Qualcomm Snapdragon 7c Performance Analysis:

Evaluating The Chromebook Experience, Performance And Battery Life

Qualcomm snapdragon 7c compute platform

HOT TECH | VISION AND ANALYSIS

February 2021

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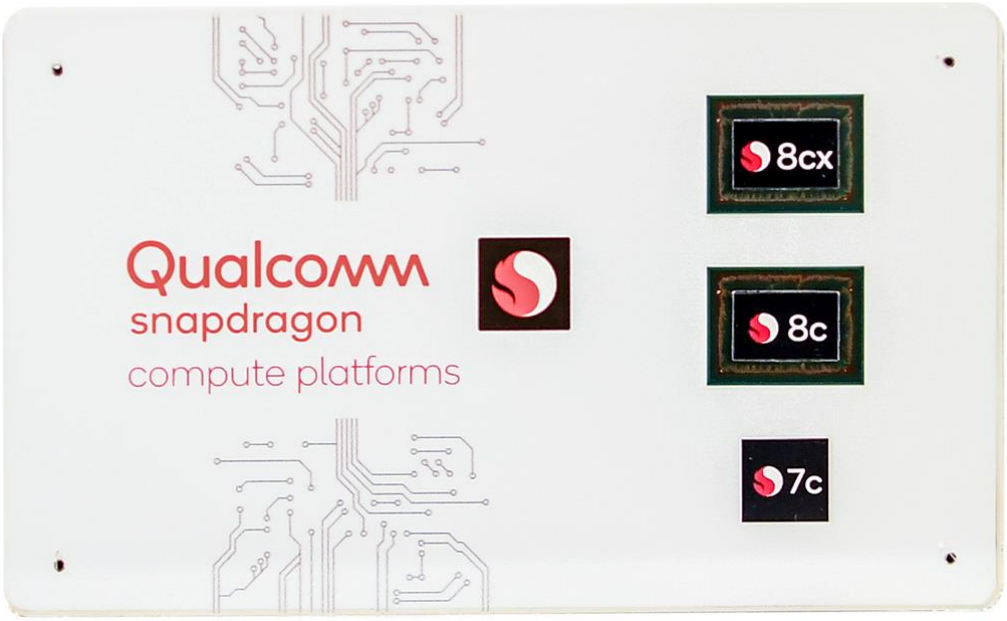


Introduction: The Qualcomm Snapdragon 7c Experience

The Snapdragon 7c compute platform is Qualcomm's current entry-level Arm64 solution for Chromebooks and Windows 10 PCs. Qualcomm has equipped the Snapdragon 7c with eight 64-bit CPU cores, Adreno graphics, and a Snapdragon X15 LTE cellular modem integrated into a single chip manufactured on an 8-nanometer process. Qualcomm's experience in providing high-performance, power-efficient processors for always-connected smartphones and tablets should translate into extended battery life and enough performance to handle mainstream and web-based productivity tasks.

In this paper, we have tested Qualcomm Snapdragon 7c Chromebook reference platforms against competing devices equipped with processors from Intel and MediaTek. This data is a first-look at Snapdragon 7c performance since the platform's launch, and it's the first time the Qualcomm Snapdragon 7c compute platform has been tested in a Chromebook.

Test Systems and Workloads

We conducted performance and battery life tests on a total of five notebooks, all of which ran Chrome OS. Two systems used processors from Intel, one from MediaTek, and two from Qualcomm. The full array of systems includes:

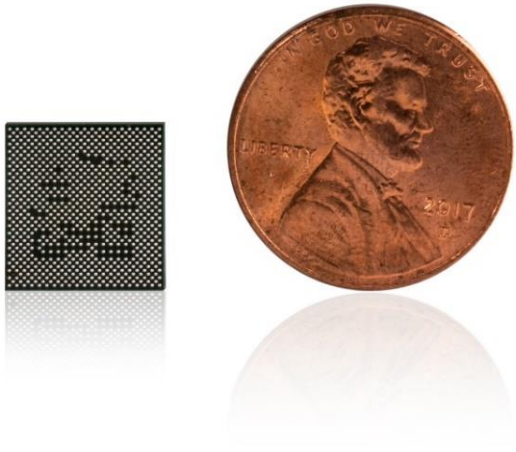
- **Snapdragon 7c Reference Platform** (Qualcomm Snapdragon 7c, 8 GB RAM, 128 GB storage)
- **Snapdragon 7c Education Reference Design** (Qualcomm Snapdragon 7c, 4 GB RAM, 32 GB storage)
- **Acer Chromebook Spin 311** (Intel Celeron N4020, 4 GB RAM, 64 GB storage)
- **Acer Chromebook Spin 311** (MediaTek MT8183, 4 GB RAM, 32 GB storage)
- **HP Chromebook x360** (Intel Pentium Silver N5030, 4 GB RAM, 64 GB storage)

The systems were tested with identical workloads in:

