

http://repo-ck.com/bench/cpu_schedulers_compared.pdf

CPU SCHEDULERS COMPARED

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Introduction

Purpose

Benchmark details

Test CPUs/systems

Purpose

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Con Kolivas' Brain Fuck Scheduler (bfs) was designed to provide superior desktop interactivity and responsiveness to machines running it.¹ However, it was not implicitly designed to provide superior performance. The purpose of this study was to evaluate the Completely Fair Scheduler (cfs) in the vanilla Linux kernel and the bfs in the corresponding kernel patched with the ck1 patchset. Seven (7) different machines were used to see if differences exist and, to what degree they scale using *performance based* metrics. Again, these end-points were never factors in the primary design goals of the bfs.

(1) <http://ck.kolivas.org/patches/bfs/sched-BFS.txt>

Benchmark Details

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The collective benchmark was called from a simple Bash script that ran each individual benchmark task multiple times – at least ten – in order to get a decent number of observations to power a statistical comparison. Test machines were booted into either the stock kernel or into a corresponding ck1 patched kernel and then challenged with three different benchmark tasks. The time to complete each task was captured to a log file and the test repeated:


1. Compilation using gcc to `make -jx bzImage` for a preconfigured linux kernel v3.6.2.²
2. Compression using lrzip to compress the source tree for the linux kernel v3.6.2.
3. Video compression using ffmpeg to transcode a 720p MPEG2 clip to a 360p video suitable for playback on a smartphone.

(2) In the `make -jx bzImage` statement, $x=(\text{number of physical cores} + \text{virtual cores})+1$. I am aware that it is recommended NOT to use the +1 for kernels running the bfs but felt that in order to fairly compare both schedulers, this needed to be held constant.


CPUs Compared with Core Count

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Athlon XP 3200+

 = 1 core

Intel E5200

 = 2 cores

Intel Atom 330

 = 4 cores

Intel i7-2620M

 = 4 cores

Intel X3360

 = 4 cores

Intel i7-3770K

 = 8 cores

Dual Intel E5620

 = 16 cores



= Physical core



= Hyperthreaded core

Each test machine ran Arch Linux x86_64 except for the Athlon XP which ran Arch i686 due to its lack of 64-bit support.

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Results and Conclusion

Compression Benchmark

Make Benchmark

Video Encoding Benchmark

Conclusion

Compression Benchmark Results

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CPU	Average Time (sec)		CK Kernel is...	
	<i>Vanilla</i>	<i>CK-Patched</i>	<i>Difference</i>	<i>Result</i>
AMD Athlon XP	558.3320	547.7577	-10.5753	1.9 % faster
Intel E5200	166.3141	165.7622	-0.5519	0.3 % faster
Intel Atom 330	470.0283	454.8185	-15.2098	3.2 % faster
Intel i7-2620M	81.2978	79.4898	-1.808	2.2 % faster
Intel X3360	68.2635	67.7987	-0.4648	0.7 % faster
Intel i7-3770K	35.2904	34.3310	-0.9594	2.7 % faster
Dual Intel E5620	27.7919	28.2716	+0.4797	1.7 % slower

Small (1-3 %) efficiency/speed gains were observed almost universally across the test systems when timing compression using lrzip. The notable exception being the multi-socket machine which was around 2 % slower.

Make Benchmark Results

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CPU	Average Time (sec)		CK Kernel is...	
	<i>Vanilla</i>	<i>CK-Patched</i>	<i>Difference</i>	<i>Result</i>
AMD Athlon XP	1,120.6486	1,095.6486	-25.4671	2.3 % faster
Intel E5200	374.0274	366.0912	-7.9362	2.1 % faster
Intel Atom 330	1,568.5016	1,546.4804	-22.0212	1.4 % faster
Intel i7-2620M	192.5477	190.6712	-1.8765	1.4 % faster
Intel X3360	127.6179	127.2340	-0.3839	0.3 % faster
Intel i7-3770K	68.9835	67.9671	-1.0164	1.5 % faster
Dual Intel E5620	74.1218	68.2665	-5.8553	7.9 % faster

Small to moderate (2-8 %) efficiency/speed gains were observed across all test systems with the gcc-based endpoint. Of note is the multi-socket “dual quad” machine which saw the largest boost using the bfs of nearly 8 %.

Video Benchmark Results

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CPU	Average Time (sec)		CK Kernel is...	
	<i>Vanilla</i>	<i>CK-Patched</i>	<i>Difference</i>	<i>Result</i>
AMD Athlon XP	380.8340	386.4206	+5.5866	1.5 % slower
Intel E5200	102.3183	99.8744	-2.4439	2.4 % faster
Intel Atom 330	471.0781	443.4450	-27.6331	5.9 % faster
Intel i7-2620M	50.1631	48.7489	-1.4142	2.8 % faster
Intel X3360	39.3656	37.6724	-1.7232	4.4 % faster
Intel i7-3770K	19.6863	18.1044	-1.5819	8.0 % faster
Dual Intel E5620	30.9037	30.7141	-0.1896	0.6 % faster

Small to moderate (2-8 %) efficiency/speed gains were observed almost universally across the test systems when timing ffmpeg video encoding. Here the oldest CPU showed a slight decrease in speed of around 1.5 %.

Conclusion

In addition to the primary design goals of the bfs, increased desktop interactivity and responsiveness, kernels patched with the ck1 patch set including the bfs *outperformed* the vanilla kernel using the cfs at nearly all the performance-based benchmarks tested. Further study with a larger test set could be conducted, but based on the small test set of 7 PCs evaluated, these increases in process queuing, efficiency/speed are, on the whole, independent of CPU type (mono, dual, quad, hyperthreaded, etc.), CPU architecture (32-bit and 64-bit), and of CPU multiplicity (mono or dual socket).

Moreover, several “modern” CPUs (Intel C2D and Ci7) that represent common workstations and laptops, consistently outperformed the vanilla kernel at all benchmarks. Efficiency and speed gains were small to moderate.

Feel free to contact the author with questions, suggestions, or rants: [graysky AT archlinux DOT us](mailto:graysky@archlinux DOT us)

Appendix/Supporting Information

List of software used

Additional hardware details

Statistical relevance of results and more details

Software Used

The requisite software packages used for each task came from the official Arch Linux repos with the exception of the linux-ck packages which came from the unofficial linux-ck repo.³ Package names including version numbers:

- linux-3.6.2-1
- linux-ck-3.6.2-1
 - linux-ck uses bfs v0.425 contained in the 3.6-ck1 patchset.⁴
- gcc-4.7.2-1
- ffmpeg-1:1.0-1
- lrzip-0.614-1

Finally, the Oneway ANOVA plots presented in the Appendix were generated using version 10.0 JMP.⁵

(3) <https://wiki.archlinux.org/index.php/repo-ck>

(4) <http://ck.kolivas.org/patches/3.0/3.6/3.6-ck1/patch-3.6-ck1.bz2>

(5) <http://www.jmp.com>

Software Used

The Bash script used to drive the benchmarks and to create the log file is available in graysky's github.⁶ Users may edit the initial variables in the script to repeat this study on their own systems. The Linux source code can be downloaded from <http://kernel.org> which will provide substrate for the "Make" and for the "Compression" benchmarks. Due to copyright limitations, I am unable to provide the 2 min 720p MPEG clip, but users seeking to run the "Video" benchmark need only provide their own clip and edit the video clip name variable in the script as a workaround.

