MidiWave Analysis of Windows 98 Second Edition MIDI Performance

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PRELIMINARY

Note:

The first author is Chair of the Transport Layer Working Group (TLWG) of the MIDI Manufacturers Association. While this work was motivated by the activities of the TLWG, it has been conducted separately from the MMA. The testing methodology described was developed entirely at IBM Research, and neither this methodology nor the results and conclusions described in this paper have been endorsed by the MMA as of this date.

Windows 98SE MIDI System Performance - Summary of Test Results

Five different types of MIDI interfaces were tested to determine overall MIDI system performance on two different Windows 98SE systems. Round-trip performance (MIDI IN → host system → MIDI Out) was assessed in terms of latency (mean event transit delay) and jitter (variation in transit delay).
Charts illustrating the test results are included at the end of this report.

Three performance clusters were apparent on each of the two systems tested.

- The best performers were clearly the non-USB "legacy" MIDI Interfaces (SCP-55, CS-401 and SBLive). The Roland SCP-55 was the best performer by a slight margin.
  Within this cluster, latency was 2.5 – 3.3 msec, peak jitter was 3.1 – 3.6 msec, and the standard deviation for jitter was 0.6 to 0.8 msec.
- The Roland SMPU-64 was a mid-range performer. Within this cluster, latency was 7 – 8 msec, peak jitter was 6.0 – 8.5 msec, and the standard deviation for jitter was 0.9 to 1.4 msec.
- The Roland UA-100 exhibited the worst performance. Within this cluster, latency was 10.8 – 12.4 msec, peak jitter was 9.1 to 10.5 msec, and the standard deviation for jitter was 1.7 to 2.4 msec.

It is interesting that the SMPU-64 exhibits significantly better MIDI performance than the UA-100, given that both devices use similar USB MIDI protocols. (UA-100 performance is roughly 64% worse; jitter performance on the Thinkpad system was 80% worse.) Note that the UA-100 also supports three stereo USB audio streams (16 bit, 44.1KHz), which were active. This represents a constant additional USB load of roughly 570 bytes/frame, equal to roughly 43% of typical USB bandwidth (assuming 1308 non-overhead bytes/frame given typical USB overheads; actual overhead factors can vary significantly). Since USB audio transfers are isochronous and USB MIDI transfers are bulk (asynchronous), it appears that the additional load imposed by three stereo audio streams significantly impacts MIDI performance.

It is likely that enhancements to the host USB drivers could mitigate this effect to some extent. However, no drivers can prevent isochronous traffic (audio) from taking priority over asynchronous traffic (MIDI). Furthermore, no tests have yet been performed in the presence of additional active USB loads. The 64% performance degradation apparently caused by the presence of three USB audio streams suggests that additional USB traffic will cause additional MIDI performance degradation.

	ThinkPad 770ED (PII, 277 MHz)				Intellistation M Pro (400MHz)		
	SCP55 (TPad)	CS401 (TPad)	SMPU64 (TPad)	UA100 (TPad)	SBLive (MPro)	SMPU64 (MPro)	UA100 (MPro)
Latency (Mean Delay):	2.47	3.23	7.74	12.38	2.85	7.10	10.80
Peak Jitter (Max-Min)	3.11	3.65	8.46	10.52	3.63	5.96	9.12
Std. Dev:	0.78	0.66	1.37	2.36	0.67	0.93	1.75
Min Delay:	1.11	1.29	4.33	7.41	1.07	4.47	6.80
Max Delay:	4.22	4.94	12.79	17.94	4.69	10.43	15.92
Median Delay:	2.57	3.20	7.60	11.84	2.81	6.90	10.93

(All units in milliseconds)

The basic approach involves recording MIDI as audio (with timing resolution of 22 microseconds) and analyzing the waveform to extract timing characteristics. Two MIDI streams are recorded (the REF events fed to the device under test, and the TEST events produced by the D.U.T.) A MidiWave transcoder is used to generate a stereo audio stream from the two MIDI streams. The resulting stereo audio file is then analyzed to determine differential timing characteristics of theTEST stream (effectively nullling out any timing errors in the REF stream).

Tests were conducted on two systems between 1-26-2000 and 1-28-2000:

- "TPad" – IBM Thinkpad 770ED (277 MHz Pentium II, 160M RAM, 8G EIDE hard drive)
- "MPro" – IBM Intellistation M Pro 6889-14U, dual Pentium II/400MHz, 320M RAM, EIDE and Fast/Wide SCSI.

> Note: the Intellistation M Pro happens to be the **only** specific system, from any vendor, certified by Digidesign at this time to run ProTools on Windows NT. Thus, this system should certainly be able to support USB MIDI effectively.

