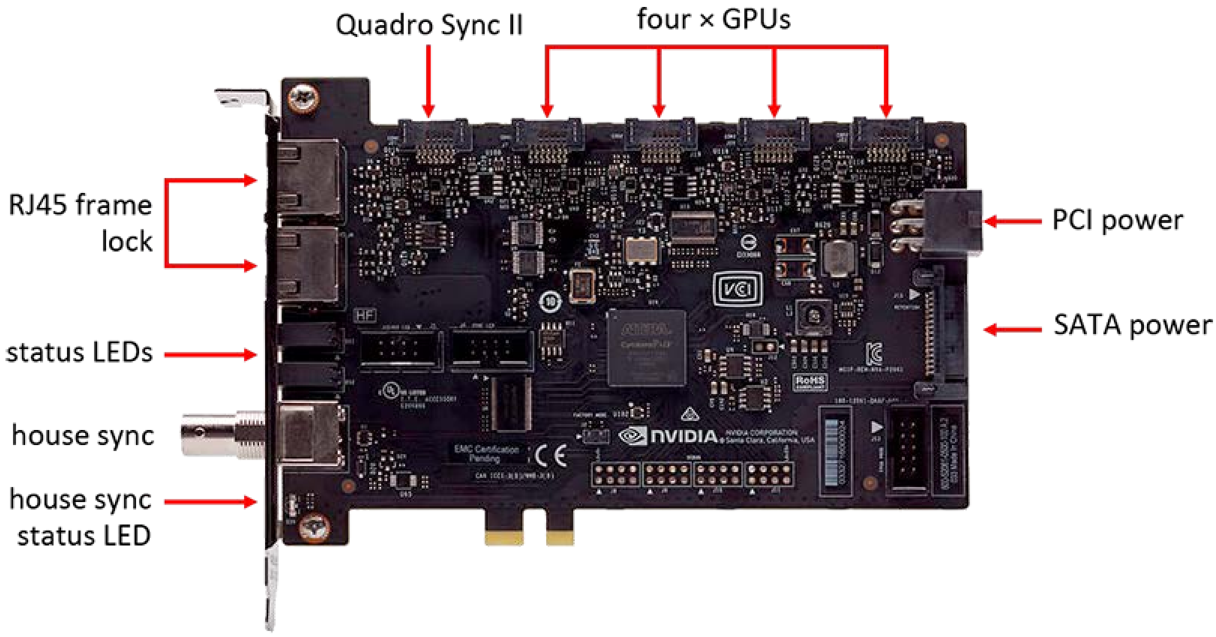
Delta media servers use a directly-injected external house sync generator signal into each graphics sync module via its BNC connector. This is called genlocking. (Genlocking is a licence option in Delta.) This 'house sync' is then selected as the timing source in each GPU's configuration.

Synchronization Modules

AMD® ATI FirePro™ S400 GPU synchronization module, partners up to four AMD FirePro graphics cards:



The NVIDIA® Quadro® Sync II is very similar, partnering up to four of their Quadro Pascal series cards:



HD-SDI Graphics Cards

HD-SDI graphics cards, such as from Bluefish444 and Matrox® have built-in synchronization (house-sync input) and do not require secondary sync cards, though multiple HDSDI cards in a single server require individual sync cables, as there is no internal distribution.

Live Capture

When live capture devices are being used, capture cards should be genlocked to the same source as the server for best performance. Delivery of a captured frame to display is not instantaneous (within a few frames, depending on how it is being processed, such as effects being applied).

Sync Generators: for Display, and More

‘House sync’ modules (also known as black-burst or sync generators), such as these examples, with the required number of outputs, generate a configurable square-wave sync pulse for genlocking the sync cards and other timing-dependent devices, such as show controllers, live capture cards, and separate audio systems:

The smaller unit, above, can be used to provide a reference pulse simply for display synchronisation. We commonly recommend a tri-level sync pulse of an appropriate format for the required display resolution and refresh rate.

The larger unit also provides an audio-synchronising ‘word clock’. This is a digital signal at 44.1 or 48 kHz designed for keeping digital audio devices in sync with a constant, precisely-timed bit-rate. Since LTC is broadcast via an audio source, a word clock will keep all devices including the LTC source in sync. A sync generator such as this will therefore meet the needs of both GPU display sync, and server playback sync via LTC.