The raw data generated during the course of this study and also presented in the Oneway analyses on the slides to follow is available as a tab delimited text file.⁷

(6) <https://github.com/graysky2/bin>

(7) http://repo-ck.com/bench/raw_data.txt

Additional Hardware Details

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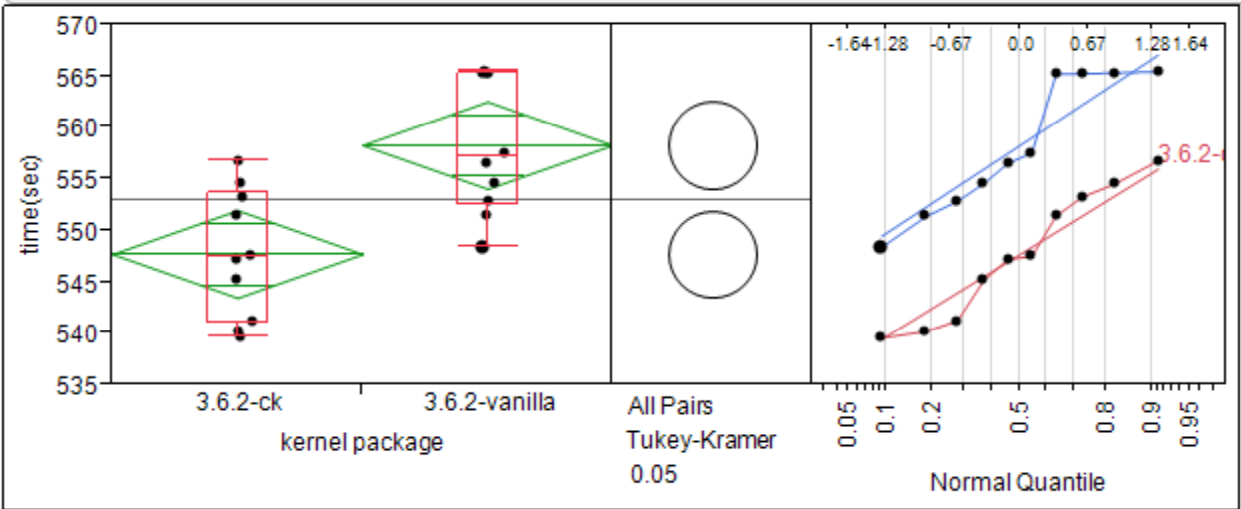
CPU Model	Clock Speed (GHz)	RAM (GB)	Comment
AMD Athlon XP 3200+	2.20	1.0	
Intel E5200	3.33	4.0	Overclocked 12.5x266
Intel Atom 330	1.60	2.0	
Intel i7-2620M	2.70	4.0	
Intel X3360	3.40	8.0	Overclocked 8.5x400
Intel i7-3770K	4.50	16.0	Overclocked 45x100
Dual Intel E5620	2.83	8.0	Dual socket machine

Note that the overclocked systems have been deemed “stable overlocks” though hours of punishment without errors including torture testing with mprime, linpack, systester, and with gcc. For more on Linux stress testing, see: https://wiki.archlinux.org/index.php/Stress_Test

Oneway Analysis

Athlon XP/Compression

Oneway Analysis of time(sec) By kernel package CPU=AMD Athlon XP 3200+, benchmark=compress



Quantiles

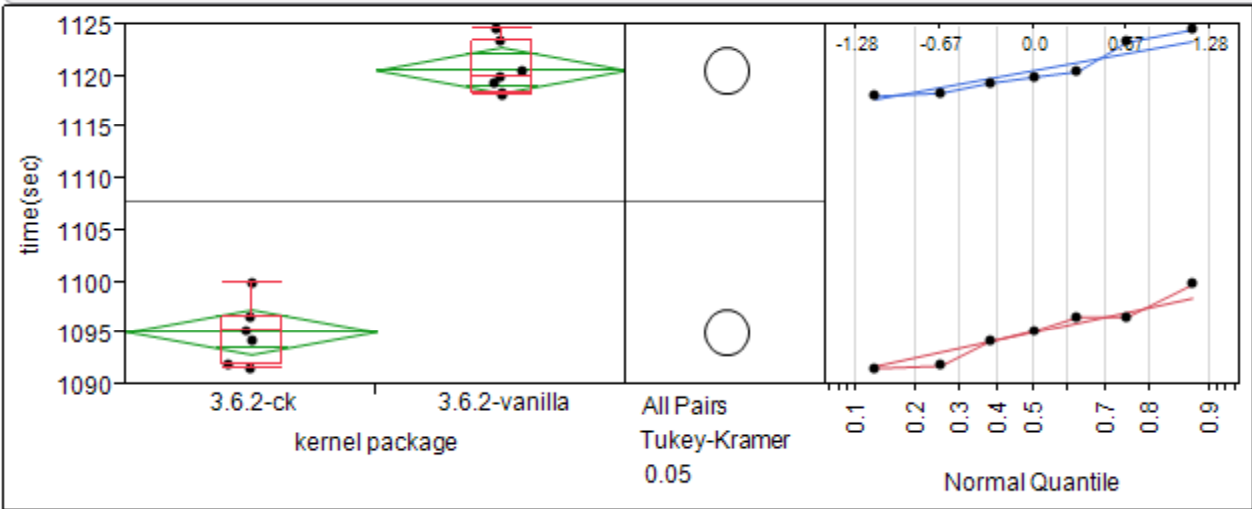
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	539.6073	539.6731	541.0496	547.4324	553.6534	556.6041	556.8295
3.6.2-vanilla	548.4695	548.7662	552.5501	557.1135	565.3703	565.5378	565.5511

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis Athlon XP/Make

Oneway Analysis of time(sec) By kernel package CPU=AMD Athlon XP 3200+, benchmark=make



Quantiles

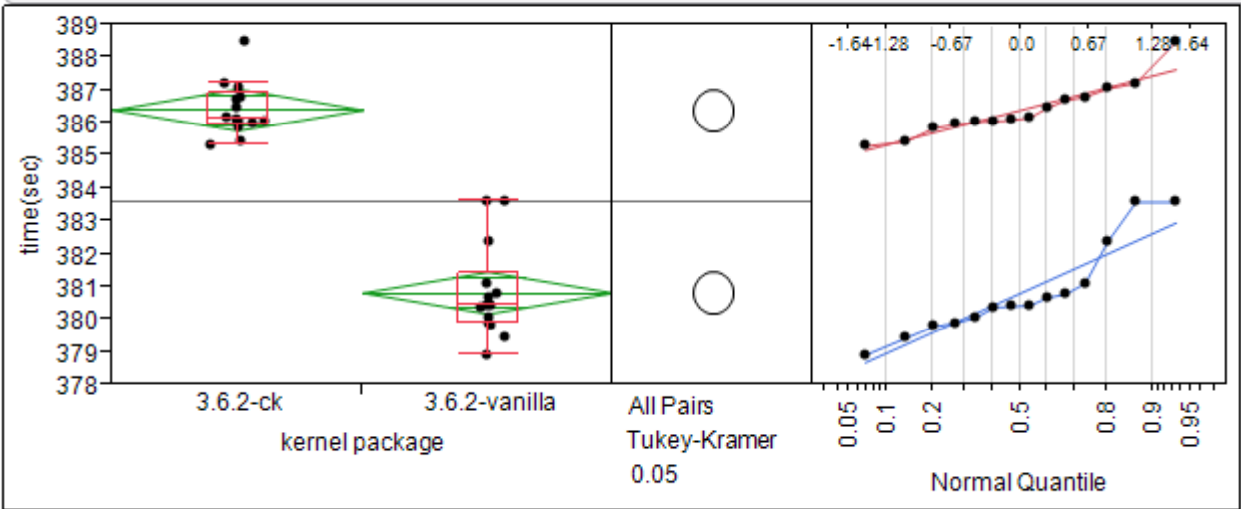
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	1091.642	1091.642	1091.878	1095.298	1096.682	1099.836	1099.836
3.6.2-vanilla	1118.161	1118.161	1118.461	1120.004	1123.378	1124.57	1124.57