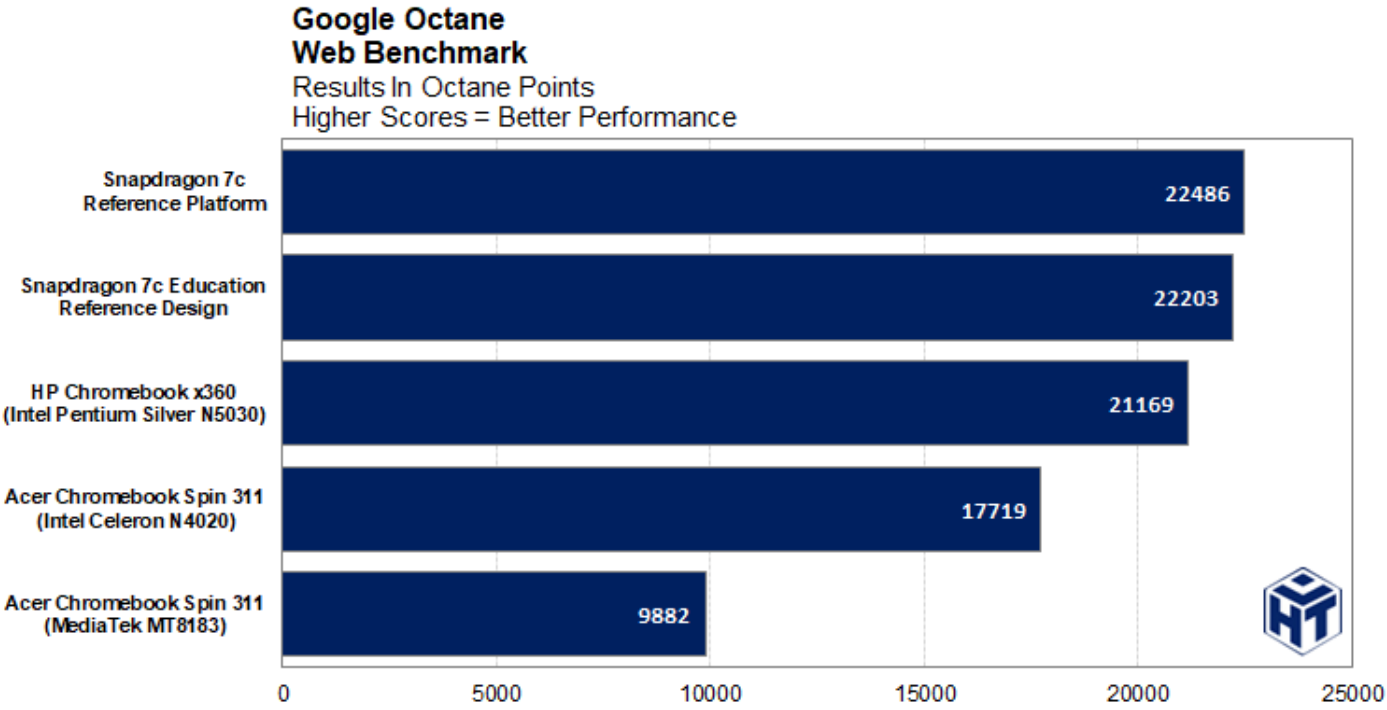
- Octane v2
- Speedometer v2.0
- JetStream v1.1
- Geekbench v5.3
- GFXBench
- Battery life using Zoom online conferencing

Octane, Speedometer, and JetStream use the web browser to test performance on a variety of typical web-based workloads, including image manipulation, encryption, and web application performance. Speedometer runs a web application in a variety of JavaScript frameworks to simulate real-world usage and performance. Geekbench is a synthetic test that examines performance in a variety of compute tasks. GFXBench focuses on graphics performance in a series of scenes.