Timing Sources

Sync Generators

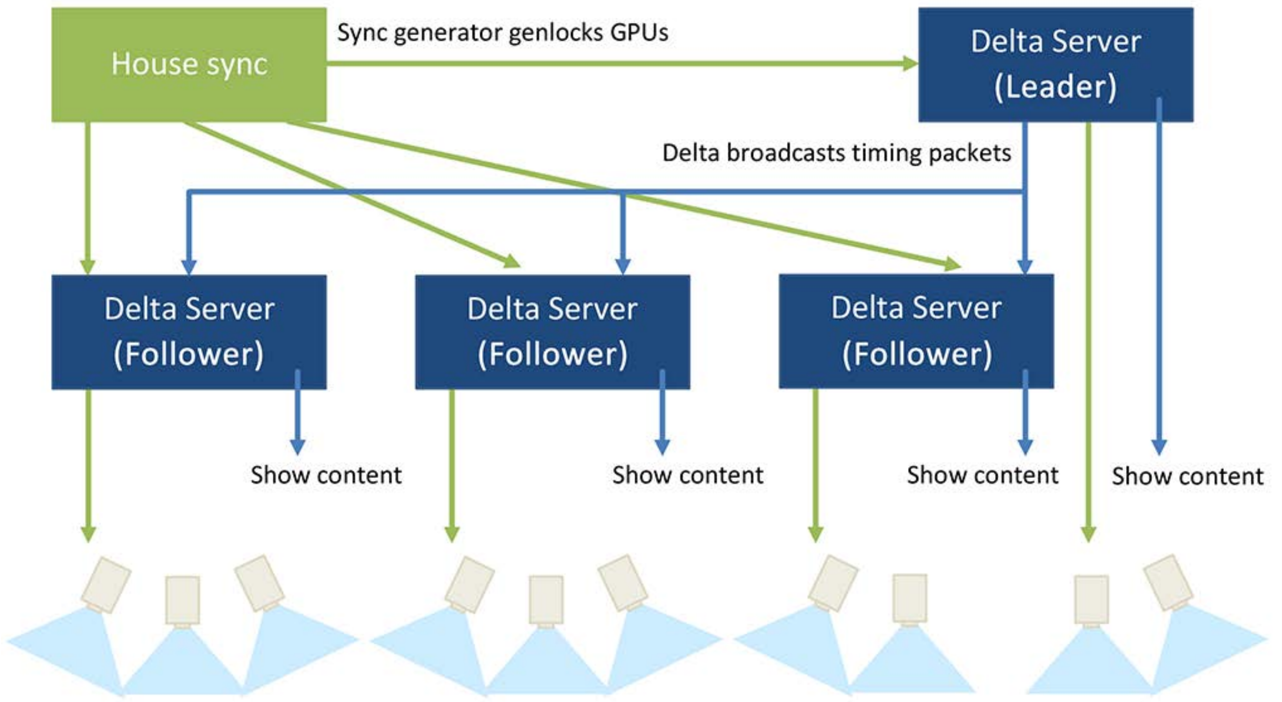
DeltaServer syncs its frame playback to the server GPU clock (in ‘Auto’ or ‘Hardware Timed’ modes), and each GPU can be synced in turn to a central house sync clock. Such **sync pulse generators** and **word clocks** do not convey data, only a highly accurate bit-rate as a common timing (not time) reference. Sync pulse generators are used for graphics display synchronisation, whereas word clocks are the standard for synchronising audio devices. Some audio devices have their own internal word clock.

LTC sources

Linear timecode (LTC) provides much more. Whilst the LTC signal is digital in structure, the transmission is traditionally analogue – typically as a .wav audio file with a bit-stream rate of around 1 kHz to 2.5 kHz, in order to be safely within audio range. This is encoded with the required framerate, sample rate, bit depth and duration, to the SMPTE 12M specification. The data block for each frame has 80 bits. These include 26 bits to carry the SMPTE time, and 32 that can carry optional user data (for example, relating to the media for which it is intended). The final 16 bits of the block comprise a fixed bit-pattern ‘sync word’ that an LTC reader uses to define the frame boundary, play direction, and bit-rate of the sync tone.

Delta Leader-Follower Timing

Synchronisation between media players, media resources, display, effects and projection equipment can be fairly complex, and real clock time is not used. However, agreement on the duration of a second, and **relative time position** do matter. Timestamp markers running through media resources provide all the reference needed for the Delta timeline, which in turn can broadcast the timeline playhead position. Another Delta server receives that position, and its playhead takes the same position on its timeline (i.e. ‘play this same frame no. now’). A Delta Follower server playhead will then always be in the same position as the Leader it is listening to, and will be frame-accurate to ±1 frame when no genlock is present, or frame-accurate with genlock. The downside is that if the Leader server fails, timeline reference is lost across all servers and the show will stop. Here a Delta Leader and three Followers are timeline synchronised, taking their clock reference from the Leader server GPU, and all GPUs and displays are house-synced:



Chasing LTC

Multiple Delta servers that are not Leader-Follower related, or are in different Leader-Follower timing groups, and systems incorporating other devices, or control desks, will need more than a Delta timeline timing packet, so instead we can use a common timing source of linear timecode (LTC), in an audio stream.

This could be played as an audio track on one Delta server, but it must be accommodated within the specification of the server **providing the LTC stream**, since it requires media storage capacity, bandwidth, and an audio channel. One audio channel of this server is assigned to LTC output, and this channel can be played through an alternative audio device (typically motherboard ASIO audio), with the show audio output running a more professional quality device. This prevents cross-talk and accidental playing of the LTC as show media. The arrangement expands the synchronisation possibilities, but the system as a whole is still vulnerable to dependency on the one server. An **LTC-chasing server** similarly requires a separate ASIO LTC audio input, which must be accommodated in the server specification if it also requires audio output.

An alternative solution is to take the LTC source from a generator app, or use a purpose-made audio track, played on a dedicated server, connected by direct audio input, or SMPTE device such as Adrielec, or an SDI card.