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis Athlon XP/Video

Oneway Analysis of time(sec) By kernel package CPU=AMD Athlon XP 3200+, benchmark=video



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	385.307	385.3796	385.9521	386.1516	386.8925	387.8765	388.5079
3.6.2-vanilla	378.9268	379.1851	379.8929	380.4344	381.4496	383.5962	383.5976

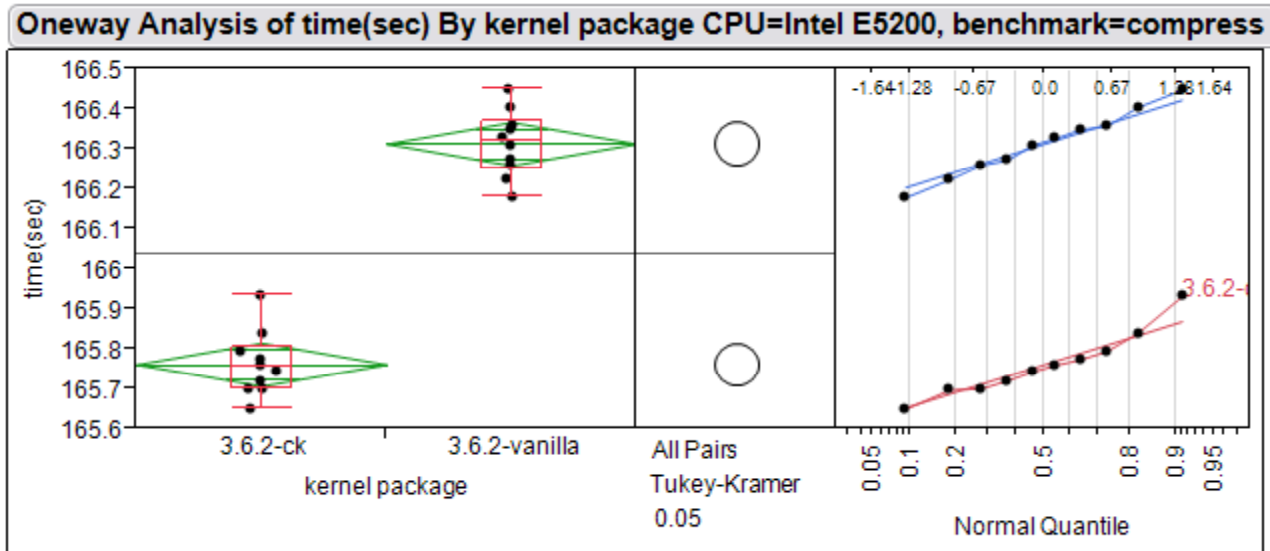
Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis

E5200/Compression

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Quantiles

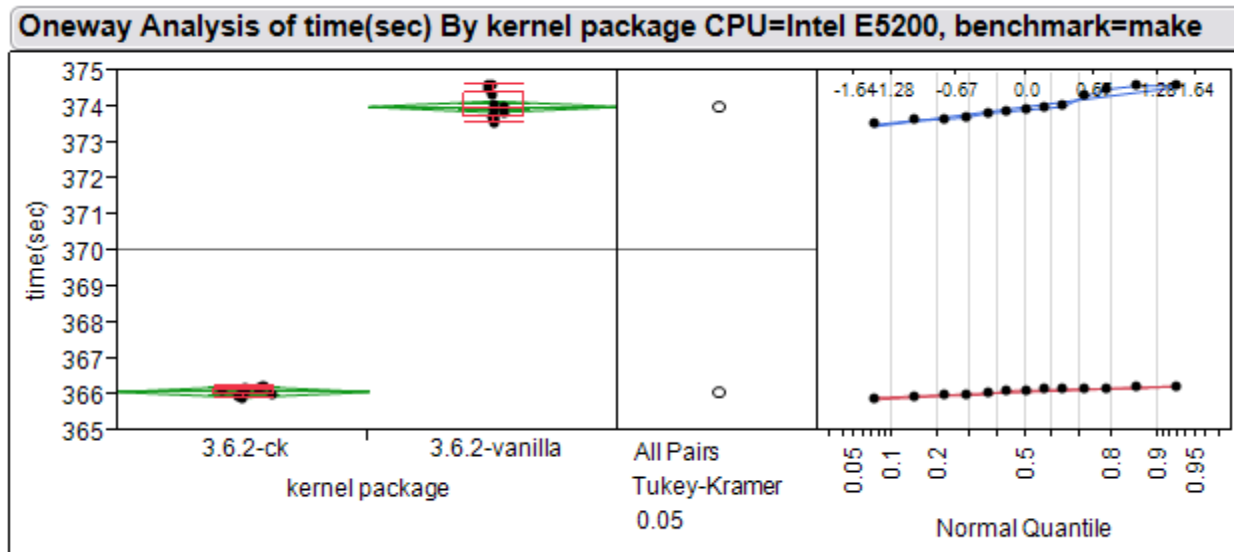
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	165.6505	165.6552	165.7005	165.7526	165.8071	165.9237	165.9328
3.6.2-vanilla	166.1793	166.1838	166.2519	166.3197	166.3704	166.4446	166.4489

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis E5200/Make

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Quantiles

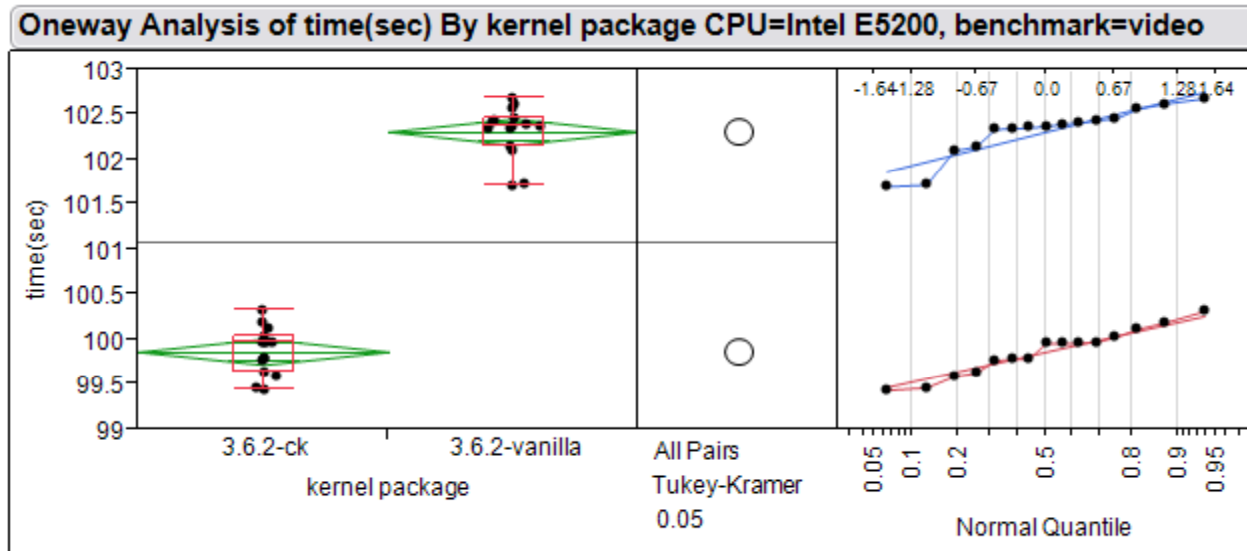
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	365.881	365.9054	365.9931	366.1343	366.1737	366.226	366.2464
3.6.2-vanilla	373.5284	373.5772	373.7111	373.9466	374.4158	374.6069	374.6087

