

Sena Technologies White Paper:
Latency/Throughput Test
of
Device Servers/Bluetooth-Serial Adapters

October 30, 2007

© Copyright Sena Technologies, Inc 2007

All rights strictly reserved. No part of this document may not be reproduced or distributed without written consent of Sena Technologies, Inc.

Although every effort has been taken to ensure the accuracy of this document it may be necessary, without notice, to make amendments or correct omissions. Sena Technologies cannot accept responsibility for damage, injury, or expenses resulting there from.

Overview

Sena Technologies is a provider of device networking solutions that connect almost any electronic device and equipment to the Internet or Ethernet network using open standard protocols. Sena Technologies offers highly scalable and affordable end-to-end products that provide out-of-box installation functionality to meet industry needs, under a constantly evolving networking environment. In the world of “networked” devices, it is important to understand the basic concepts of the “connection”. This paper will discuss the basics of latency and the impact it may have on your network with our Devices.

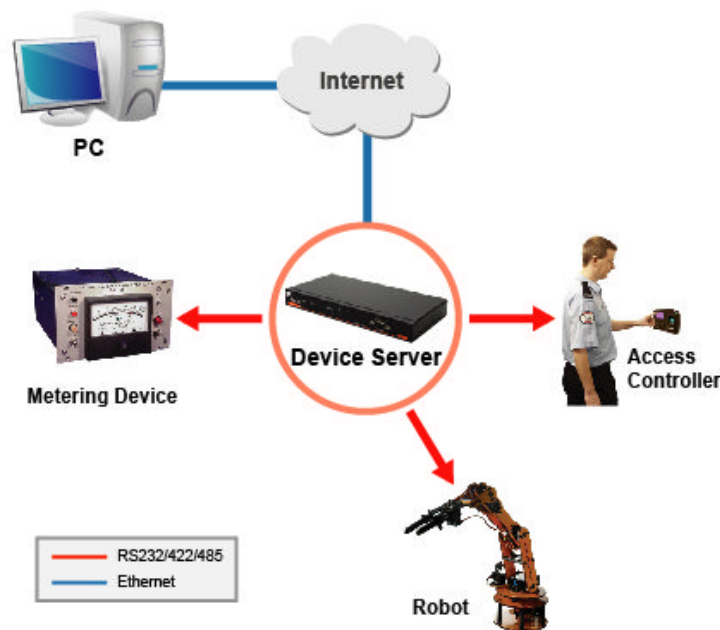


Figure 1: Device Server Application

What is Latency?

In general, latency can be described as an expression of how much time it takes for a packet of data to get from one designated point to another. Some may also view latency as a measurement of how much time it takes to send a packet that is returned to the sender or what we call “round-trip time”.

In theory latency assumption data should be transmitted instantly between one point and another, with no delay. Unfortunately, in the real world, contributors to network latency include:

- **Propagation:** The time it takes for a packet to travel between one place and another.
- **Transmission:** The medium itself introduces some delay. Depending on the medium quality, this may create a delay factor.

- **Routers and Other Network delays:** Each gateway may take time to examine and determine where to send the packets. Other network delays may include network congestion at local switches, network bandwidth limitations, or the number of hops in a network required to cross a network. For Example: The more stop over flights a person makes in a airplane trip from point A to B will increase the time it takes for that person to reach their destination.
- **Message Size:** Depending on the application, the message size can influence the speed at which the message will be sent. For Example: The heavier the box the longer it will take for a person to move the box from one room to another.
- **Network Application:** Applications can be a source of network delay. Network applications include, various operating systems and the actual host application (server configuration, telnet, internet explorer, etc) used in network communication.

What is Throughput?

Throughput can be described as expression of how much amount of data is sent or transacted during a defined period of time. It depends on the speed and message size.

Sena Technologies Products and Latency / Throughput

As it was stated earlier, Sena Technologies is committed to providing highly scalable and cost effective network solutions to the ever changing network and communication environment. We here at Sena Technologies view latency as the time it takes to send one character from a host application to the device server and back again to the host application, or “round trip time” (Due to the variance in different operating system architecture latency measurement times may vary). We also view throughput as the amount of the data sent to and received from the device server. Testing for latency and throughput was done in-house by Sena with the full line of Sena products. Figure 2 shows how Sena carried out its testing methodology for the device servers and Figure 3 for the Bluetooth-serial adapters.

