
IndigoVision 8000 Series Video Latency

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This document provides an explanation and measurements of the 'end-to-end' system latency for IndigoVision 8000 series products. A description of the method used to determine system latency is also included along with the results achieved.

A summary of these results is contained in the table below:

	TCP Video Latency Streaming from 8000 Series Transmitter (ms)		UDP Video Latency Streaming from 8000 Series Transmitter (ms)	
	8000 Series Receiver	Control Center	8000 Series Receiver	Control Center
1M-1SIF PAL	60	60	84	68
2M-2SIF PAL	80	80	132	98
4M-4SIF PAL	200	160	194	120
1M-1SIF NTSC	96	94	70	74
2M-2SIF NTSC	96	96	90	90
4M-4SIF NTSC	166	154	134	94



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1 Background

High latency in an IP video system is undesirable, as typically it makes positioning and controlling Pan Tilt Zoom (PTZ) cameras more difficult.

The various sources of latency in such systems, however, often allow for an assortment of misleading metrics to be produced, such as 'encode/decode time' or 'time to network.'

This document will instead describe a means for measuring 'end-to-end' system latency and present a series of gathered results.

1.1 Terminology

Term	Definition
2SIF	704x288 PAL, 704x240 NTSC
4SIF	704x576 PAL, 704x480 NTSC
NTSC	National Television Systems Committee (America)
PAL	Phase Alternate Line
SIF	352x288 PAL, 352x240 NTSC
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

2 Introduction

Throughout this document, the term 'System Latency' is defined as meaning the time for an analogue image at a camera source to be presented to a system user via either IndigoVision's Control Center software or a monitor connected to an 8000 series receiver. More concisely, System Latency is the measurement of the time taken to capture, encode, transmit, decode and present a frame of video.

On a reliable 100Mbps network, the time taken to transmit even a 4SIF 4Mbps I-Frame (of approximately 32KB in size) should be no more than a few milliseconds. The significant contributors to overall system latency are therefore capture, encode, decode and presentation time.

Additionally, two other sources of latency may be present in an 8000 series product: packet shaping and jitter buffering.

2.1 Packet Shaping

As of firmware release v2-13-1, packet shaping on an 8000 series transmitter can be enabled or disabled using the 'Advanced Network Configuration' web page.

By default, packet shaping is turned off in order to minimize latency on the more common switched network infrastructure. This type of network infrastructure can cope easily with rapid transmission of packets.

When turned on, packet shaping throttles the rate at which video packets are transmitted from the unit. This prevents potential receive buffer overruns in a routed network infrastructure which would otherwise result in lost packets and poor video quality. This is at the expense of an overall increase in latency.

The packet-shaping algorithm present in the 8000 series can delay the delivery to network of a typical I-Frame by an additional 15-20ms. Although the magnitude of this increase may not seem particularly significant when considering just transmitters, it should be noted that the amount of network jitter (see below) between I and P-Frames is also increased, thus enabling packet shaping also has an associated impact on the receiver side as well.

2.2 Jitter Buffer

A Jitter buffer is implemented in receiver products to compensate for the variation in the arrival of the video packets, by intentionally delaying the presentation of video/audio. When a receiver first connects to a stream, the initial jitter buffer size is 40ms, but this figure is adjusted as each received video frame provides more information on network conditions. When measuring system latency, it is therefore important to give any recently connected receivers some time to tune themselves to the network and generate typical behaviour.

2.3 Measurement Process

In order to measure system latency, it is necessary to instantaneously compare the analogue output from a camera or pattern generator with the frame simultaneously being presented by the receiver technology. To quantify the latency, the analogue source should comprise some form of clock providing resolution to 10 milliseconds. A digital snapshot can then be taken of the two images and the time difference (latency) calculated.

3 Measurement

3.1 Test Set-up

The set-up in Figure 1 below was used to measure system latency.