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis E5200/Video

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Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	99.44407	99.46113	99.64017	99.96727	100.0389	100.2493	100.3253
3.6.2-vanilla	101.7047	101.7181	102.1543	102.3778	102.4627	102.6535	102.6897

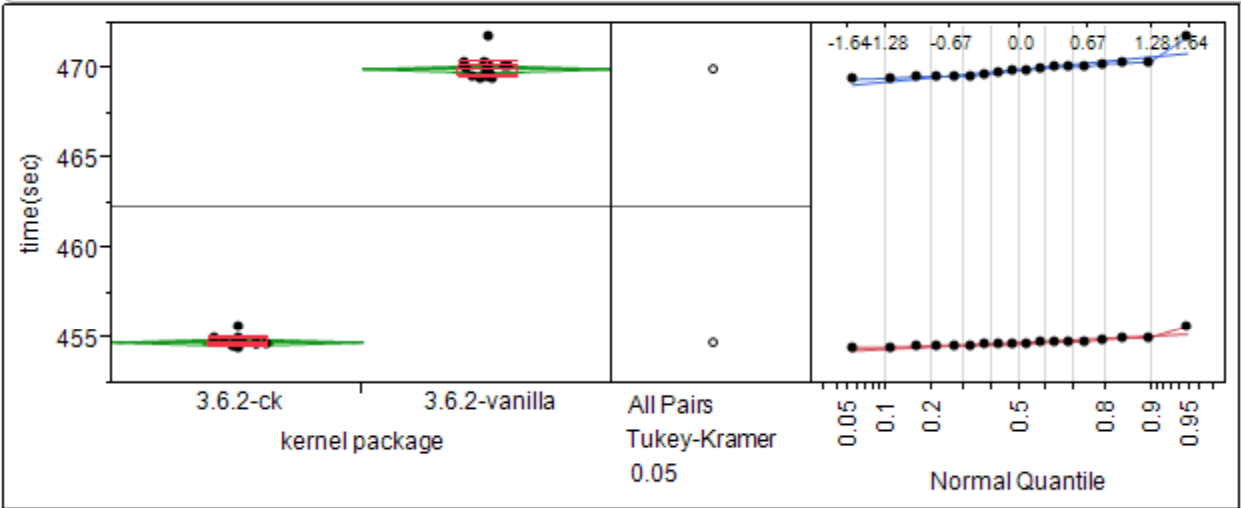
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

Atom 330/Compression

Oneway Analysis of time(sec) By kernel package CPU=Intel Atom 330, benchmark=compress



Quantiles

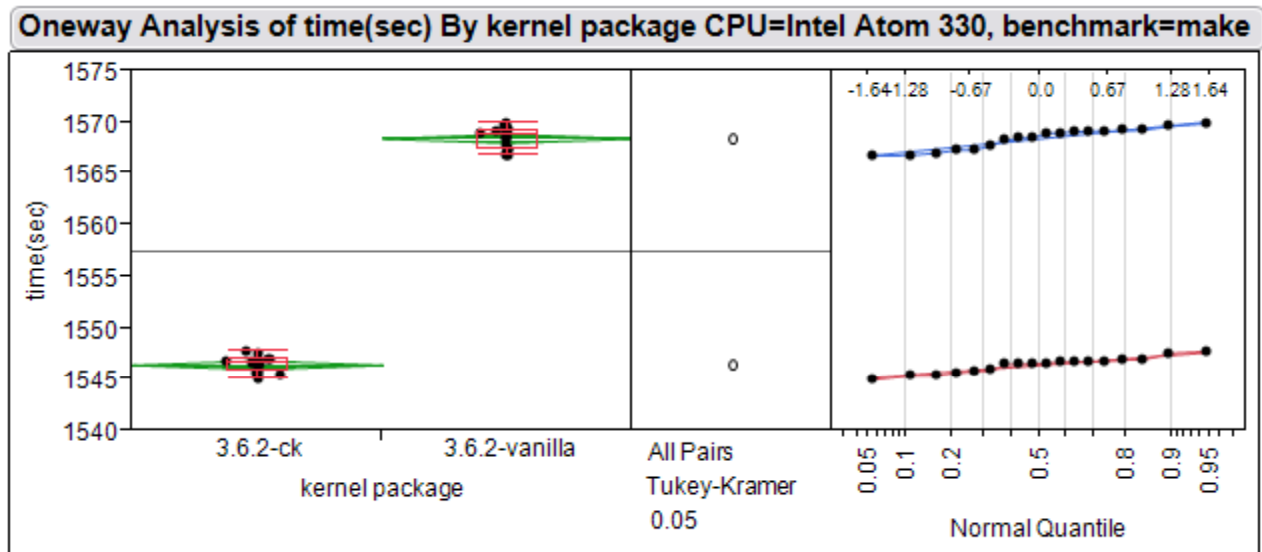
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	454.5351	454.5523	454.6568	454.7236	454.9065	455.1499	455.7635
3.6.2-vanilla	469.463	469.5264	469.6391	469.9667	470.2116	470.5511	471.8169

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis Atom 330/Make

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Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	1545.025	1545.389	1545.83	1546.647	1546.92	1547.674	1547.843
3.6.2-vanilla	1566.849	1566.891	1567.403	1568.821	1569.252	1569.737	1569.991

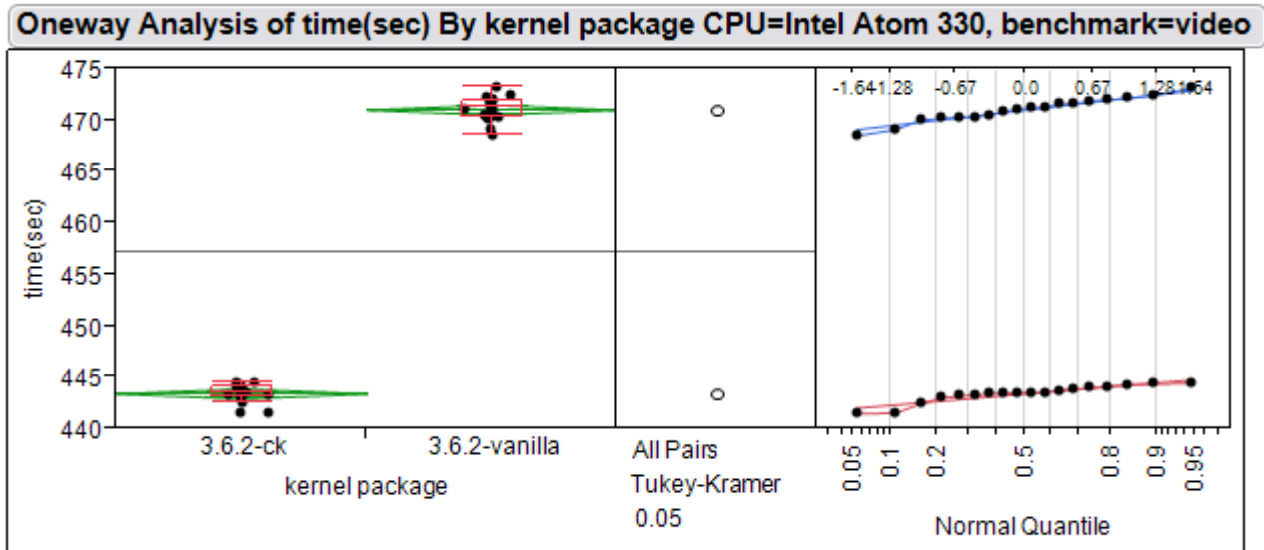
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