Each test system was running Windows 98 Second Edition with all hotfixes applied as of 1-5-2000. A separate system was used to generate the stream of reference MIDI events and to capture the stereo audio stream produced by the MidiWave transcoder.

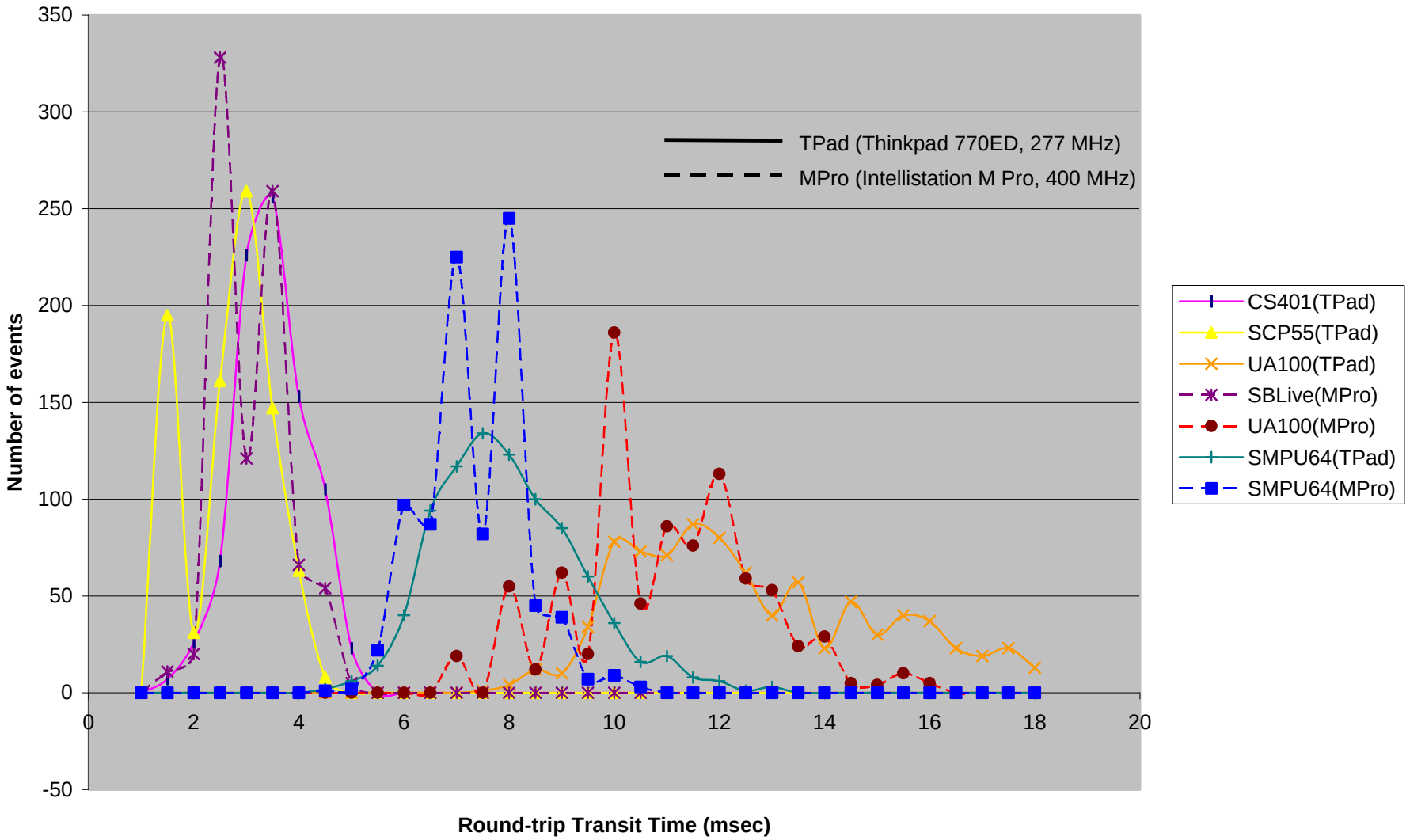
Three test runs were run on each combination of PC system and MIDI interface, with test results combined for subsequent analysis. Schedulers, anti-virus software, network drivers and similar software were disabled. Each system was rebooted when changing the MIDI interface to ensure that unneeded MIDI drivers were not loaded. Each test run consisted of 288 pairs of REF and TEST events (yielding 864 event pairs for each tested interface/system combination). Nominal REF event spacing was 4 msec (about 25% of MIDI 1.0 DIN capacity). The REF event stream is composed of alternating PitchBend and Control Change events in order to produce a consistent stream of 3-byte events with no running status.