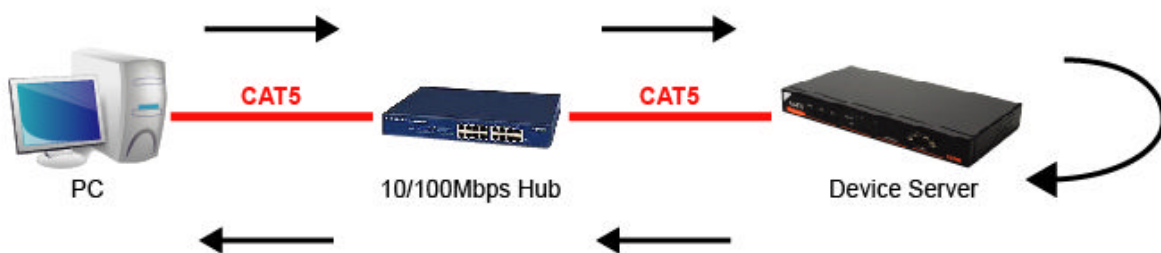


Figure 2: Test System Configuration for Device Server

The test program (written in Visual C++) sends a packet, consisting of one byte of data, over an isolated Ethernet network, to a remote device server where the data is echoed back to the host PC. A loop-back plug that connects the RS-232 Tx data pin to the Rx data pin was used to echo back the data sent by the host pc. Latency time was measured by the time it takes for the one byte of data to be sent by the Host PC to the

Device Server or Terminal Server and back again to the Host PC. For throughput test, the test program sends certain amount of data, measures the time it takes to receive all data and calculates the received data per second in Mbps. Table 1 displays the parameters that were set to each of the serial ports before testing. From here two types of latency tests were then conducted, single-port latency tests and full-load latency tests. In the case of throughput, just full-load test was conducted. Full port tests were conducted by sending data to each and every available serial port at the same time.

Sena Technologies also provides Serial/IP software that enables your existing serial communication programs that use Windows serial port drivers to be used over the network allowing you to keep using your existing program having to modify your existing Windows applications. The second benchmark test which is similar to that of the first test provides users a look at how our Serial/IP software plays an impact on Serial to Ethernet latency/throughput. The version used for this test is 4.8.4.

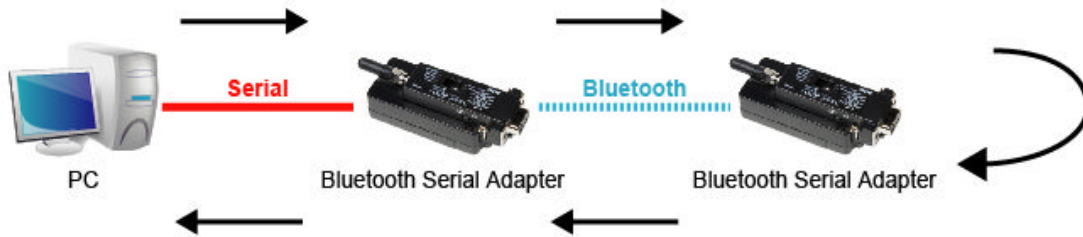


Figure 3: Test System Configuration for Bluetooth-Serial Adapter

Sena Technologies also provides the Bluetooth-serial adapters designed to replace RS-232 serial cables through the use of Bluetooth connectivity. Latency / Throughput tests of the Bluetooth-serial adapters are conducted in a similar way as those of the device servers (Figure 3).

	Performance Test	Latency Test
Baud rate	All the baud rate	9600bps
Data Bits		8bit
Parity		None
Stop Bits		1bit
Flow Control		Hardware Flow Control
Inter Character Time-out		0ms
Communication Protocol		TCP
Others	Data Size : Refer to Table 3: Data Size for Throughput Test	Number Of Iteration : 10000 Data Size : 1 byte

Table 1: Latency / Throughput Test Parameters

PC SPECIFICATIONS	
Processor	Intel® Pentium®4 CPU 3.00GHz (2 CPUs)
RAM	1024MB
Operating System	Microsoft Windows XP Professional (5.1, Build 2600)
Network Adaptor	Marvell Yukon 88E8001/8003/8010 PCI Gigabit Ethernet Controller