Atom 330/Video

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Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	441.5302	441.5832	443.1782	443.5815	444.0579	444.4053	444.4724
3.6.2-vanilla	468.592	469.123	470.3104	471.2141	471.9702	472.6027	473.2096

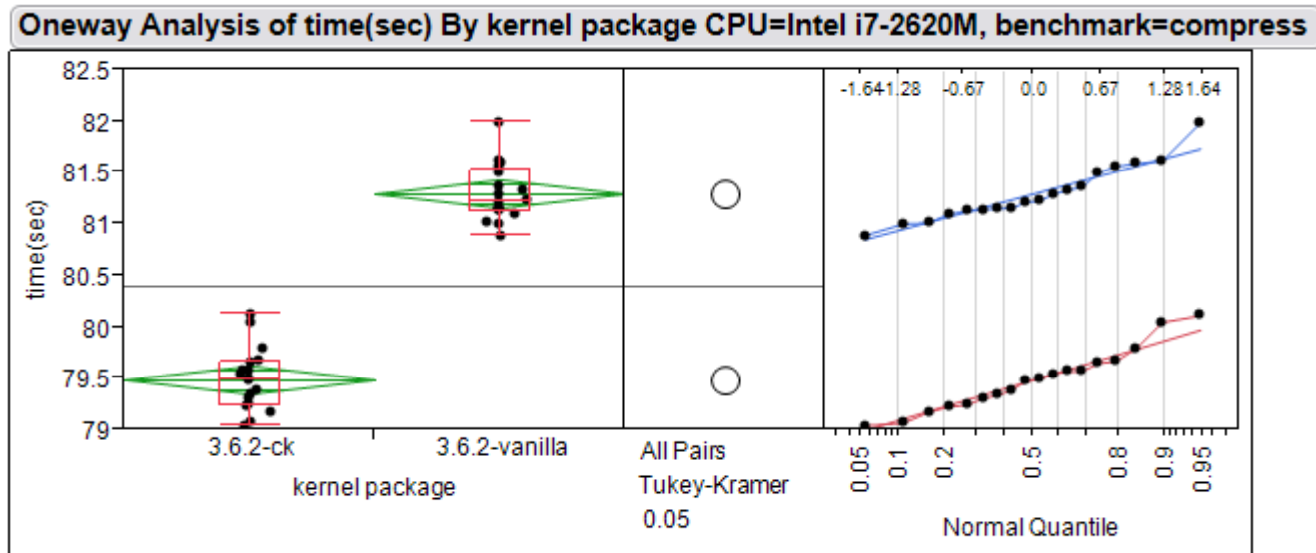
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

i7-2620M/Compression

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Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	79.04556	79.06819	79.24252	79.49191	79.66084	80.0603	80.11871
3.6.2-vanilla	80.89518	80.99464	81.12388	81.22404	81.521	81.66374	81.99479

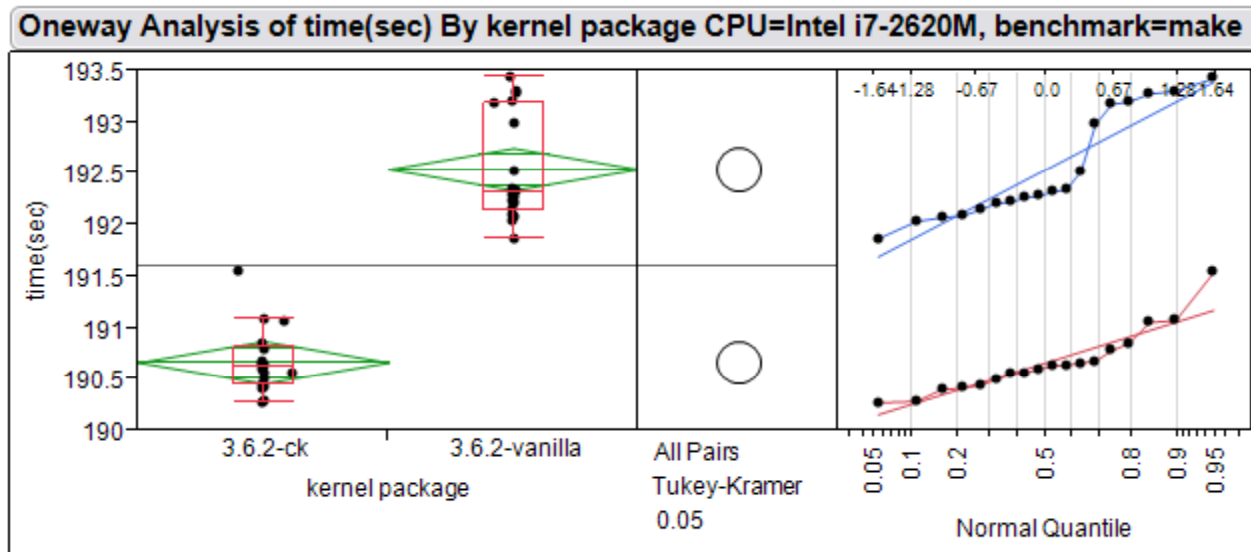
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

i7-2620M/Make

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Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	190.2779	190.2893	190.4424	190.6249	190.8079	191.1278	191.5468
3.6.2-vanilla	191.8749	192.0244	192.1397	192.3075	193.1887	193.3217	193.434

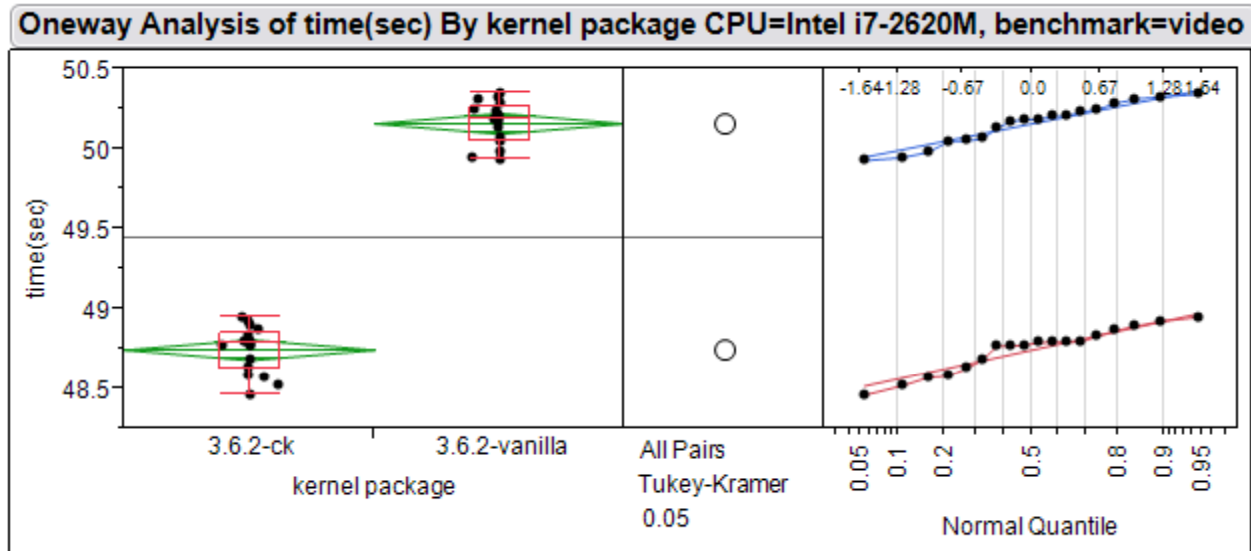
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

