EAN-Performance and Latency

PN: EAN-Performance and Latency

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Alerts

The following notifications are used throughout the document to help identify important safety and setup information to the user:

> △ **CAUTION:** Alerts to a potential hazard that may result in personal injury, or an unsafe practice that causes damage to the equipment if not avoided.

ⓘ **IMPORTANT:** Identifies crucial information that is important to setup and configuration procedures.

📄 *Used to emphasize points or reminds the user of something. Supplementary information that aids in the use or understanding of the equipment or subject that is not critical to system use.*

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1   Overview

This document describes how to use the Performance Graph features to measure processing time and latency on the SightLine OEM boards. The performance monitoring graphs are useful for identifying problem areas and analyzing system performance.

1.1   Additional Support Documentation

Additional Engineering Application Notes (EANs) can be found on the Documentation page of the SightLine Applications website.

The Panel Plus User Guide provides a complete overview of settings and dialog windows located in the Help menu of the Panel Plus application.

The Interface Command and Control (IDD) describes the native communications protocol used by the SightLine Applications product line. The IDD is also available as a PDF download on the Documentation page under Software Support Documentation.

1.2   SightLine Software Requirements

The Performance Graphs feature requires version 2.22.xx and higher.

ⓘ **IMPORTANT:** The Panel Plus software version should match the firmware version running on the board. Firmware and Panel Plus software versions are available on the Software Download page.

2   System Performance

2.1   Processing

Processing on the SightLine boards is divided into two categories:

- **Analyze**: Registration, stabilization, tracking, and detection and other non-display processing.
- **Render**: Enhancement, blending, rotation, digital zoom, overlays, encoding, and other display processing.

2.2   Latency

Figure 1 shows where the board video processing takes place (blue) in relation to total system latency (external latency sources in green). Each step in the processing introduces latency.
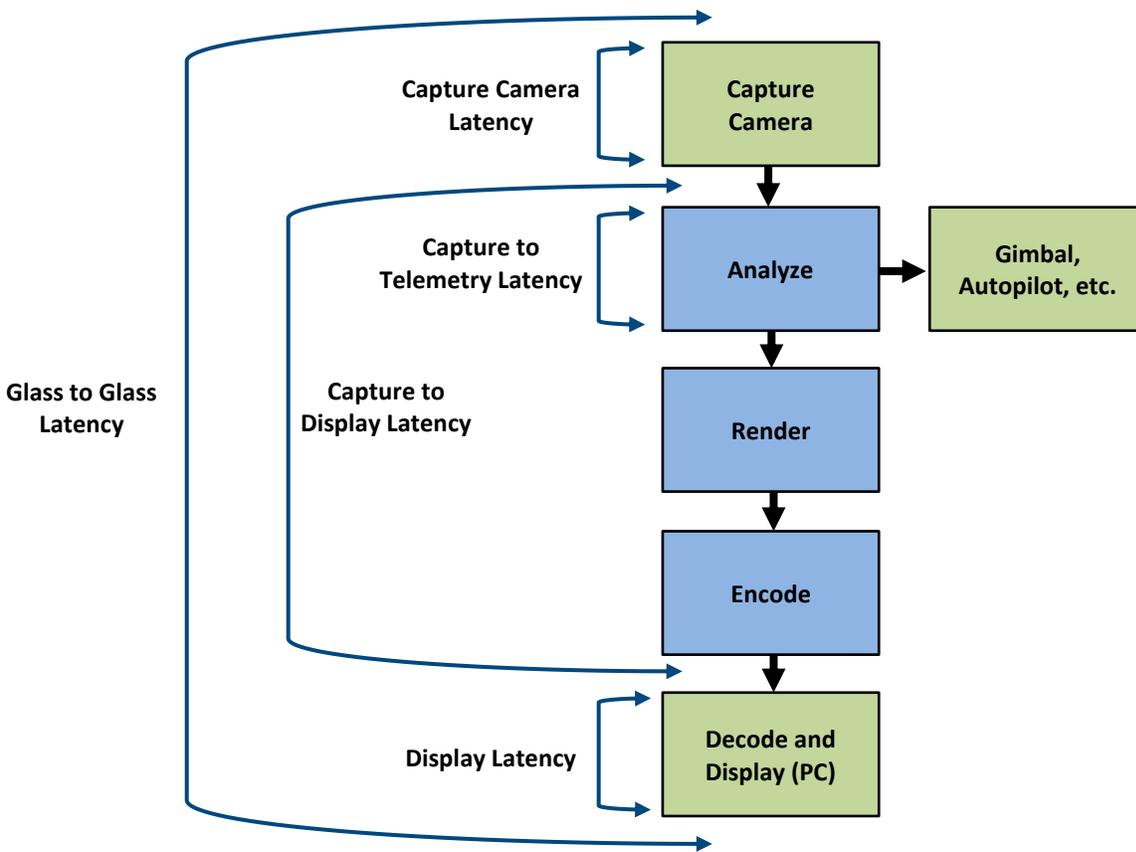
Figure 1: System Latency