Network Nodes		
Network Node	Vendor	Connection
NETGEAR FS2108	NETGEAR	10/100Mbps
Marvell Yukon 88E8001/8003/8010 PCI Gigabit Ethernet Controller	Marvell	10/100Mbps

Table 2: Hardware Used in the Test

Baudrate	Data Size(Kbyte)	Baudrate	Data Size(Kbyte)
75	2	4800	140
150	4	9600	284
200	6	19200	569
300	9	38400	1139
600	18	57600	1710
1200	35	115200	3420
1800	53	230400	6966
2400	70		

Table 3: Data Size for Throughput Test

Category	Product Name	Firmware Version	Specification
Device Server	LS100	v1.4.4	Ethernet: 10Mbps
	LS110	v1.0.0	Ethernet: 10Mbps
	PS110	v1.4.0	Ethernet: 10/100Mbps
	PS410	v1.4.0	Ethernet: 10/100Mbps
	PS810	v1.2.0.1	Ethernet: 10/100Mbps
	SS100	v1.4.4	Ethernet: 10/100Mbps
	STS400	v1.4.4	Ethernet: 10/100Mbps
	STS800	v1.4.4	Ethernet: 10/100Mbps
	STS1600	v1.4.4	Ethernet: 10/100Mbps
Bluetooth-Serial Adapter	Parani_SD100	v1.1.1	Bluetooth Class 1
	Parani_SD200	v1.1.1	Bluetooth Class 2
	Parani_ESD100	v1.1.1	Bluetooth Class 1
	Parani_ESD200	v1.1.1	Bluetooth Class 2

Table 4: Products List

Latency Test Results

Final test results are shown in Table 5, 6 and 7. Table 5 displays the latency time of a native RS232 serial port. Table 6 displays the latency time of the device servers when TCP/IP based connection is used. Table 6 also demonstrates the usage of Serial/IP in conjunction with our serial device servers. Table 7 displays the latency time of the Bluetooth-serial adapters.

Product		Single Port (ms)	4-Port (ms)	8-Port (ms)	16-Port (ms)
Name	Methodology				
COM1	RS232 Serial Port	5.51	Not Available	Not Available	Not Available

Table 5: Latency Test Result of Native Serial Port

Product		Single Port (ms)	4-Port (ms)	8-Port (ms)	16-Port (ms)
Name	Methodolog				
LS100	TCP/IP	39.22	Not Available	Not Available	Not Available
	Serial/IP	39.09	Not Available	Not Available	Not Available
LS110	TCP/IP	31.63	Not Available	Not Available	Not Available
	Serial/IP	31.58	Not Available	Not Available	Not Available
PS110	TCP/IP	10.00	Not Available	Not Available	Not Available
	Serial/IP	10.04	Not Available	Not Available	Not Available
PS410	TCP/IP	10.00	16.31	Not Available	Not Available
	Serial/IP	10.04	17.01	Not Available	Not Available
PS810	TCP/IP	10.11	Not Conducted	35.85	Not Available
	Serial/IP	10.03	Not Conducted	36.85	Not Available
SS100	TCP/IP	10.05	Not Available	Not Available	Not Available
	Serial/IP	10.00	Not Available	Not Available	Not Available
STS400	TCP/IP	10.53	22.44	Not Available	Not Available
	Serial/IP	13.91	22.87	Not Available	Not Available
STS800	TCP/IP	11.21	Not Conducted	45.61	Not Available
	Serial/IP	11.17	Not Conducted	49.10	Not Available
STS1600	TCP/IP	12.35	Not Conducted	48.00	112.89
	Serial/IP	12.75	Not Conducted	45.64	113.34

Table 6: Latency Test Result of Device Servers

Product		Single Port (ms)	4-Port (ms)	8-Port (ms)	16-Port (ms)
Name	Methodolog				
Parani-SD100	Bluetooth	100.96	Not Available	Not Available	Not Available
Parani-SD200	Bluetooth	104.77	Not Available	Not Available	Not Available
Parani-ESD100	Bluetooth	100.93	Not Available	Not Available	Not Available
Parani-ESD200	Bluetooth	103.28	Not Available	Not Available	Not Available