i7-2620M/Video

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Quantiles

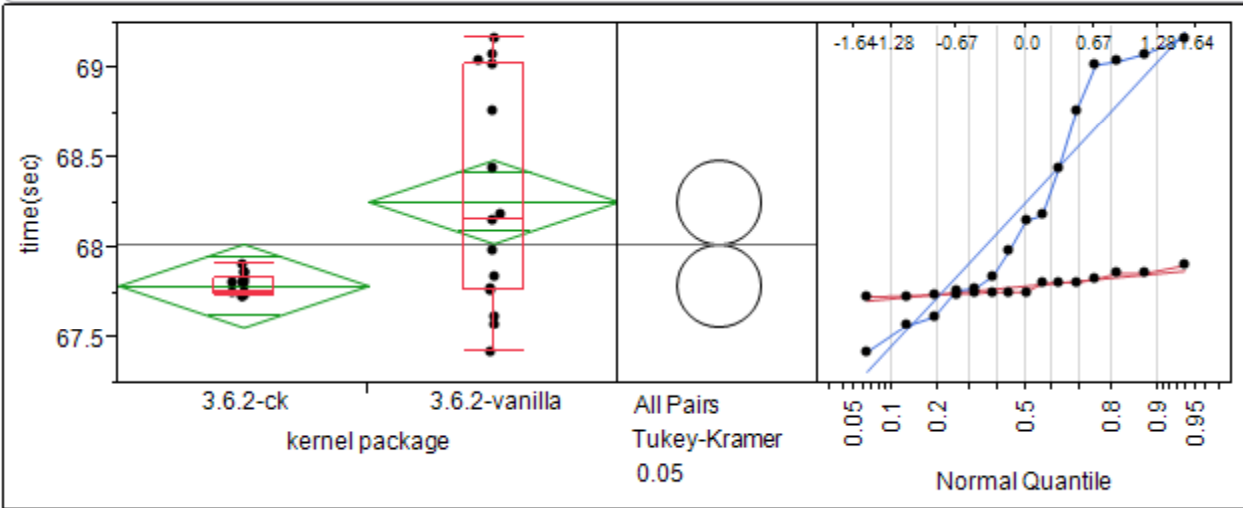
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	48.46352	48.51674	48.62136	48.78806	48.84548	48.93185	48.95508
3.6.2-vanilla	49.93418	49.9509	50.05604	50.18935	50.26114	50.33204	50.34686

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis X3360/Compression

Oneway Analysis of time(sec) By kernel package CPU=Intel X3360, benchmark=compress



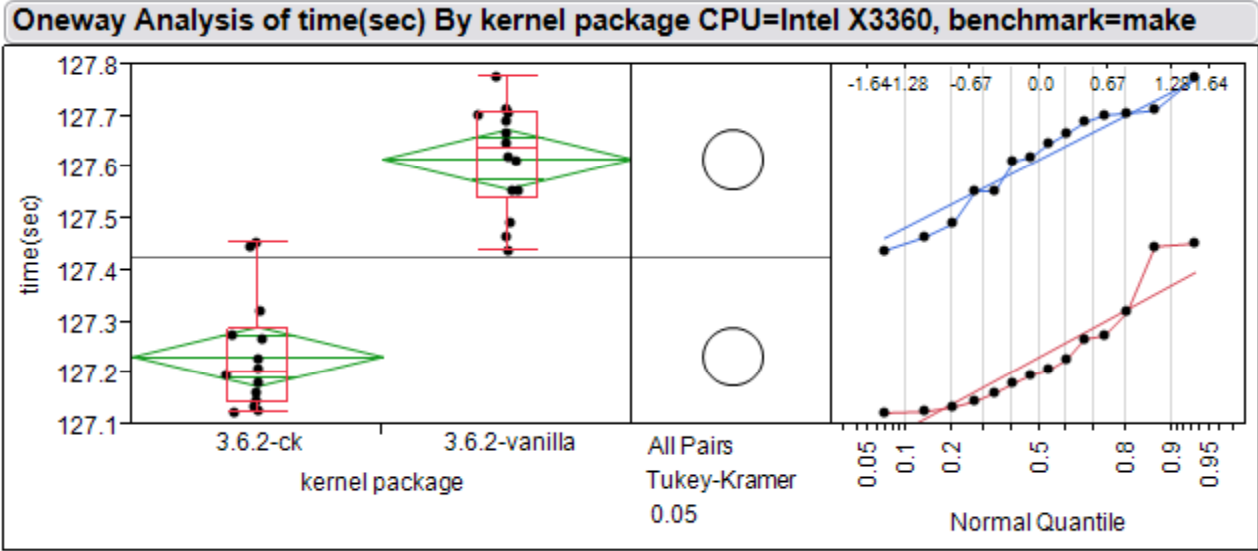
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	67.73978	67.74253	67.75487	67.76638	67.83807	67.88628	67.91238
3.6.2-vanilla	67.42879	67.51857	67.77203	68.15837	69.02623	69.1229	69.1775

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis X3360/Make



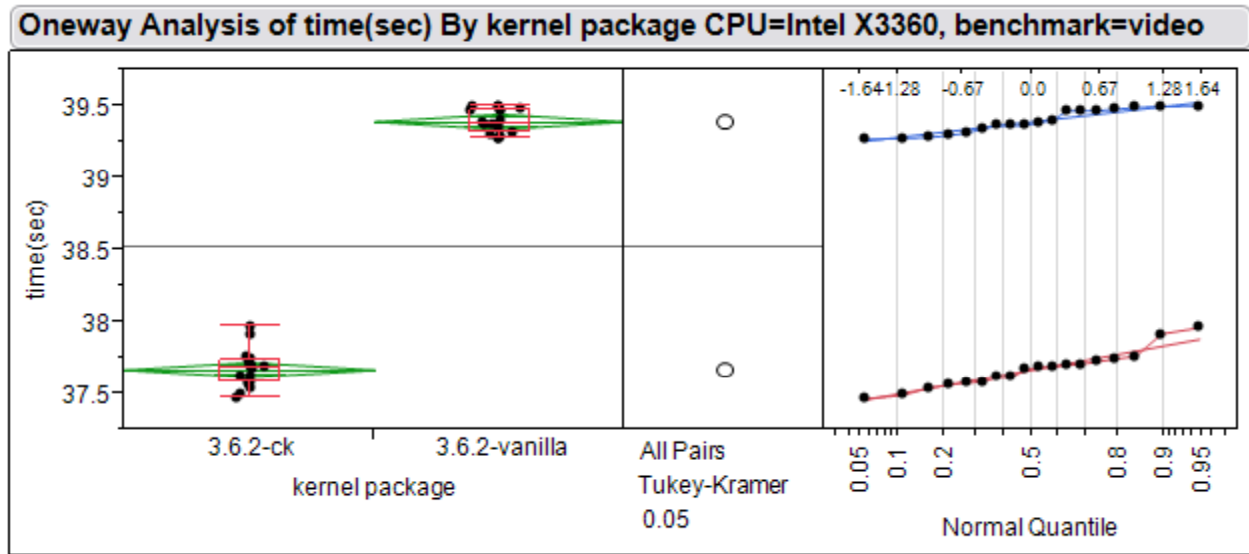
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	127.1239	127.1253	127.1439	127.203	127.2864	127.4507	127.4536
3.6.2-vanilla	127.4401	127.4531	127.5396	127.6348	127.7049	127.7447	127.7765

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis X3360/Video



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	37.46904	37.49109	37.57792	37.68317	37.73687	37.92717	37.9663
3.6.2-vanilla	39.27443	39.28103	39.3148	39.38101	39.47541	39.5018	39.5063