Camera Capture Latency: Camera dependent latency in the camera capture, readout, and send-time to SightLine board.

Capture to Telemetry Latency: Internal measurement from the time a frame is captured in the SightLine board to the time that telemetry (frame to frame motion, track location, etc.) is sent out over network or serial port. This is important when closing a feedback loop in a gimbal.

Capture to Display Latency: Internal measurement from the time a frame is captured on the SightLine board to the time that a frame is sent out of the system for display (encoded for network video or sent to physical output interface, e.g., Analog, HDMI, or HD-SDI, etc. This is important for visual latency.

Display Latency: The time delay introduced in either the network display (decode and display video) or in a monitor (analog or HDMI). Latency in decoding network video will depend on software, settings, and PC.

Glass to Glass Latency: Requires an external measurement to determine the time from when the scene changes to the time when the scene is displayed. This number will depend on the camera, processing steps enabled, and system on which it is displayed.

2.3   Processing and Streaming Frame Rate Expectations

The following tables provide a basic understanding of how the system performs. For a more comprehensive understanding of system performance see the _Using Performance Graphs_ section.

Table 1: 1500-OEM Frame Rate Expectation

Video Input	Expected Frame Rate	Encoding Only MPEG4	Stabilization + Track	Add Roll Stabilization	Add Vehicle MTI	Add CLAHE
NTSC	30	Yes	Yes	Yes	No	No
NTSC	15	Yes	Yes	Yes	Yes	Yes
PAL	25	Yes	Yes	Yes	Yes	No
720P30	15*	Yes	Yes	Yes	Yes	Yes
720P25	25	Yes	Yes	No	No	No

The 1500-OEM cannot maintain 30fps with 720p input and output. When using this format, frame-step either the capture or compression by 2. The resulting consistent 15 fps looks better to the operator than an irregular frame rate of 20-23 fps. It will also have consistent frame to frame time and better worst-case latency.

Table 2: 3000-OEM Frame Rate Expectation

Video Input 1	Video Input 2	Expected Frame Rate In 1	Expected Frame Rate In 2	Encoding Only	Stabilization + Track	Add Roll Stabilization	Add Vehicle MTI	Add CLAHE
1080P30	None	30	N/A	Yes	Yes	Yes	Yes	No
720P60	None	60	60	Yes	Yes	Yes	No	No
720P30	None	30	30	Yes	Yes	Yes	Yes	Yes
1080P25	720P25	25	25	Yes	Yes	Yes	Yes	No
1080P30	1080P30	15	15	Yes	Yes	Yes	Yes	Yes

Table 3: 4000-OEM Frame Rate Expectation

Video Input 1	Video Input 2	Expected Frame Rate In 1	Expected Frame Rate In 2	Encoding Only	Stabilization + Track	Add Roll Stabilization	Add Vehicle MTI	Add CLAHE
4Kp30	None	30	N/A	Yes	No	No	No	No
4Kp25	None	25	N/A	Yes	Yes	Yes	No	No
4Kp30	None	15	N/A	Yes	Yes	Yes	Yes	Yes
1080P60	None	60	N/A	Yes	Yes	Yes	No	Yes
1080P30	None	30	N/A	Yes	Yes	Yes	Yes	Yes
4Kp25	1080P25	25	25	Yes	Yes	Yes	No	No
4Kp30	1080P30	15	15	Yes	Yes	Yes	Yes	Yes
1080P30	1080P30	30	30	Yes	Yes	Yes	Yes	No

New in 3.01.xx software.