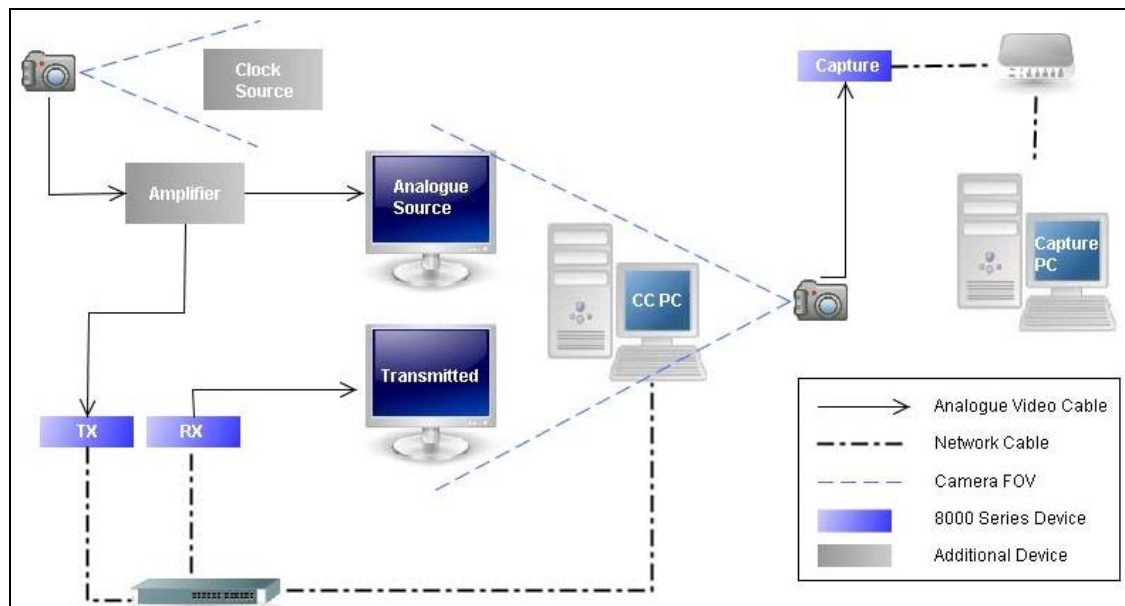


Figure 1 – Test Set-up

An analogue camera was positioned to view a timer value generated by a hardware counter. The signal from this camera was connected via an amplifier to a monitor (Analogue Source) as well as an 8000 series unit (TX) running firmware version v2-13-1 and configured to operate as a video transmitter with packet shaping disabled.

A second 8000 series unit (RX) was configured to run as a receiver with its analogue output connected to an additional monitor (Transmitted).

The 8000 series units were networked along with a PC running Control Center (CC PC), using a 3Com, SuperStack 3 100Mbps, switch.

A second camera was positioned to view the analogue and PC monitors. The output from this camera was transmitted using a third 8000 series device (Capture) to a further PC, also running Control Center, which was used to generate still image, snapshot captures.

After a change was made to the transmitted video stream, a period of 5 minutes was allowed to pass before any captures were made to give the receiver device time to adjust to network conditions.

3.2 Results

The following subsections detail the results acquired from 5 captures of each tested video format/resolution. A captured image is also included for each section.

3.2.1 1M-1SIF PAL TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
43.07	43.01	43.01	60	60
44.87	44.81	44.81	60	60
46.67	46.61	46.61	60	60
48.63	48.57	48.57	60	60
50.75	50.69	50.69	60	60
		Avg	60	60

Table 1 – Results for 1M, 1SIF, TCP, PAL Stream



Figure 2 – Screen Capture of 1M, 1SIF, TCP, PAL Stream

3.2.2 1M-1SIF PAL UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
76.15	76.09	76.09	60	60
77.83	77.77	77.77	60	60
79.31	79.21	79.21	100	100
81.31	81.21	81.25	100	60
82.99	82.89	82.93	100	60
		Avg	84	68

Table 2 – Results for 1M, 1SIF, UDP, PAL Stream



Figure 3 – Screen Capture of 1M, 1SIF, UDP, PAL Stream

3.2.3 2M-2SIF PAL TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
77.09	77.01	77.01	80	80
77.81	77.73	77.73	80	80
78.37	78.29	78.29	80	80
78.77	78.69	78.69	80	80
79.13	79.05	79.05	80	80
		Avg	80	80

Table 3 – Results for 2M, 2SIF, PAL, TCP Stream



Figure 4 – Screen Capture of 2M, 2SIF, PAL, TCP Stream

3.2.4 2M-2SIF PAL UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
3.97	3.83	3.87	140	100
5.53	5.4	5.43	130	100
7.13	7	7.03	130	100
8.65	8.52	8.55	130	100
10.28	10.15	10.19	130	90
		Avg	132	98