Table 7: Latency Test Result of Bluetooth-Serial Adapters

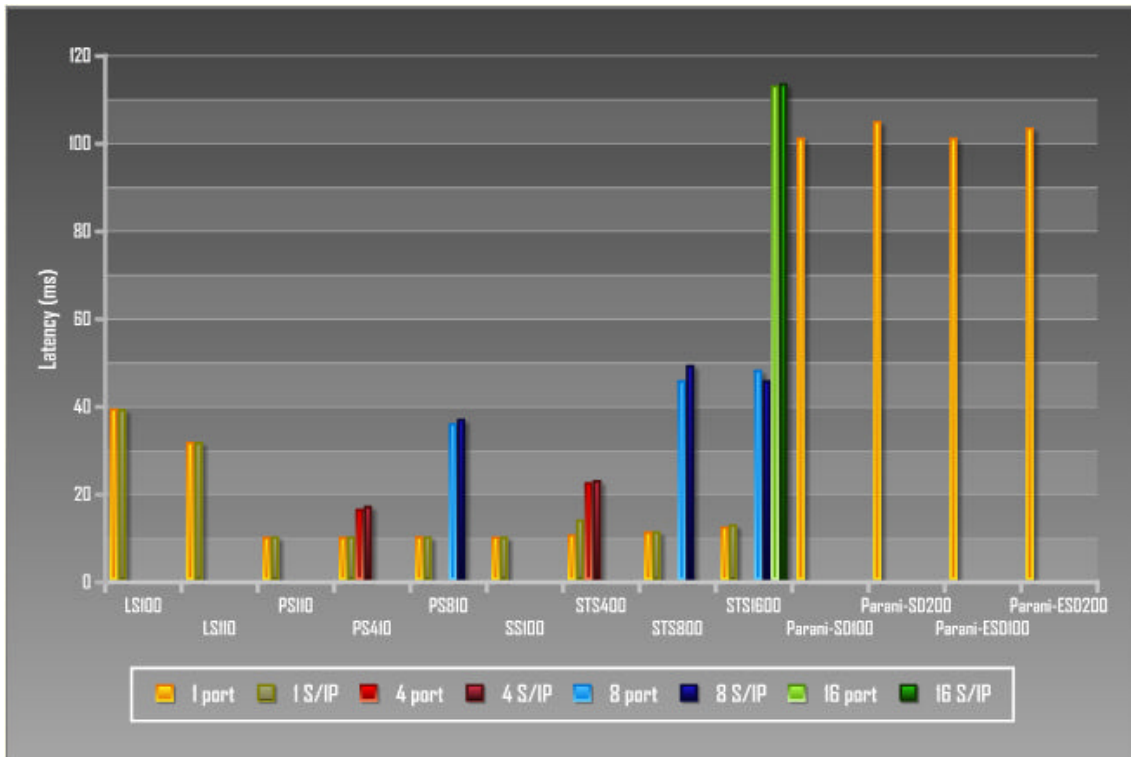


Figure 4: Latency Test Result

Throughput Test Results

Final test results are categorized by product. Test results display an average baud rate in bps and a percentage of the average baud rate vs. theoretical maximum baud rate. A ratio is also given when compared with that Serial/IP vs. the theoretical maximum baud rate.

The test results of Lite Series are shown in Tables 8 and 9 and Figures 5 and 6.

The test results of Pro Series are shown in Tables 10 and 11 and Figures 7 and 8.

The test results of Super Series and STS Series are shown in Tables 12 and 13 and Figures 9 and 10.

The test results of Bluetooth-Serial Adapters are shown in Table 14 and Figure 11.

Lite Series

Status	LS100		LS110	
	Average Baudrate(bps)	Average Baudrate(%)	Average Baudrate(bps)	Average Baudrate(%)
75	Not Available	Not Available	Not Available	Not Available
150	Not Available	Not Available	Not Available	Not Available
200	Not Available	Not Available	Not Available	Not Available
300	Not Available	Not Available	Not Available	Not Available
600	Not Available	Not Available	Not Available	Not Available
1200	1198.79	99.90	1199.03	99.92
1800	Not Available	Not Available	Not Available	Not Available
2400	2398.70	99.95	2398.33	99.93
4800	4795.92	99.91	4795.90	99.91
9600	9589.47	99.89	9590.48	99.90
19200	10944.47	57.00	19185.06	99.92
38400	11146.60	29.03	38378.18	99.94
57600	11740.87	20.38	57576.33	99.96
115200	11546.65	10.23	77388.73	67.18
230400	Not Available	Not Available	Not Available	Not Available