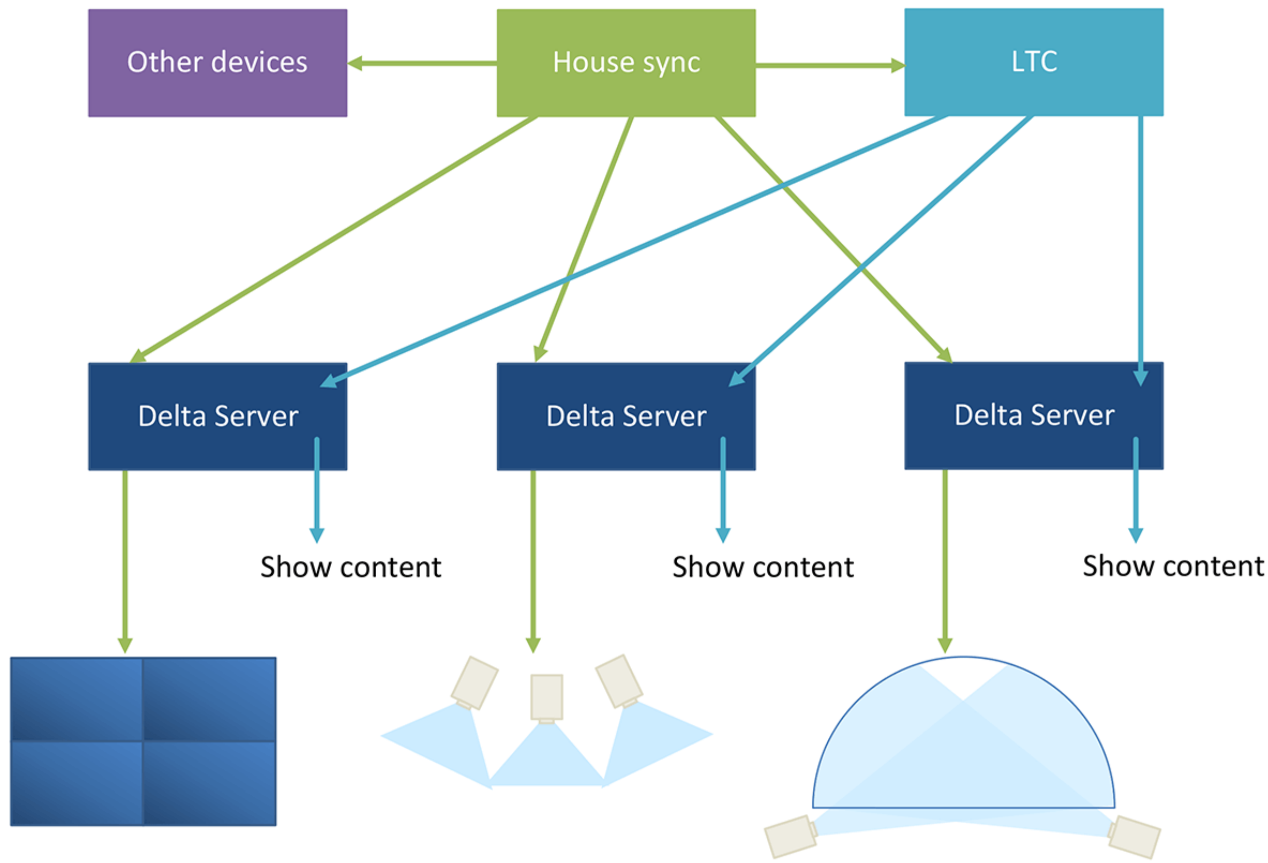
By switching Delta timelines to listen to this LTC source instead of Leader server timing packets, their playheads will track the position dictated by the LTC source (their new ‘Leader’). Set the LTC to run, and the Delta LTC-chasing playheads follow with a configurable pre-roll time. Delta has an LTC reader (LTCReader) that converts the analogue audio signal into digital format SMPTE code, and which free-runs for a number of frames to cover any transient loss from the TLC source. (An Adrielec or similar card will do the same thing as the LTC reader.)

What this does not do, is synchronise a non-Delta LTC player with any other device. So if an LTC source is used that is not genlocked, then the LTC player system clock will inevitably drift from that of the Delta server(s). Over shorter play durations this should not matter, but for longer shows, the drift more will eventually become apparent.

Genlocking

Frame synchronisation, therefore, may not be enough. The many independent clock devices in items of digital equipment, accurate as they may be, can disagree about the precise length of a unit of time, and drift apart. However, by giving them **all** the same ‘pacemaker’, in the form of genlocking, they can all be kept in precise clock sync.

In this diagram, all the hardware systems are genlocked, and all servers are playing in sync with a common LTC, which is itself genlocked.