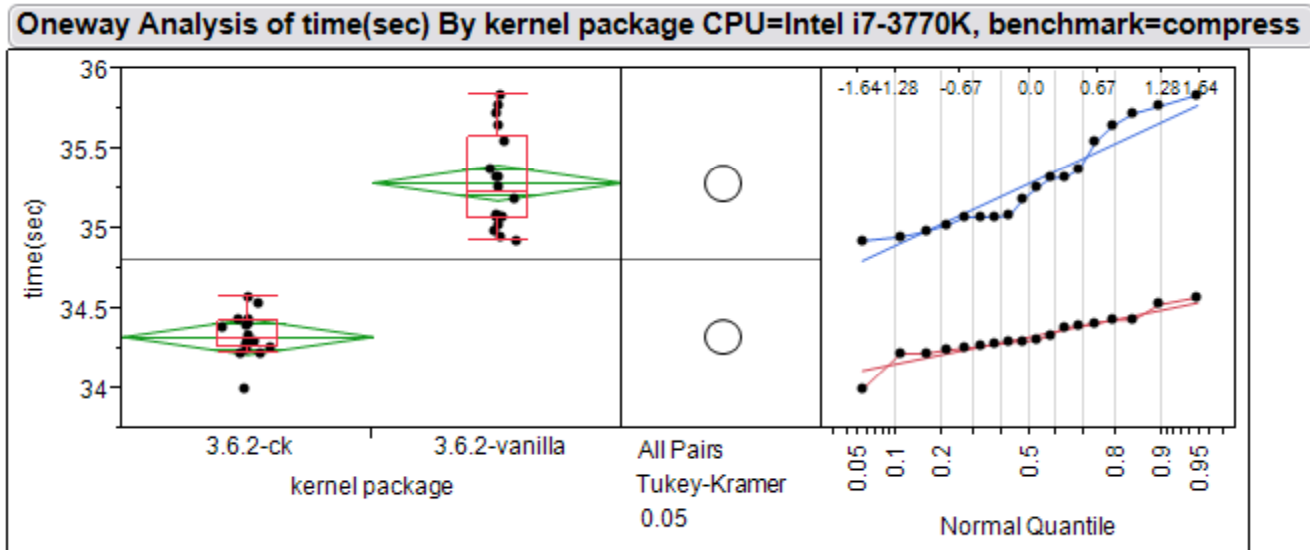
Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

i7-3370K/Compression

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Quantiles

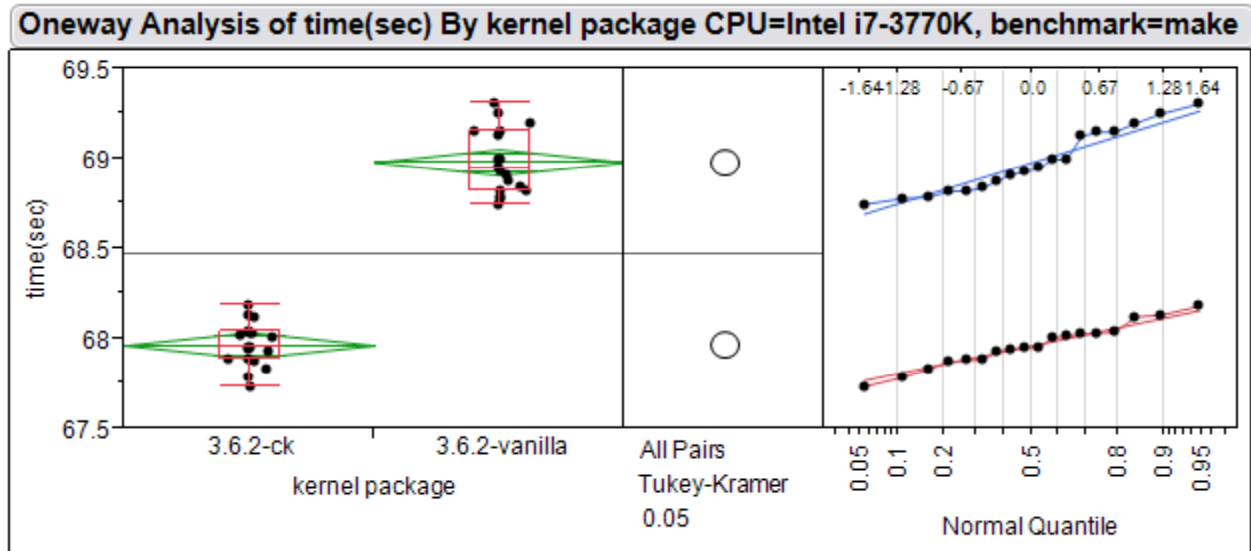
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	33.99958	34.20376	34.2564	34.30687	34.42245	34.53651	34.57686
3.6.2-vanilla	34.92964	34.95013	35.06251	35.22448	35.57513	35.77885	35.8428

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis i7-3370K/Make

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Quantiles

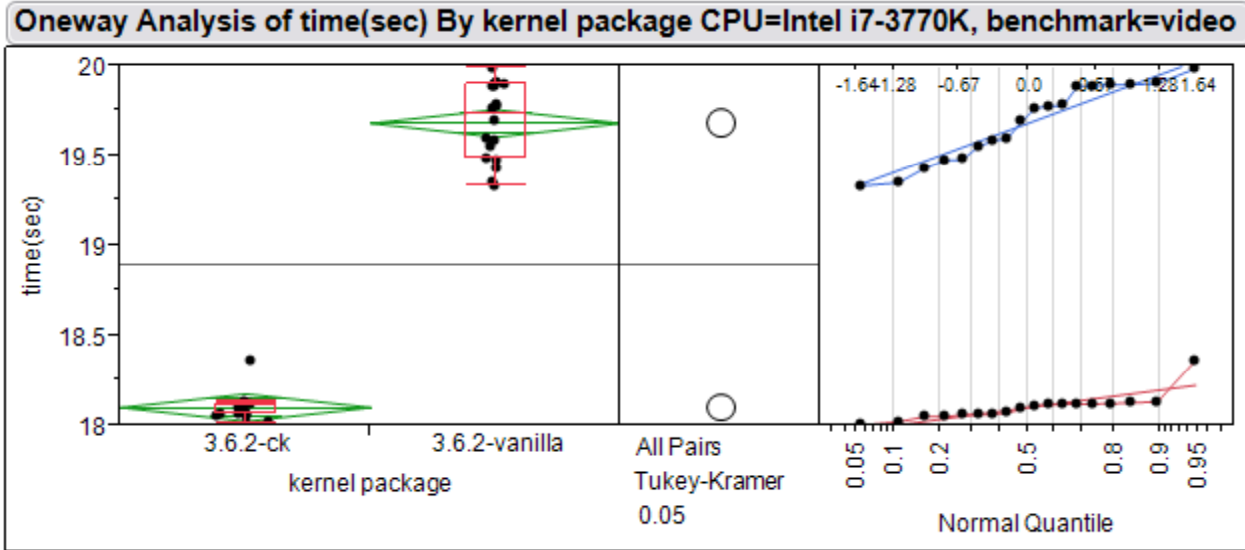
Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	67.73833	67.78417	67.884	67.95547	68.03935	68.1426	68.18633
3.6.2-vanilla	68.74998	68.77916	68.82491	68.94149	69.1544	69.26126	69.31054

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

i7-3370K/Video



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	18.00721	18.02432	18.06216	18.10588	18.12513	18.16041	18.3706
3.6.2-vanilla	19.33625	19.35266	19.48368	19.73188	19.89535	19.91505	19.99021