The Steinberg Cubase VST/24 sequencer (v3.7 R1) was used to provide a high-performance MIDI Thru connection on each test system. This software was benchmarked against the Win32 API midiConnect() MIDI Thru facility, and was found to provide significantly better performance (lower latency, better jitter) for routing incoming MIDI events to a MIDI Out port.

For the Thinkpad system, four MIDI interfaces were tested (SCP55, CS401, SMPU64 and UA100). For the Intellistation system, three MIDI interfaces were tested (SBLive, SMPU64 and UA100):

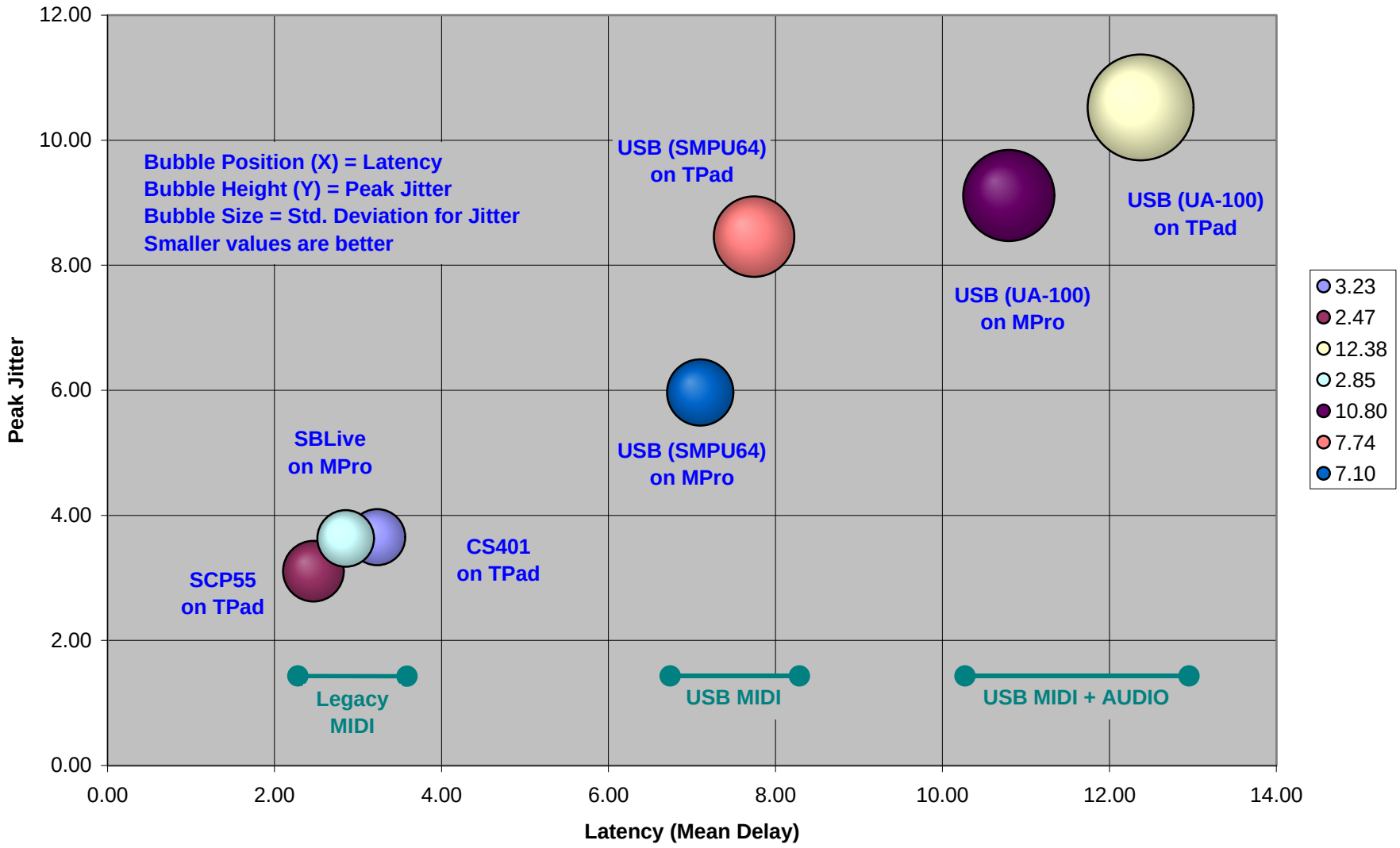
> CS401 = Crystal Semiconductor MPU-401 emulation (native Thinkpad MIDI support)
> CS401 MIDI Driver dated 5-29-1998
>
> SCP55= Roland SCP-55 PCMCIA card.
> Roland SCP-55 driver 4.02.000, dated 12-6-1996
>
> UA100 = Roland UA-100 MIDI/Audio interface.
> Roland UA-100 USB driver V1.6 for Windows 98, dated 10-29-1999 (supports ASIO)
>
> SMPU64 = Roland SMPU-64 4 Port MIDI interface.
> Roland SMPU-64 USB driver V1.0 for Windows 98, dated 8-18-1999
>
> SBLive = Creative Soundblaster Live (original version).
> Version 3.0 drivers dated late November 1999 were used.