Table 4 – Results for 2M, 2SIF, PAL, UDP Stream



Figure 5 – Screen Capture of 2M, 2SIF, PAL, UDP Stream

3.2.5 4M-4SIF PAL TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
80.18	79.98	80.02	200	160
81.54	81.34	81.38	200	160
83.58	83.38	83.42	200	160
85.18	84.98	85.02	200	160
86.78	86.58	86.62	200	160
		Avg	200	160

Table 5 – Results for 4M, 4SIF, PAL, TCP Stream



Figure 6 – Screen Capture of 4M, 4SIF, PAL, TCP Stream

3.2.6 4M-4SIF PAL UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
87.77	87.52	87.65	250	120
89.65	89.49	89.53	160	120
91.13	90.93	91.01	200	120
92.41	92.25	92.29	160	120
94.33	94.13	94.21	200	120
		Avg	194	120

Table 6 – Results for 4M, 4SIF, PAL, UDP Stream



Figure 7 – Screen Capture of 4M, 4SIF, PAL, UDP Stream

3.2.7 1M-1SIF NTSC TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
23.92	23.82	23.83	100	90
25.38	25.28	25.28	100	100
26.88	26.78	26.78	100	100
28.28	28.18	28.18	100	100
30.1	30.02	30.02	80	80
		Avg	96	94

Table 7 – Results for 1M, 1SIF, TCP, NTSC Stream



Figure 8 – Screen Capture of 1M, 1SIF, TCP, NTSC Stream

3.2.8 1M-1SIF NTSC UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
30.02	29.96	29.96	60	60
31.71	31.66	31.62	50	90
33.42	33.36	33.38	60	40
35.28	35.2	35.2	80	80
36.98	36.88	36.88	100	100
		Avg	70	74

Table 8 – Results for 1M, 1SIF, UDP, NTSC Stream



Figure 9 – Screen Capture of 1M, 1SIF, UDP, NTSC Stream

3.2.9 2M-2SIF NTSC TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
55.38	55.28	55.28	100	100
57.08	56.98	56.98	100	100
58.68	58.58	58.58	100	100
60.3	60.22	60.22	80	80
62.08	61.98	61.98	100	100
		Avg	96	96

Table 9 – Results for 2M, 2SIF, NTSC, TCP Stream



Figure 10 – Screen Capture of 2M, 2SIF, NTSC, TCP Stream

3.2.10 2M-2SIF NTSC UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
75.78	75.7	75.7	80	80
77.58	77.5	77.5	80	80
79.18	79.09	79.09	90	90
80.71	80.61	80.61	100	100
82.48	82.38	82.38	100	100
		Avg	90	90

Table 10 – Results for 2M, 2SIF, NTSC, UDP Stream



Figure 11 – Screen Capture of 2M, 2SIF, NTSC, UDP Stream

3.2.11 4M-4SIF NTSC TCP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
98.58	98.38	98.38	200	200
0.32	0.18	0.18	140	140
2.08	1.88	1.92	200	160
3.58	3.45	3.45	130	130
5.16	5	5.02	160	140
		Avg	166	154

Table 11 – Results for 4M, 4SIF, NTSC, TCP Stream



Figure 12 – Screen Capture of 4M, 4SIF, NTSC, TCP Stream

3.2.12 4M-4SIF NTSC UDP

Source	8000 Series	Control Center	8000 Series Diff (ms)	Control Center Diff (ms)
48.88	48.72	48.78	160	100
50.48	50.32	50.38	160	100
52.28	52.12	52.18	160	100
53.98	53.89	53.9	90	80
55.79	55.69	55.7	100	90
		Avg	134	94

Table 12 – Results for 4M, 4SIF, NTSC, UDP Stream



Figure 13 – Screen Capture of 4M, 4SIF, NTSC, UDP Stream

3.3 Conclusion

The above metrics show that UDP video streams have lower latency than the equivalent TCP streams. Where packet-shaping is used to reduce packet loss on routed networks, this will typically add a further 20-40ms of latency. The latency may further increase depending on the packet jitter characteristics of the network itself.

When considering the highest measurements taken for the 8000 series receiver, the maximum latency for 1M-1SIF, 2M-2SIF and 4M-4SIF is unlikely to exceed 100, 150 and 200ms respectively for PAL streams. The smaller frame size of NTSC has been shown to generate video streams with slightly less latency than a comparable PAL stream.

When compared to an 8000 series product, the faster decoding and rendering time of Control Center has been demonstrated to reduce latency by as much as 40ms for 4Mbps streams.