For 4K video camera type can have a big impact on frame rate.

2.4 Glass-to-Glass Latency Values - General Expectations

Example system configurations for glass-to-glass latency are shown in the tables below.

Table 4: 1500-OEM Glass-to-Glass Latency

Software Release	Camera	Input Format	Output Format	Encoder/ Display	Latency
2.24.7.39064	Analog	NTSC	Analog NTSC	tv-small	130
2.24.7.39064	Analog	NTSC	480p	H.264	145
2.24.7.39064	Analog	NTSC	480p	RTP H.264	150
2.25.4.43906	Hitachi	720p	480p	H.264	170
*2.25.4.43906	Hitachi	720p	720p/15fps	H.264	200

📄 *Note on latency for 720p in/out: The 1500-OEM cannot maintain 30fps with 720p input. See frame rate notes above.*

Table 5: 3000-OEM Glass-to-Glass Latency

Software Release	Camera	Input Format	Output Format	Encoder/ Display	Latency
2.24.7.39064	Analog	NTSC	NTSC	tv-small	145
2.24.7.39064	Analog	NTSC	480p	H.264	145
2.24.7.39064	Bench HD-SDI	720p	720p	H.264	145
2.24.7.39064	Bench HD-SDI	1080p	1080p	H.264	210
2.24.7.39064	Bench HD-SDI	1080p	1080p	RTP H.264	210

Table 6: 3000-OEM Glass-to-Glass Latency with HDMI Monitor

Software Release	Camera	Input Format	Output Format	Display	Latency
2.25.1.42458	Bench HD-SDI	1080p 30	1080p 60	HDMI	190
2.25.6.44688	Bench HD-SDI	1080p 30	1080p 30	HDMI	230
2.25.6.44688	Bench HD-SDI	1080p 25	1080p 25	HDMI	245
2.25.6.44688	Bench HD-SDI	720p 50	720p 50	HDMI	180
2.25.6.44688	Bench HD-SDI	720p 60	720p 60	HDMI	160

Table 7: 4000-OEM Glass-to-Glass Latency with HDMI Monitor

Software Release	Camera	Input Format	Output Format	Display	Latency
3.01.00.52751	Bench HD-SDI	720p 60	720p 60	HDMI	120
3.01.00.52751	Bench HD-SDI	720p 50	720p 50	HDMI	140
3.01.00.52751	Bench HD-SDI	1080p 30	1080p 30	HDMI	160
3.01.00.52751	Bench HD-SDI	1080p 25	1080p 25	HDMI	190
3.01.00.52751	Bench HD-SDI	4Kp 30	4Kp 30	HDMI	170

Table 8: 4000-OEM Glass-to-Glass Latency with Panel Plus

Software Release	Camera	Input Format	Output Format	Display	Latency
3.01.00.52751	Bench HD-SDI	720p 60	720p 60	H.264	150
3.01.00.52751	Bench HD-SDI	720p 50	720p 50	H.264	160
3.01.00.52751	Bench HD-SDI	1080p 30	1080p 30	H.264	170
3.01.00.52751	Bench HD-SDI	1080p 25	1080p 25	H.264	190
3.01.00.52751	Bench HD-SDI	4Kp 30	4Kp 30	H.264	270

3   Performance Optimization

It is important to run a consistent frame rate. For SightLine hardware, providing gimbal feedback at a regular rate (not occasionally skipping a frame) will improve control loops by minimizing the worst-case latency. Motion in output video with inconsistent frame rate tends to look erratic e.g., 15 Hz can look better than 23 Hz.

3.1   Optimizing Performance

Use the performance graphs to monitor telemetry rate, display frame rate, processor load, latency, and process tree. If the telemetry or display rate is at an in-between rate, i.e., 21 Hz, and the processor has a high load, improvements to the system performance can be made by changing parameters and setting frame steps.

3.1.1   Video Compression

1500-OEM:

Video compression takes significant DSP processor time. Using lower resolution, frame step and a faster codec will reduce this impact. MPEG4 uses less processor time than H.264 with low impact to bitrate and quality. MJPEG uses even less processor time, but at the expense of higher bitrate.