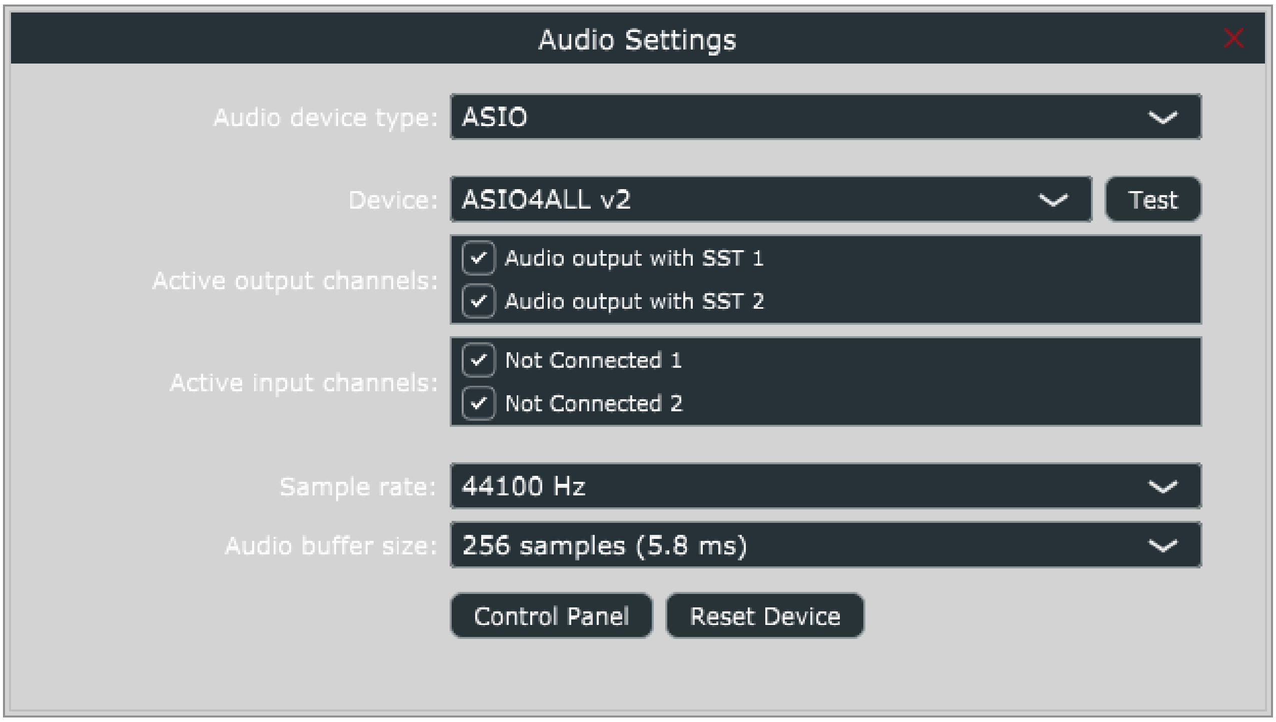
Note that display devices also carry different degrees of latency, and this will depend also on how much internal processing they have.

LTCReader: Chasing LTC

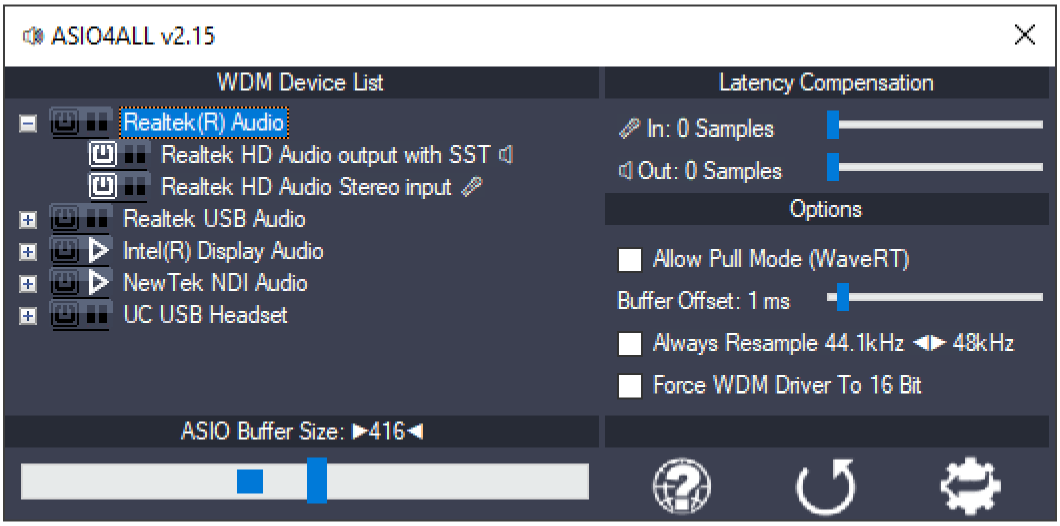
ASIO4All is free, a universal ASIO driver for WDM sound cards, and must be downloaded and installed on any 7thSense Media Servers sending or receiving LTC. It can be used in place of a dedicated LTC card to decode the LTC signal.

Configure LTCReader

Click the 'Config' button and select ASIO4ALL as your device, then select the channel(s) to use for your Line Input:



The Control Panel button will show the current device list, for example:



Use with Delta Media Server

If using LTCReader, for the first time, this can be found on the Delta server in C:\7thSense Data\Software & Drivers\Delta\Utilities.

Once installed, it will run from the system tray, with its own icon. Right click the icon and select 'Show'.