Table 8: Throughput Test Result of Lite Series

(*NOTE: Lite Series does not support such baudrates as 75, 150, 200 and so on)

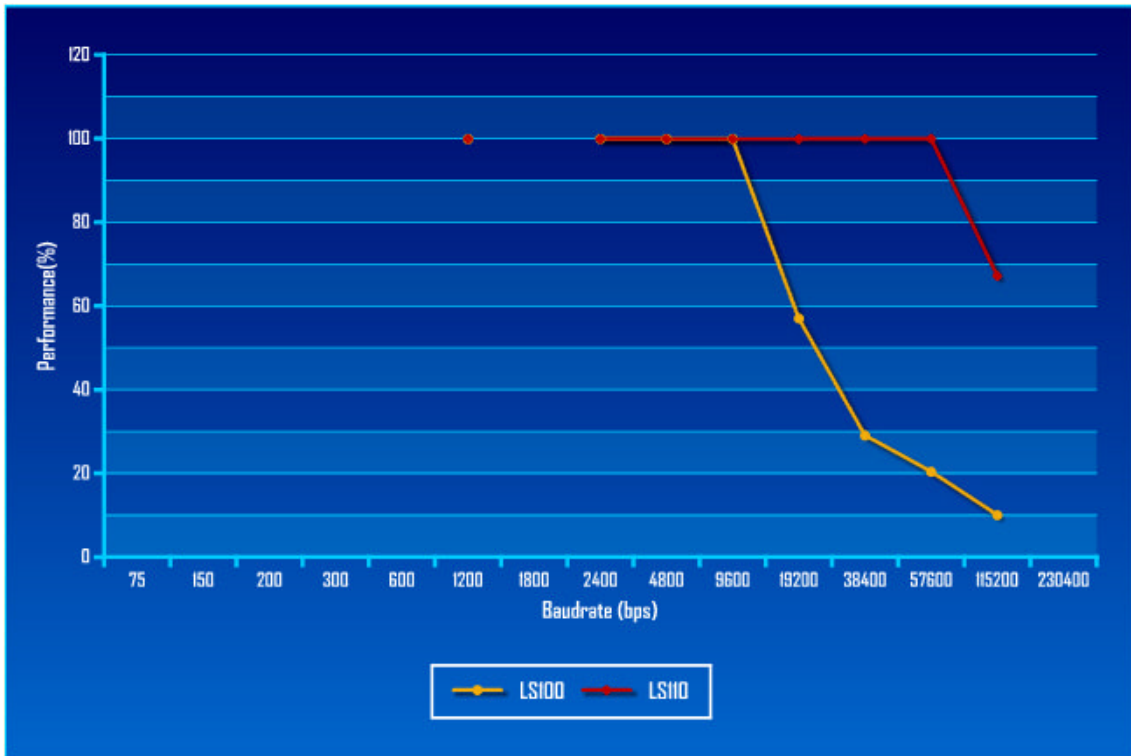


Figure 5: Throughput Test Result of Lite Series

Status	LS100		LS110	
	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)
75	Not Available	Not Available	Not Available	Not Available
150	Not Available	Not Available	Not Available	Not Available
200	Not Available	Not Available	Not Available	Not Available
300	Not Available	Not Available	Not Available	Not Available
600	Not Available	Not Available	Not Available	Not Available
1200	99.90	99.83	99.92	99.92
1800	Not Available	Not Available	Not Available	Not Available
2400	99.95	99.91	99.93	99.95
4800	99.91	99.93	99.91	99.91
9600	99.89	99.92	99.90	99.91
19200	57.00	57.73	99.92	99.96
38400	29.03	28.85	99.94	99.92
57600	20.38	20.49	99.96	99.94
115200	10.23	10.08	67.18	67.17
230400	Not Available	Not Available	Not Available	Not Available