3000-OEM / 4000-OEM:
Video compression does not significantly impact processor load.

3.1.2   Image Rotation, Zoom, Rotation Stabilization

1500-OEM / 3000-OEM:

Enabling image rotation, zoom or rotation stabilization increases the render time. Turn off features that are not used.

4000-OEM:
Video rotation and zoom does not significantly impact processor load.

3.1.3   Video Enhancement

Video Enhancement increases render time. Turn off this feature if it is not being used.

3.1.4   Detection

Detection can use more down-sample, smaller search area, and frame step to reduce processor time. This will impact detection sensitivity.

3.1.5   Multiple Displays

Multiple display impacts processor load and latency. Turn off unused outputs, e.g., network + analog » network only.

3.2   Frame Step

Frame step is set up in the *Acquisition Settings* tab*.* The render and display frame step are set up in the *Compression* tab.

3.2.1   Capture Frame Step

From the main menu, got to *Configure » Acquisition Settings*. Setting *Frame Step* to a value greater than 1 throws away frames as they are captured. Analyze and render will not process the discarded frames. This is most useful for a smooth display frame rate.
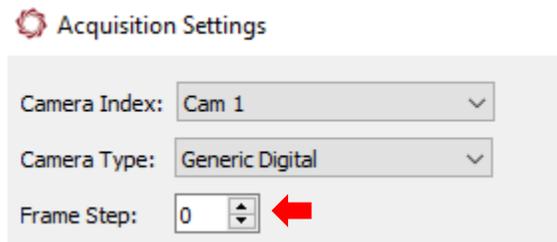
Figure 2: Capture Frame Step

3.2.2   Render and Display Frame Step

Render and display frame step are set in the *Compression* tab. Setting the frame step to value greater than 1 skips frame rendering and display. Analyze still processes all frames, but some frames are not rendered or displayed. This is most useful when using full rate telemetry for control and still being able to save processing cycles.

Figure 3: Render and Display Frame Step

3.2.3   Frame Step Optimization - SightLine Systems for Gimbal Control

If the camera is 60Hz, set the capture frame step to 2.

📄 *In some setups, it may be possible to run at 60Hz with the 3000-OEM or 4000-OEM.*

If the system is not able to output full frame rate telemetry, increase the render and display frame step until you get 30 Hz telemetry and a consistent display frame rate.

### 3.2.4   Frame Step Optimization - SLE Systems for Display

Increase the capture frame step as necessary to get a consistent display frame rate.

4   Using Performance Graphs

4.1   Configuring Panel Plus

1. Connect to the board using the Panel Plus application. See the corresponding OEM startup guide for connection instructions.

2. From the main menu in Panel Plus, go to *View* » *Performance Graphs*. A separate window opens that displays the performance monitoring areas (see Figure 4).
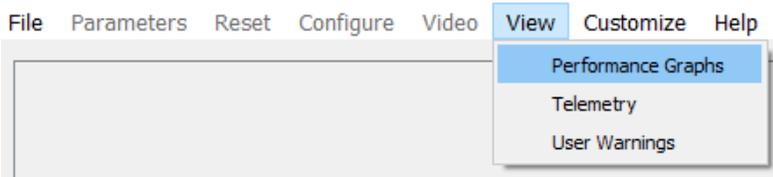
3. To enable/start system monitoring, check the following boxes at the top of the window:

   - ***Enable System Status***: Shows the processor loads and frame rates at the bottom left.

   - ***CPU Timing***: Displays process timing for major functions.

   - ***Detailed CPU Timing***: Displays process timing for low level functions (less useful).

   - ***Show High Low***: Displays the minimum and maximum in the Load Plot (less useful).

4.2   Performance Monitoring Areas

The *Performance Graphs* window (Figure 4) displays four performance monitoring areas:

- ***Process***: Displays CPU execution time broken down by function and latency type.

- ***Time Data***: Displays a graph of the process functions, matched by color.

- ***Loads***: Displays processor load, temperature and frame rate.