Means Comparisons

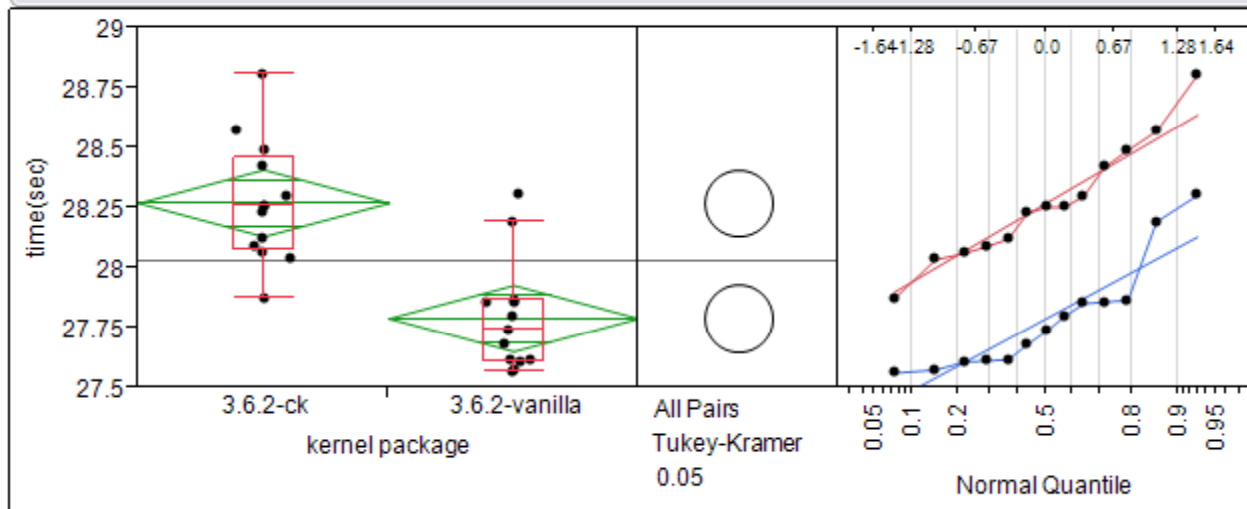
Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis

Dual E5620/Compression

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Oneway Analysis of time(sec) By kernel package CPU=Dual Intel E5620, benchmark=compress



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	27.87629	27.94078	28.07853	28.25501	28.45682	28.71387	28.8091
3.6.2-vanilla	27.56355	27.56889	27.61228	27.73805	27.86547	28.26136	28.30558

Means Comparisons

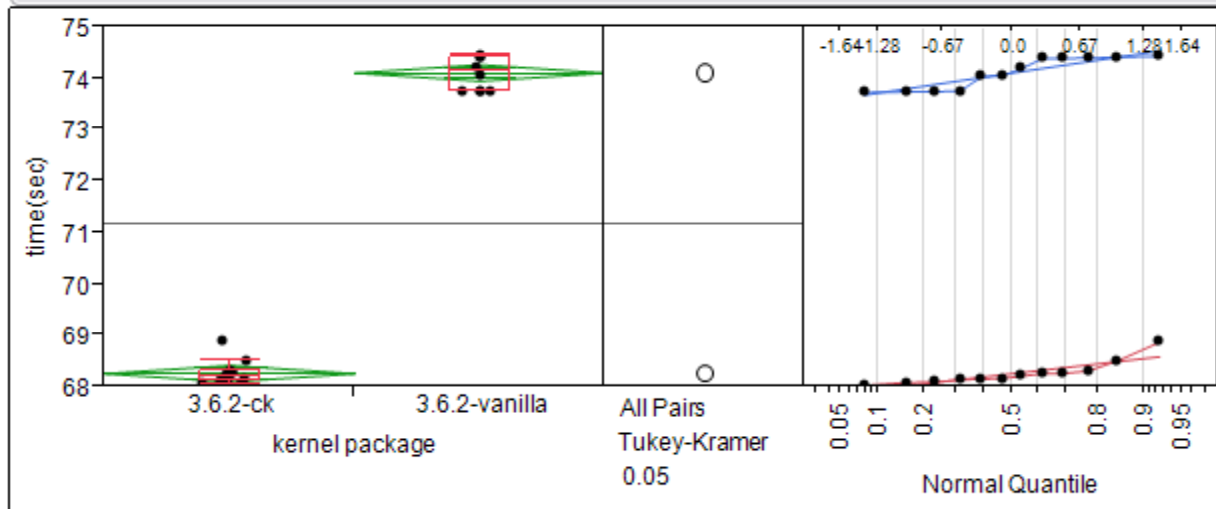
Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

Dual E5620/Make

34

Oneway Analysis of time(sec) By kernel package CPU=Dual Intel E5620, benchmark=make



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	68.04048	68.05724	68.11607	68.19607	68.30738	68.76734	68.87501
3.6.2-vanilla	73.74548	73.74943	73.76533	74.13851	74.40957	74.44319	74.4502

Means Comparisons

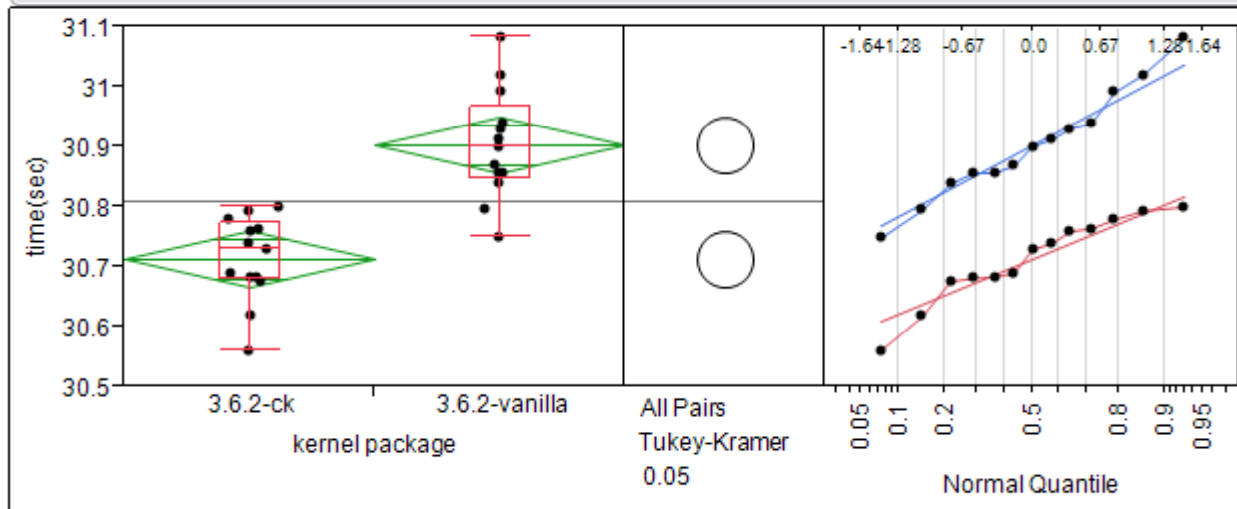
Comparisons for all pairs
using Tukey-Kramer HSD

Oneway Analysis

Dual E5620/Video

35

Oneway Analysis of time(sec) By kernel package CPU=Dual Intel E5620, benchmark=video



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
3.6.2-ck	30.5611	30.58402	30.67964	30.73033	30.77223	30.79803	30.80062
3.6.2-vanilla	30.74909	30.76749	30.84827	30.90154	30.96608	31.05753	31.08175

Means Comparisons

Comparisons for all pairs
using Tukey-Kramer HSD