Table 9: Throughput Test Result of Lite Series – TCP/IP vs. Serial/IP



Figure 6: Throughput Test Result of Lite Series – TCP/IP vs. Serial/IP

Pro Series

Status	PS110		PS410		PS810	
	Average Baud rate	Average Baudrate(%)	Average Baud rate	Average Baudrate(%)	Average Baudrate	Average Baudrate(%)
75	74.99	99.98	74.97	99.97	74.44	99.26
150	149.99	99.99	149.96	99.97	148.90	99.27
200	199.98	99.99	199.92	99.96	198.85	99.42
300	299.97	99.99	299.90	99.97	298.34	99.45
600	599.96	99.99	599.85	99.97	596.69	99.45
1200	1199.92	99.99	1199.62	99.97	1193.20	99.43
1800	1799.79	99.99	1799.18	99.95	1789.46	99.41
2400	2399.58	99.98	2399.08	99.96	2386.91	99.45
4800	4799.41	99.99	4798.60	99.97	4773.42	99.45
9600	9598.87	99.99	9595.92	99.96	9542.40	99.40
19200	19197.89	99.99	19193.94	99.97	19090.36	99.43
38400	38395.87	99.99	38384.06	99.96	37311.07	97.16
57600	57594.13	99.99	57579.40	99.96	49602.84	86.12
115200	115128.80	99.94	99852.10	86.68	61964.88	53.79
230400	221603.156	96.18	104721.74	45.45	69410.22	30.13

Table 10: Throughput Test Result of Pro Series



Figure 7: Throughput Test Result of Pro Series

Status	PS110		PS410		PS810	
Baudrate	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)
75	99.98	99.96	99.97	99.97	99.26	99.24
150	99.99	99.97	99.97	99.97	99.27	99.38
200	99.99	99.97	99.96	99.97	99.42	99.45
300	99.99	99.97	99.97	99.97	99.45	99.46
600	99.99	99.97	99.97	99.98	99.45	99.44
1200	99.99	99.97	99.97	99.98	99.43	99.44
1800	99.99	99.97	99.95	99.98	99.41	99.46
2400	99.98	99.97	99.96	99.96	99.45	99.45
4800	99.99	99.97	99.97	99.98	99.45	99.44
9600	99.99	99.98	99.96	99.98	99.40	99.43
19200	99.99	99.98	99.97	99.98	99.43	99.44
38400	99.99	99.98	99.96	99.96	97.16	92.48
57600	99.99	99.98	99.96	99.67	86.12	81.89
115200	99.94	99.92	86.68	87.20	53.79	55.24
230400	96.18	97.75	45.45	55.48	30.13	36.64