- ***Load Plot***: Displays a graph of the Loads information.
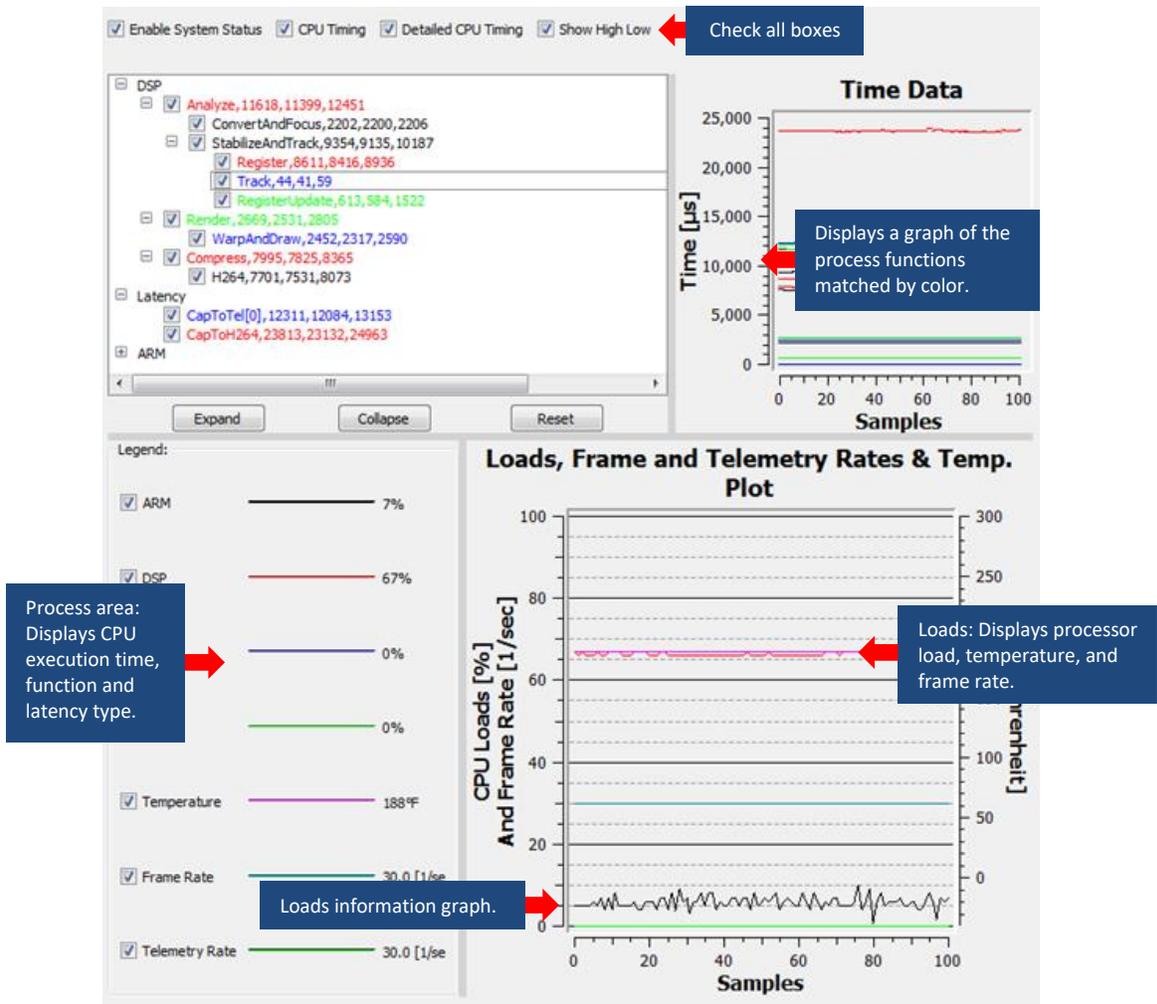
Figure 4: Performance Graphs

4.3   Process Area

All the timings show the average, minimum, and maximum execution time or latency in microseconds. Labels and can be expanded by clicking on the + sign. The data for each is collected and updated every few seconds.

📄 *The list order of the process areas (analyze, compress, render, etc.) may vary depending on when the monitor begins to poll the CPU.*

📄 *Click Reset to clear out stale categories as setting are changed.*

4.3.1   Example Process Tree - 1500-OEM

DSP: Displays Ave, Min, and Max time to run each processing function each frame.