Additional Settings

LTCReader has an XML .settings file which holds these and other parameters, which can be added using a text editor. It can be found at:

C:\Users\[UserName]\AppData\Roaming\LTCReader\LTCReader.settings (LTCReader v.1)

C:\Users\[UserName]\AppData\Roaming\LTC Reader\LTC Reader.settings (LTCReader v.2)

Example LTCReader.settings file for Delta:

```
<?xml version="1.0" encoding="UTF-8"?>

<PROPERTIES>
  <VALUE name="soundManPort" val="20000"/>
  <VALUE name="freewheelUnlimited" val="0"/>
  <VALUE name="freeWheelTime" val="100"/>
  <VALUE name="audioDeviceState">
    <DEVICESETUP deviceType="ASIO" audioOutputDeviceName="ASIO4ALL v2"
audioInputDeviceName="ASIO4ALL v2"
                 audioDeviceRate="44100" audioDeviceInChans="1"/>
  </VALUE>
  <VALUE name="startMinimised" val="1"/>
</PROPERTIES>
```

SoundManPort

the port number on which LTCReader will communicate with Delta (see http://portal.7thsense.one/user-guides/MC255-managing-servers/index.html?ports_ports-used.html).

freewheelUnlimited

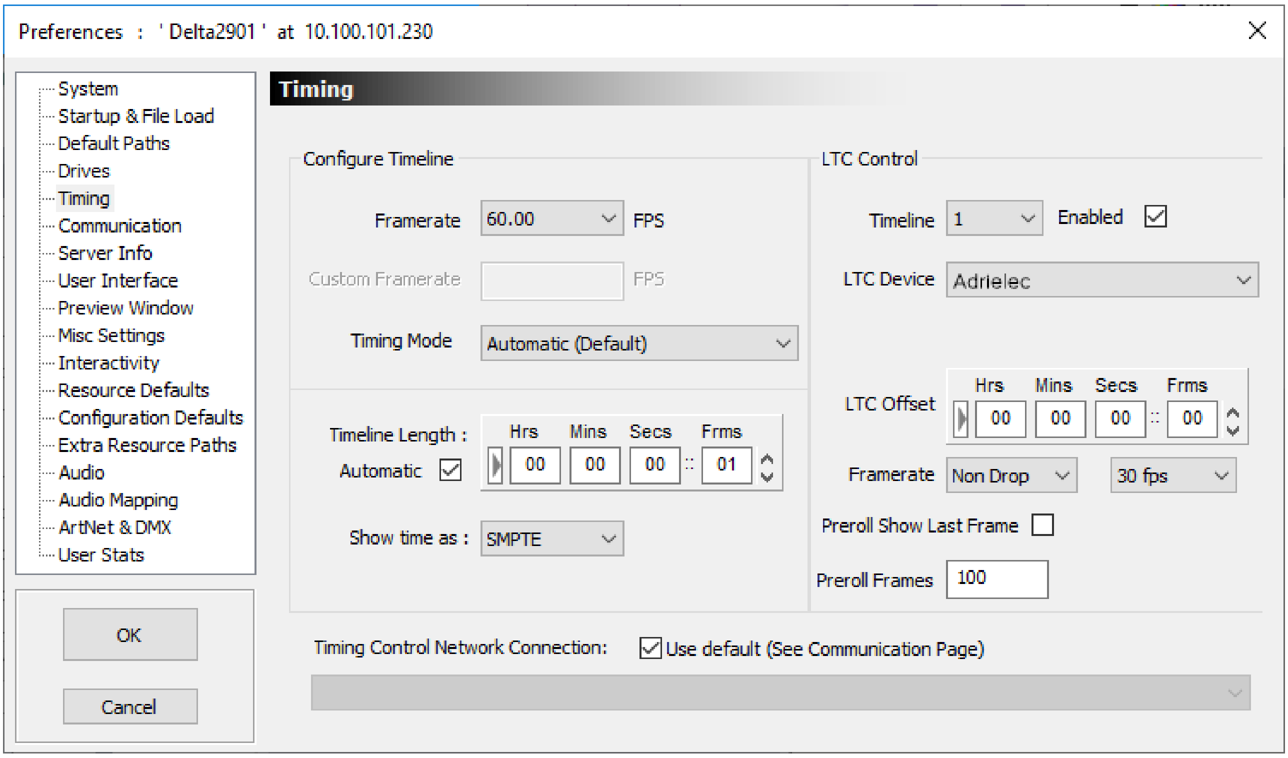
set this to 1 if you want it to free wheel indefinitely, so it will continue counting upwards as if an LTC source was still present, even if it is not or a signal is temporarily lost, or if the LTC source does not have a true 'pause/hold' state.
Setting to 0 will disable this.

freeWheelTime

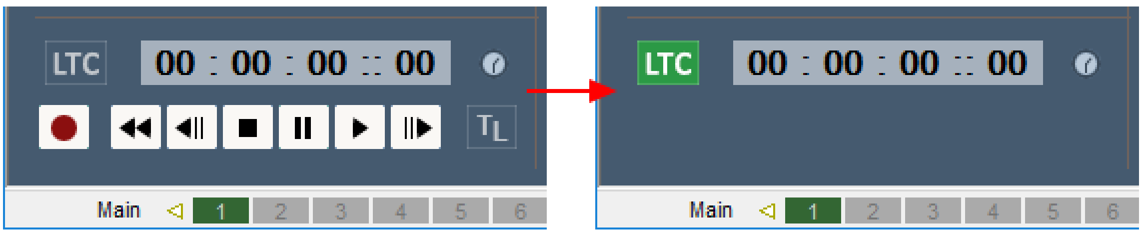
the number of frames to which LTCReader will freewheel for before it stops (default 100).