Table 11: Throughput Test Result of Pro Series – TCP/IP vs. Serial/IP

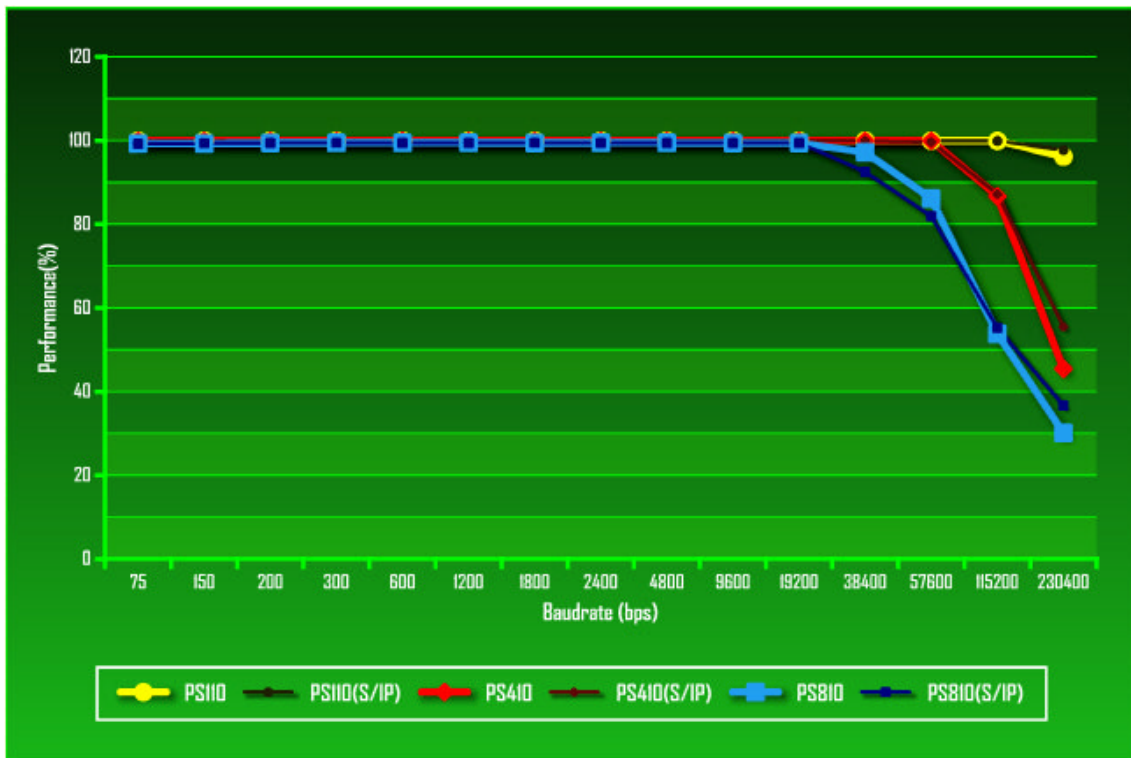


Figure 8: Throughput Test Result of Pro Series – TCP/IP vs. Serial/IP

Super Series and STS Series

Status	SS100		STS400		STS800		STS1600	
	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)
75	74.84	99.79	74.81	99.74	75.21	100.27	74.80	99.73
150	149.67	99.78	149.75	99.84	149.74	99.83	149.77	99.85
200	199.69	99.85	199.76	99.88	199.74	99.87	199.73	99.86
300	299.40	99.80	299.77	99.92	299.68	99.89	299.57	99.86
600	599.75	99.96	599.57	99.93	599.46	99.91	599.50	99.92
1200	1197.66	99.81	1199.01	99.92	1199.03	99.92	1198.51	99.88
1800	1796.44	99.80	1759.07	97.73	1758.87	97.72	1794.46	99.69
2400	2395.32	99.81	2326.92	96.95	2326.52	96.94	2396.57	99.86
4800	4790.64	99.81	4550.32	94.80	4538.73	94.56	4785.04	99.69
9600	9595.89	99.96	8658.17	90.19	8621.71	89.81	9574.35	99.73
19200	19252.38	100.27	15752.10	82.04	15742.45	81.99	19030.77	99.12
38400	26946.87	70.17	26944.21	70.17	26262.23	68.39	31366.77	81.68
57600	35309.92	61.30	35283.20	61.26	34122.96	59.24	35618.13	61.84
115200	51200.00	44.44	50799.38	44.10	44690.19	38.79	34357.35	29.82
230400	68266.27	29.63	63983.91	27.77	62949.62	27.32	32163.38	13.96

Table 12: Throughput Test Result of Super Series and STS Series



Figure 9: Throughput Test Result of Super Series and STS Series

Status	SS100		STS400		STS800		STS1600	
Baudrate	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)	TCP/IP (%)	Serial/IP (%)
75	99.79	99.78	99.74	99.75	100.27	100.15	99.73	99.71
150	99.78	99.78	99.84	99.84	99.83	99.84	99.85	99.80
200	99.85	99.85	99.88	99.88	99.87	99.77	99.86	99.89
300	99.80	99.81	99.92	99.91	99.89	99.90	99.86	99.92
600	99.96	99.96	99.93	99.69	99.91	99.93	99.92	99.93
1200	99.81	99.81	99.92	99.94	99.92	99.93	99.88	99.84
1800	99.80	99.81	97.73	97.73	97.72	97.73	99.69	99.90
2400	99.81	99.81	96.95	96.96	96.94	96.95	99.86	99.73
4800	99.81	99.81	94.80	94.73	94.56	94.59	99.69	99.88
9600	99.96	99.96	90.19	90.39	89.81	89.89	99.73	99.79
19200	100.27	100.27	82.04	82.05	81.99	81.81	99.12	99.56
38400	70.17	70.17	70.17	70.15	68.39	68.38	81.68	62.18
57600	61.30	61.30	61.26	61.22	59.24	59.21	61.84	43.75
115200	44.44	44.44	44.10	44.02	38.79	38.83	29.82	26.71
230400	29.63	27.78	27.77	27.77	27.32	33.83	13.96	16.32

Table 13: Throughput Test Result of Super Series and STS Series – TCP/IP vs. Serial/IP