↳ Analyze (register, track, etc., average 3.243 ms)

↳ Compress (encoding h.264, average 17.664 ms)

↳ Render (enhance, rotate, draw graphics, etc., average 4.860 ms)

ARM: In most cases the ARM processor is not the limiting factor in system performance.

Figure 5: 1500-OEM Example Process Tree

Latency: Internal time between capture frame completion and video or telemetry output.

↳ CapToTel: Time from capture to sending telemetry to network or serial (average 4.266 ms)

↳ CapToH264: Time from capture to putting H.264 video on the network (average 27.874 ms)

📄 *When a system is running at full frame rate (typically 30 fps), CapToTel will be close to the analyze time in the DSP tree. CapTo H264 will be close to the sum of Analyze, Render, and Compress in the DSP tree. When a system is running below full frame rate, the latencies will be higher due to frame buffering.*

📄 *Additional communications and processing steps add small amounts of latency. These values will not add up exactly to the latencies shown.*
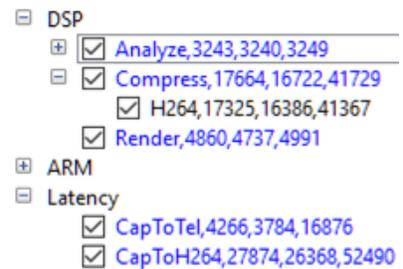
4.3.2   Example Process Tree - 3000-OEM

The 3000-OEM has multiple DSPs and up to two simultaneous video chains. It also has a dedicated hardware encoder which contributes to latency, but not to DSP processor load for video compression.

DSP: Helper DSP when DSP1/2 are enabled, primary DSP for low power mode.

DSP1: Video processing routines for the first camera.

DSP2: Video processing routines for the second camera.

Figure 6: 3000-OEM Example Process Tree

DSP1: Cam 0 Ave, Min, and Max time in (us) to run each processing function each frame.

↳ Analyze (register, track, etc., average 7.383 ms)

↳ Render (enhance, rotate, draw graphics, etc., average 1.582 ms)

DSP2: Cam 2 Ave, Min, and Max time (us) to run each processing function each frame.

↳ Analyze (register, track, etc., average 9.793 ms)

↳ Render (enhance, rotate, draw graphics, etc., average 2.011 ms)

Latency: Internal time between capture frame completion and video or telemetry output.

↳ *CapToH264[0]*: Network 0 time from capture to putting H.264 video on the network (average 42.816 ms)

↳ *CapToTel[2]*: Cam 2 time from capture to sending telemetry on the network (average 18.905 ms)

↳ *CapToTel[0]*: Cam 0 time from capture to sending telemetry on the network (average 12.825 ms)
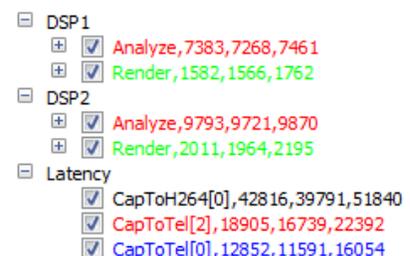
4.3.3 Example Process Tree - 4000-OEM

The 4000-OEM has four processor cores and a GPU used in render/enhance. It also has a dedicated hardware encoder which contributes to latency, but not to processor load for video compression. The processors for the 4000 are labeled CPU0 - CPU3 or Core0 – Core3.

CPU1: *Render* video processing routines.

CPU2: *Analyze* video processing routines for the first camera

CPU3: *Analyze* video processing routines for the second camera.

CPU2: Ave, Min, and Max time (us) to run each analyze function each frame.

↳ Analyze (register, track, etc., average 10.473 ms)

CPU1: Ave, Min, and Max time in (us) to run each *render* function each frame.