Configure DeltaGUI (LTC-chasing server)

In an LTC-chasing server, go to DeltaGUI > *Configure* > *Preferences* > *Timing* and ensure the LTC Device is set to Adrielec where available for balanced input, or Local LTC if not, and the required framerate:



In timeline view, click the LTC button for the timeline to play by chasing LTC:



Delta Server providing LTC Output

For versions of Delta greater than or equal to: 2.3.49, 2.4.27 or 2.5.4 and 2.6, see the respective guides for configuring LTC Output in DeltaGUI: *Configure* > *Preferences* > *Audio*. Using the default device occupies a playback channel, whereas ASIO provides an alternative output. See the same guide for playing an LTC audio track resource on the timeline.

Notes

Periodic dropped frames caused by timeline resyncs are to be expected if chasing LTC from non-genlocked sources due to the inevitable drift between different device clocks. A dedicated balanced LTC input card (with phono or mini XLR connectors) instead, ensure good (balanced) LTC signal input.

Prior to Delta 2.6.50, LTCReader required a genlock licence.

From Delta 2.7 LTCReader is not installed as standard. Please contact support@7thsense.one for the installer.

Use with Actor Media Server

For Actor media servers in Compere systems, use LTC Reader v.2.0.6. This should be installed on an Actor device in C:\7thSense\LTC.

Actor timeline `ltc-loop` markers

From v2.0.6, the default behaviour is for LTC Reader to request the markers on all Compere timelines controlled, and to check that they have an `ltc-loop` marker. If any of the controlled timelines is missing the marker, then LTCReader sends a command to add the marker to that particular timeline. The check is performed once each time the LTC timecode reaches 23:55:00:XX and again every time the timecode passes into this range. This is because LTC does not handle more than 24 hours, so it will loop back to 00:00:00:00 and Compere's timeline will otherwise continue on past the 24 hour mark.

Additional Settings

LTCReader from 2.0.4 has an XML settings file which holds these and other parameters, which can be added using a text editor. It can be found at:

C:\Users\[UserName]\AppData\Roaming\LTC Reader\LTC Reader.settings

Example LTC Reader.settings file (additional Compere settings highlighted):

```
?xml version="1.0" encoding="UTF-8"?>

<PROPERTIES>
  <VALUE name="soundManPort" val="20000"/>
  <VALUE name="freewheelUnlimited" val="0"/>
  <VALUE name="freeWheelTime" val="100"/>
  <VALUE name="logLevel" val="Note"/>
  <VALUE name="compereMode" val="0"/>
  <VALUE name="compereIPAddresses" val="10.100.101.66,10.100.101.67"/>
  <VALUE name="comperePortNumber" val="5584"/>
  <VALUE name="frameTolerance" val="3"/>
  <VALUE name="compereTimelinesControlled" val=""/>
  <VALUE name="frameMultiplier" val="1"/>
  <VALUE name="usingFractionalFrameRate" val="0"/>
  <VALUE name="preRollDurationSeconds" val="2"/>
  <VALUE name="preRollEnabled" val="0"/>
  <VALUE name="audioDeviceState">
    <DEVICESETUP deviceType="ASIO" audioOutputDeviceName=""
audioInputDeviceName="ASIO4ALL v2"
                 audioDeviceRate="44100.0" audioDeviceOutChans="0"/>
  </VALUE>
</PROPERTIES>
```

SoundManPort

the port number on which LTCReader will communicate with Delta (see http://portal.7thsense.one/user-guides/MC255-managing-servers/index.html?ports_ports-used.html).

freewheelUnlimited

set this to 1 if you want it to free wheel indefinitely, so it will continue counting upwards as if an LTC source was still present, even if it is not or a signal is temporarily lost, or if the LTC source does not have a true 'pause/hold' state.
Setting to 0 will disable this.

freeWheelTime

the number of frames to which LTCReader will freewheel for before it stops (default 100).

logLevel

this is entered manually in the settings file as required: Verbose, Note, Warning, Important, Error, Critical.

compereMode

1=Compere, 0= Delta

compereIPAddresses

IP(s) of the instance(s) of Compere to be controlled. Multiple IP addresses are comma-delimited.

comperePortNumber

ExternalControl port number of the Compere instance to be controlled.

frameTolerance

If the incoming LTC timecode is more than this many frames different from the previously received timecode, then send a message to Compere to go to the new time.

compereTimelinesControlled

A comma separated list of timeline names to be controlled by the LTC signal,
e.g. "Timeline 1,Timeline 2".

frameMultiplier

(integer) multiplies only the frame section of the timecode sent to Compere by this value, to account for differential drop frame timing on Compere timelines (e.g. 29.97 LTC signal and a 59.94 timeline in Compere).

usingFractionalFrameRate

(Boolean) specifies whether timecodes in Compere External Control messages are separated by : if this value is false or ; if this value is true.