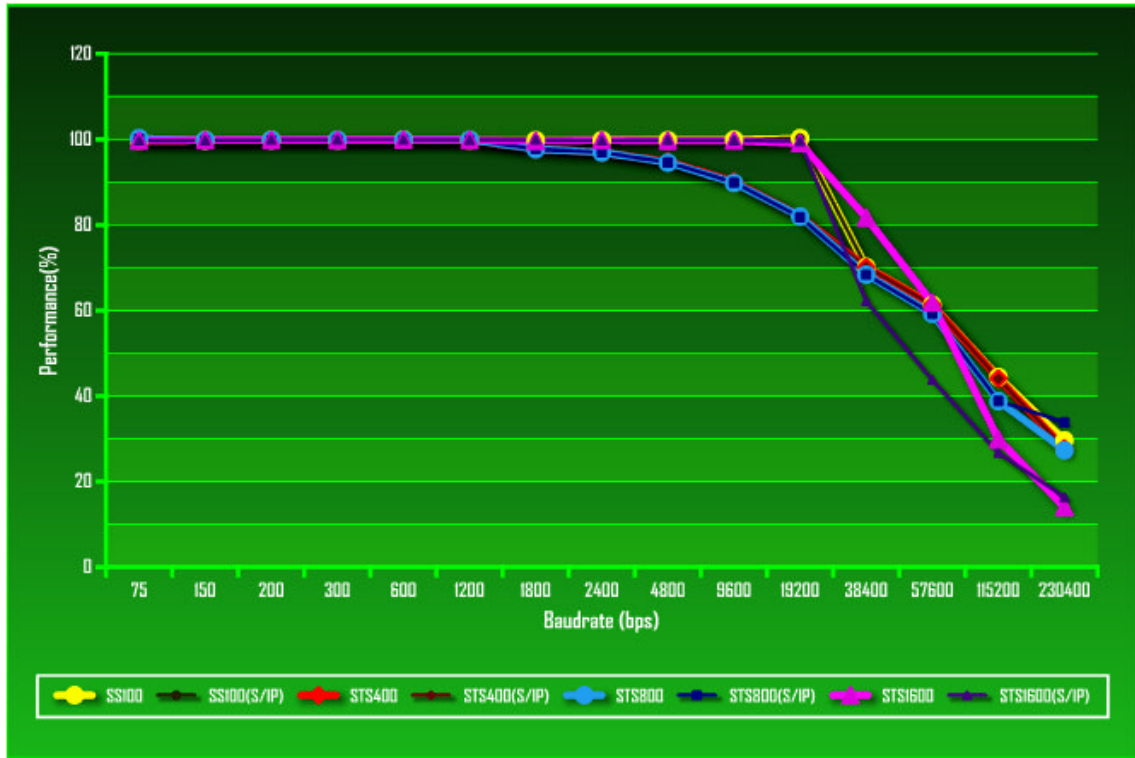


Figure 10: Throughput Test Result of Super Series and STS Series – TCP/IP vs. Serial/IP Bluetooth-Serial Adapters

Status	Parani-SD100		Parani-SD200		Parani-ESD100		Parani-ESD200	
	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)	Average Baudrate	Average Baudrate (%)
75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1200	985.29	82.11	986.44	82.20	983.69	81.97	993.06	82.75
1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2400	2008.99	83.71	2024.94	84.37	2003.72	83.49	2036.18	84.84
4800	4409.60	91.87	4417.03	92.02	4401.97	91.71	4381.79	91.29
9600	9064.97	94.43	9086.67	94.65	9061.89	94.39	9050.89	94.28
19200	18846.61	98.16	18817.20	98.01	18884.84	98.36	18898.26	98.43
38400	37741.59	98.29	37716.94	98.22	37766.52	98.35	37730.24	98.26
57600	56047.27	97.30	55904.66	97.06	39517.14	68.61	55630.07	96.58
115200	76666.00	66.55	76394.24	66.31	61578.50	53.45	78103.26	67.80
230400	72310.27	31.38	76664.88	33.27	62910.62	27.30	66491.46	28.86

Table 14: Throughput Test Result of Bluetooth-Serial Adapters



Figure 11: Throughput Test Result of Bluetooth-Serial Adapters

Final Thoughts

The benchmark test and test setup, we feel creates a realistic view of performance under both real-world configurations under a controlled environment, which give users and integrators with strict timing designs a good measure of how a Sena device will react within their network. Although, one must remember that all the latency / performance results reported are an average taken over a number of iterations, real-world results may vary depending on the complexity of various network configurations out in today's technologically advanced society.