↳ WarpAndDraw0 (enhance, rotate, draw graphics, etc. first camera, average 3.163 ms)

↳ WarpAndDraw1 (enhance, rotate, draw graphics, etc. second camera, average 5.127 ms)
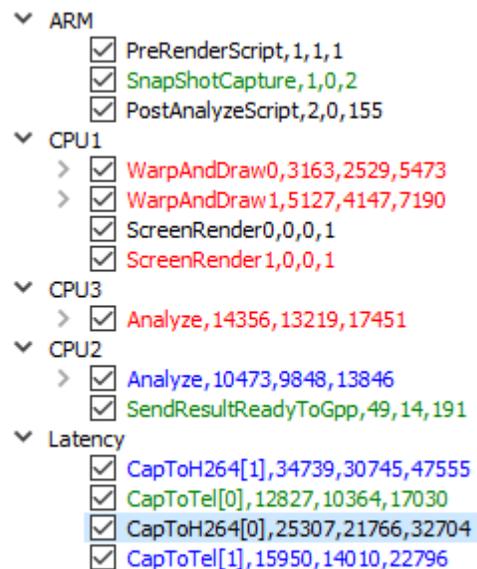
Figure 7: 4000-OEM Example Process Tree

Latency: Internal time between capture frame completion and video or telemetry output.

↳ *CapToH264[0]*: Time from capture to putting H.264 video on the network for network 0 (average 25.307 ms)

↳ *CapToH264[1]*: Time from capture to putting H.264 video on the network for network 1 (average 34.739 ms)

↳ *CapToTel[0]*: Time from capture to sending telemetry on the network for first camera (average 12.827 ms)

↳ *CapToTel[1]*: Time from capture to sending telemetry on the network for second camera (average 15.950 ms)

ARM: Shows times for user scripts (none used in this example).

5   Measuring Decoder Latency with Performance Graph

The 3000-OEM and 4000-OEM can be configured to be used as a decoder as described in EAN-Decoder. The decoder is supported in software version 2.25.xx (3000-OEM) or 3.00.xx (4000-OEM) and higher.

Follow the steps in EAN-Decoder to configure the 3000-OEM/4000-OEM support the IP camera input using Panel Plus software. Configure the 3000-OEM/4000-OEM to either receive video from a Network Source or from the MicroSD card.

Once the decoder starts receiving video the Performance Graph can be used to measure the latency involved in decoding frames. See the Performance Monitoring Areas section for Performance Graph monitoring. A sample performance graph when the 3000-OEM is configured as a decoder is shown in Figure 8.

In this example, camera 0 is configured as a decoder that receives a 1280x720 video over the network from another 3000-OEM.

CapToDecoded is the time difference between receiving a compressed frame of video and when the decoder returns with an uncompressed frame.

CapToTel is the time difference between receiving a compressed frame of video and sending telemetry data to the network or serial port.
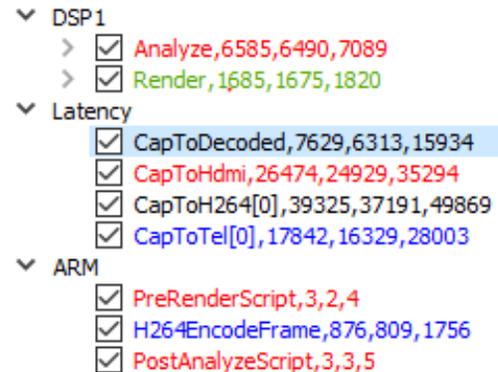

Figure 8: Performance Graph for Decoder

📄 *The CapToTel time starts as soon as the uncompressed frame is received. This includes the time to decode the frame.*

6   Measuring Full System Latency

This section describes different methods to setup and perform latency tests using an oscilloscope and online digital clocks. Two examples of digital clocks are available at Flash Clocks and Java Script Clock.

 A connection to the video processing board using the Panel Plus application is required.

📄 *See the corresponding OEM startup guide for connection instructions.*

6.1   Oscilloscope Latency Test

Follow the steps below to measure end-to-end latency using an oscilloscope and blinking LED configuration. Correct measurement requires a blinking LED with blinking interval ~1 sec.

1. Connect the LED light green cable to CH1 ground on the oscilloscope. Connect black/brown LED light cable to the probe.