Note that when interacting with LTC Reader v.2.0.2 for Actor/Compere systems, drop frame expression is punctuated with semi-colons 00;00;00;00.

The JSON external control **execute-at-time** allows for precision play/stop triggering of, for example, simultaneous main and failover parallel systems. This requires use of PTP (Precision Time Protocol) to avoid differential delays in receiving play/stop signals, due to network traffic. These two settings are then required:

preRollEnabled

Defaults to 0. When set to 1, this puts LTC Reader into PTP mode so that the **execute-at-time** parameter is added to commands sent to Compere.

preRollDurationSeconds

Defaults to 2. The number of seconds to add to the system time at the point of sending the command, before inserting it into the command.

Timing Glossary

29.97	NTSC standard, the TV broadcast video framerate, originating from early colour TV transmission problems between chrominance and audio carrier signal phasing at 30 fps. Resolved through use of *drop frame* timecoding.
Adrielec	A *SMPTE* device enabling linear timecode (LTC) chasing. A product of Adrienne Electronics Corporation (AEC). Benefits from balanced input allowing longer cable runs.
ASIO / ASIO4ALL	Audio Stream Input/Output: a sound card driver protocol allowing software direct access to sound cards to reduce latency. ASIO4ALL is a generic driver for Windows Driver Model (WDM) devices.
drop frame (DF)	In order to match video at 29.97 fps with real time clocks at 30 fps, this time code drops two frames every minute, on the minute, except every tenth minute.
genlock	Generator locking: the means by which multiple devices are linked to a single synchronising clock signal.
House Sync	Method by which an signal generator produces the time reference (clock signal) for all genlocked servers in group, together with their channel outputs and devices. The signal may be a square-wave pulse or *word clock* for audio synchronisation.
LTC	Linear (or Longitudinal) Time Code: a form of SMPTE timecode encoded into an audio signal along its duration.
LTC chasing	Synchronising playback to a reference LTC audio signal.
LTCReader	A Delta utility app that translates the analogue LTC audio stream into digital SMPTE code. Receives LTC timecode though a standard audio input on a PC to enable *LTC chasing*.
non-drop frame (NDF)	30 fps timecode video source played back at 29.97 fps. Note that being played more slowly this drifts from real time.
NTSC	National Television System Committee; defined pre-digital standards.
real time	Real time clocks (RTC) ‘tell the time’ rather than relative time displacement.

SMPTE	Society of Motion Picture and Television Engineers; defines timecode reference standards for positional identification and additional timecode metadata.
SoundMan	SoundMan Server Virtual Sound System (Richmond Sound Design Ltd), receives LTC timecode though a standard audio input on a PC to enable *LTC chasing*.
tearing	Display image discontinuity caused by display synchronisation problems.
timecode	Relative position in a movie, expressed as hh:mm:ss:ff (hours, minutes, seconds, frames)
timing mode	In Delta: display a Delta timeline in SMPTE, frames or seconds.
word clock	A digital audio signal designed for keeping digital audio devices in sync with a constant, precisely-timed bit-rate of 44.1 or 48 kHz.

LTC Troubleshooting

Here are some checkpoints for ensuring smooth timing operation. It is important that all elements of the system are configured to match.

➢ See also: Display Configuration

Emulation / Format Selection

AMD or NVIDIA (DP, DVI, HDMI)

- What is your EDID format in the Deltas? You can export it in NVIDIA > *System Topology* or AMD > *EDID Management* and then emulate.
- Is this EDID emulated to all utilized outputs? Or are you reading EDIDs naturally from each display?

SDI (e.g. Matrox, BlueFish)

- Is your SDI output format DeltaGUI > *Display* > *Output Setup* > *Output Mode* set to HDSDI?

Grouping (DP, DVI, HDMI)

Is your AMD Eyefinity or NVIDIA Mosaic fully and correctly configured?

Is your server genlocked to house sync?

What is the exact house sync video format being received? This should match the rate of the incoming LTC signal. In NVIDIA this must match 1:1. In AMD 2:1 scaling can be used.

AMD

Open FirePro Control Centre > *Advanced* > *Synchronization* and confirm:

- what is shown for detected External Sync signal format
- all outputs being utilised for the show have green checkboxes next to them in the list
- the timing reference for them is ‘External’ not Internal.

NVIDIA

Open NVIDIA Control Panel > *System Topology* and make sure all utilized outputs have green check marks next to ‘Frame Lock Sync Pulse’.