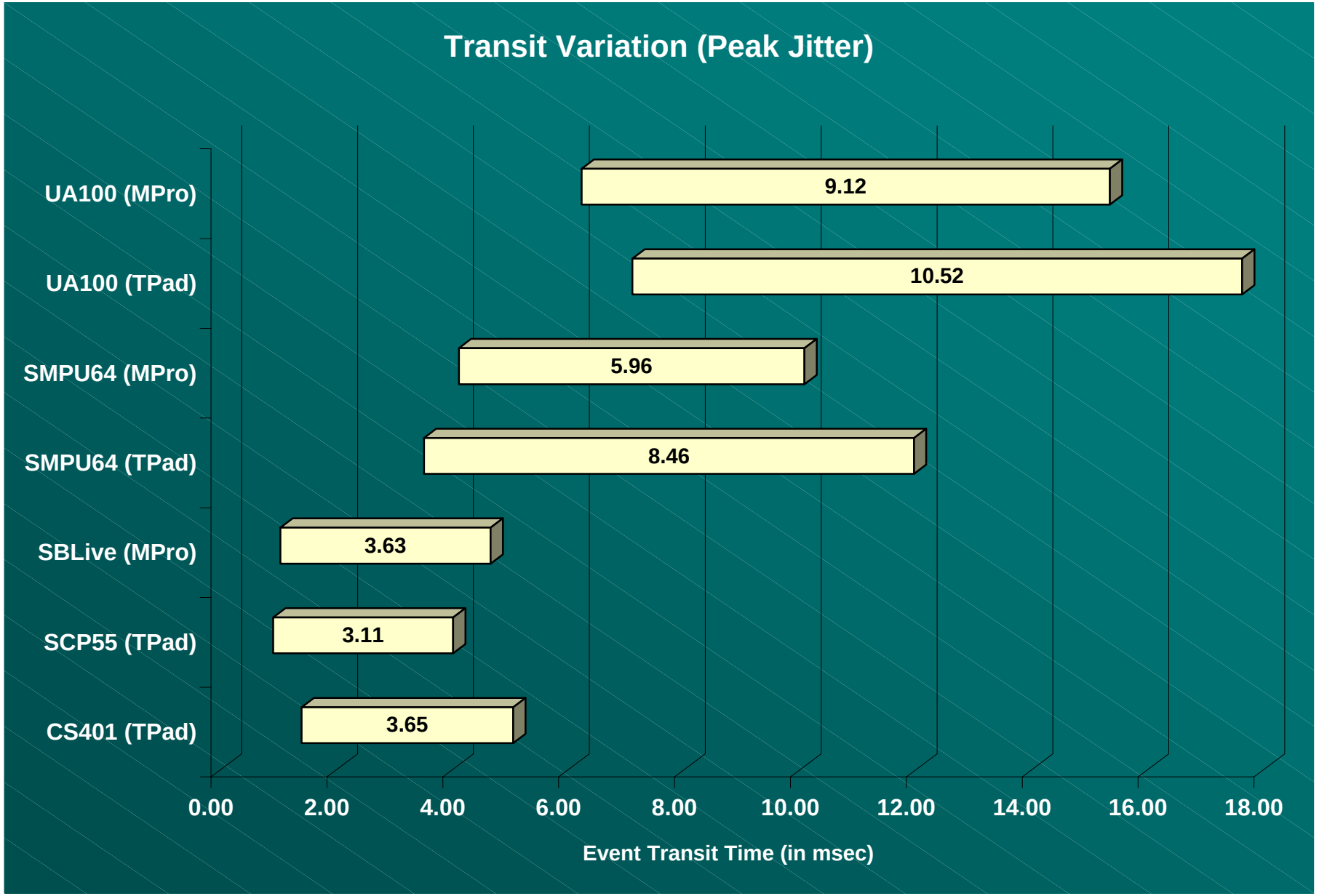
Raw Timing Distributions



Latency, Peak Jitter and Std. Deviation

(Round-trip Windows 98 SE MIDI System Performance)




Transit Variation (Peak Jitter)
UA100 (MPro)
UA100 (TPad)
SMPU64 (MPro)
SMPU64 (TPad)
SBLive (MPro)
SCP55 (TPad)
CS401 (TPad)
9.12
10.52
5.96
8.46
3.63
3.11
3.65
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
Event Transit Time (in msec)

Event Latency and Peak Jitter with Jitter Bars