2. Power on the oscilloscope and LED light.

3. Tape the LED light close to the camera lens.

4. Position the Panel Plus display to center on the LED. Press the *Autoset* button on the oscilloscope.

   The display should show a pulse on CH1 after a few seconds. The pulse should remain in the same location on the oscilloscope display. If the display is not showing the pulse, use the CH1 menu and make sure the following parameters are correct:

   - Trig on downslope
   - X10 on probe (check the probe)

   - Normal trigger mode
   - DC Coupling for channels (looks better)

5. Tape the sensor to the monitor. Position the Panel Plus display to center on the taped sensor. Plug in the 5.7 V power. Connect CH2 ground to one side of the sensor resistor and the CH2 probe to the other side of the resistor.

6. Locate the CH2 pulse with the oscilloscope. If it is at the top of the oscilloscope display, the pulse is too large. Select CH2 and use the *Position* knob and CH2 position to move CH2 into view and show a good pulse.

7. Go to the *Trig* menu and set the following settings:

   - *Slop*: Falling
   - *Trig Mode*: Normal
   - *Source*: CH1

   Move the horizontal trigger line anywhere on the CH1 pulse. Move the pulses to the left using the round knob on the oscilloscope.

8. Measure the difference between the two pulses. Press the *Cursor* button on the oscilloscope, and then moving the cursor of CH1 to the start of edge transition (falling edge) of the CH1 pulse. Move the cursor of CH2 to the start of edge transition (falling edge) of the CH2 pulse. Type should be *Time*.

9. Use the *Acquire* button and select *Average*. Average is set to 16 by default.

10. Use the cursor button and place the falling edge of the cursor to the midpoint of the start of the edge transition of CH2. The falling edge should change slowly at first. Wait until the curve is formed before reading the delta. This gives the average, versus a range (the CH2 pulse edge changes) from the previous step.

6.2   Online Millisecond Clock Latency Test

1. Use any online digital clock available on the web.

2. Stream network video and decode with Panel Plus.

3. Overlap the millisecond clock on the web page with Panel Plus.

4. Use the Snipping Tool and create a screen capture.

5. Subtract the two numbers to obtain the latency measurement, e.g., 707 - 540 = 167 ms.

End-to-End Glass latency value depends on several factors other than the SightLine firmware and Decoder. Windows OS version, display monitor latency, network configuration, and refresh rate also affect latency.
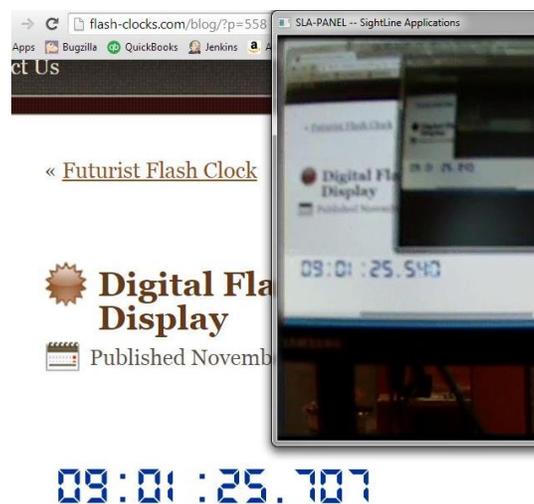

Figure 9: Panel Plus Online Digital Clock Overlap

6.3 RTSP Latency Measurement

See [EAN-RTSP](#) for more information on how configure the VLC application to stream video from the RTSP server running on SightLine OEM hardware.

1. Use any online digital clock available on the web.

2. Point the camera to the millisecond clock on the web page.

3. Open the VLC application.

4. Go *Tools* » *Preferences* » *Input / Codecs* » *Default caching policy*. In the drop menu select *Lowest latency*.

5. Stream VLC using RTSP. Go to *Media* » *Open Network Stream*. In the URL field enter the IP address of the SightLine board: e.g., *rtsp:\\192.168.1.145\net0*

6. Use VLC to start streaming the clock. The clock screen should appear twice in VLC.

7. Use the Snipping Tool and create a screen capture.

8. Subtract the two numbers to obtain the latency measurement, e.g., 707 - 540 = 167 ms.

7 Questions and Additional Support

For questions and additional support, please contact [Technical Support](#). Additional support documentation and Engineering Application Notes (EANs) can be found on the [Documentation](#) page of the SightLine Applications website.