SDI (Matrox)

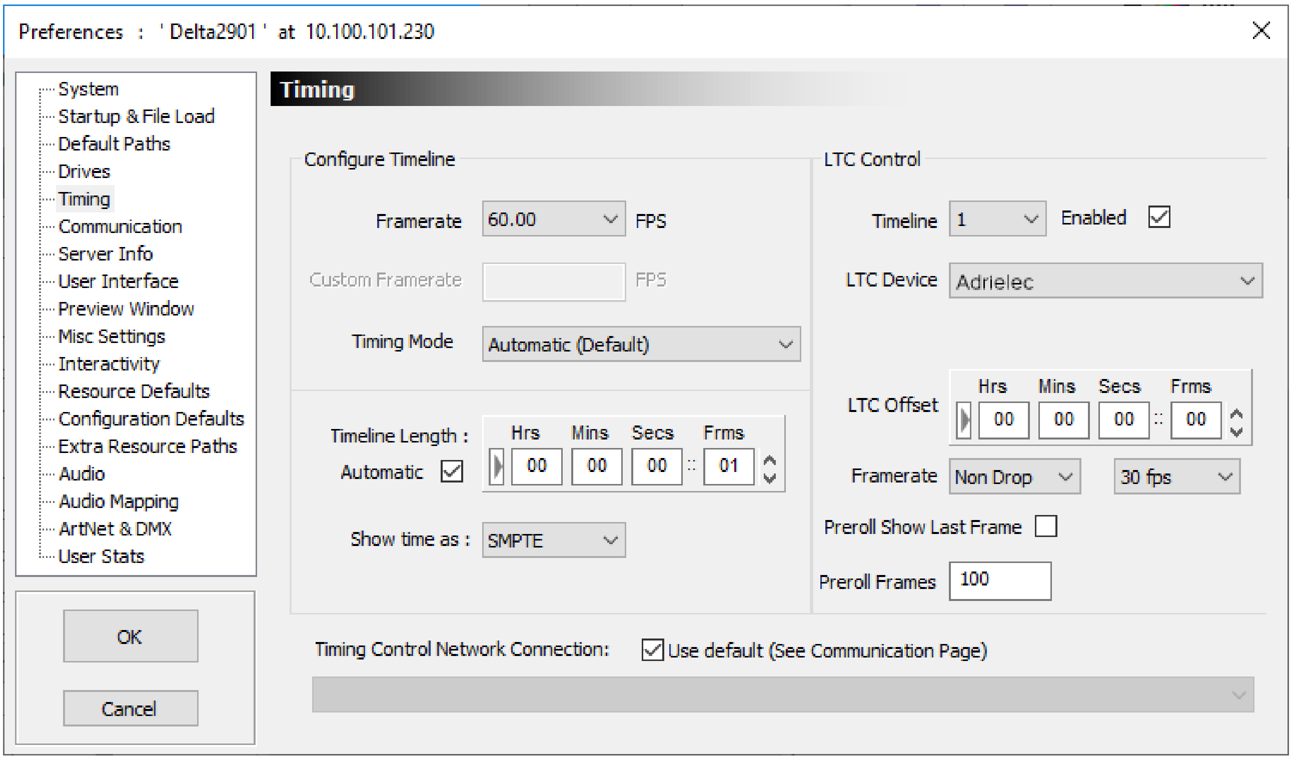
Open Matrox Topology Builder. In the bottom left, click the ‘Cards’ tab. Click on each card detected, and then look near the top of the window and you should see ‘Genlock’ and ‘Locked’ for each card.

SDI (BlueFish)

Check BlueInfo > genlock status and solid white status lights on all cards.

Is Delta Configured Correctly for Incoming LTC?

Go to DeltaGUI > *Configure* > *Preferences* > *Timing*



Check points:

- Delta timeline Framerate is set as required (can be a multiple of LTC rate). (In DeltaGUI > *Config* > *Preferences* > *Configuration Defaults*, you must also check ‘Force Framerate’ to this figure, and uncheck ‘Automatic Framerate’, and set the correct default.)
- Delta Timing Mode (use ‘Automatic’ unless someone has advised you use otherwise for a specific reason.)
- LTC Framerate is set to the required framerate (not Auto).
- setup for SMPTE input

Note: In Leader/Follower configuration, only the Leader server needs to chase LTC. Followers should be configured with forced framerate as above.

Other Considerations

- Is your LTC generator genlockable *and* locked to the same house sync, in other words, is it generating LTC in phase with house sync? If not, this can cause drift and dropped framed due to resync and pre-roll.
- In multi-server configurations, identical EDIDs are recommended across all servers.
- What is the rate (drop / non-drop) of the LTC signal? **Note**: 29.97 non-drop is a non-real-time measure so drifts relative to real-time clocks.
- Adrielec PCIe card Mini-XLR input: check that the input is definitely not pinned out as stereo, and definitely balanced mono.
- Do Leader and Follower servers play happily when not chasing LTC? Or do you get frame drops/stutters/tears then as well?
- Are the frame drop/stutters/tears that you are experiencing when chasing LTC periodic? For example, recurring every 30 s?
  For diagnosis, you might want to take a screenshot of playback stats/graphs around the time it is happening if possible.
- Signal voltage of the incoming LTC, especially over long cable lengths. This is important, and each LTC receiver type will have a different tolerance. If this is the problem, you may need a time code distributor / reshaper.
- Pin-out connections? Motherboard mini TRS audio connectors should be Tip+Sleeve only for LTC. For balanced mono Mini-XLR connectors, pin 1 is ground, pin 2 is LTC+ and pin 3 is LTC-.

Useful Additional Sources

These links might also help as background reading. That some are getting a little dated is more an indication that with SMPTE standards, little has needed to change.

Synchronisation and SMPTE timecode
http://www.philrees.co.uk/articles/timecode.htm

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