**(Full specifications for each system available in Appendix A)*



Google Octane Web Benchmark Results

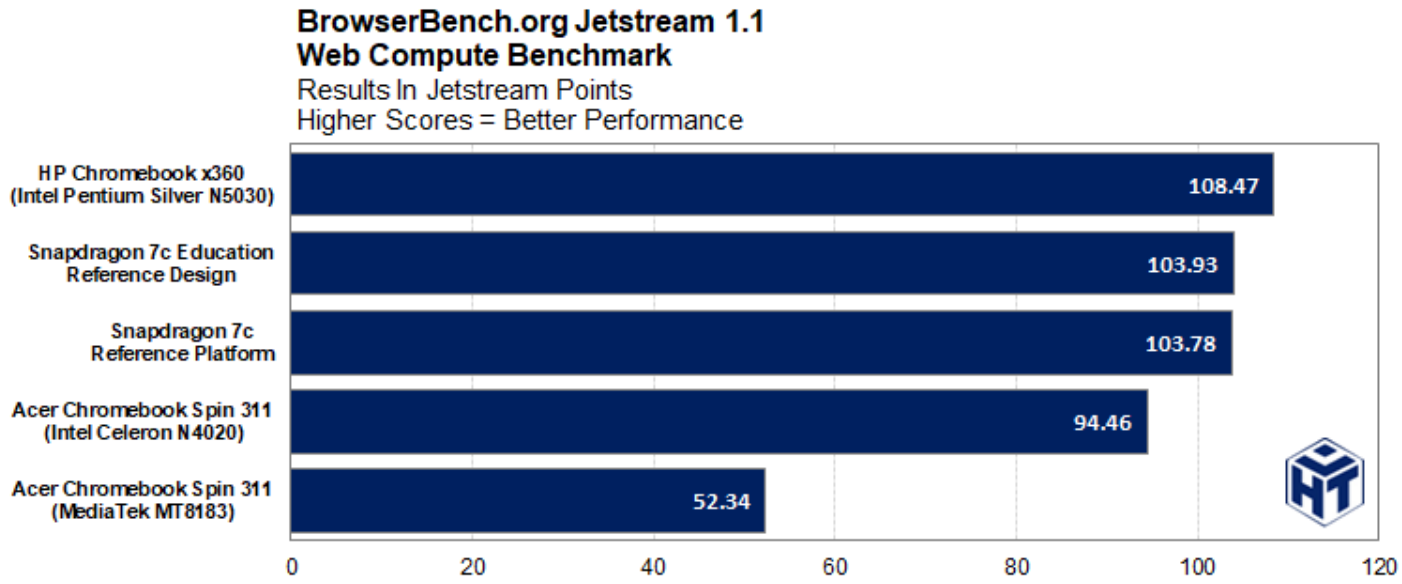


The Snapdragon 7c Reference Platform and Education Reference Design exhibited nearly identical performance, which bodes well for retail products based on the Snapdragon 7c.

Both Qualcomm-based systems outperformed the Intel Pentium Silver N5030 by approximately 3.7%.

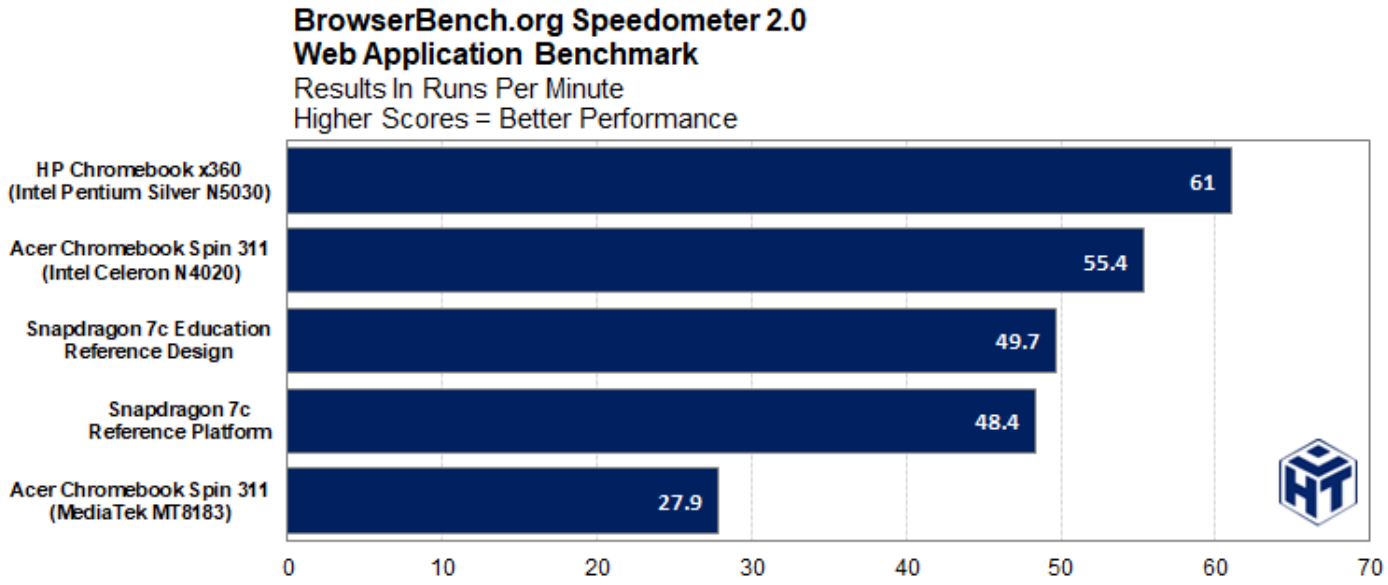
Meanwhile, the Snapdragon 7c beat the Celeron N4020 by 26.9% and more than doubled the performance of the MediaTek MT8183. Neither of these results are unexpected, as the Celeron N4020 has just two CPU cores and a lower maximum boost speed when compared to the Pentium Silver. The MT8183 has eight CPU cores, but they are based on older designs in comparison to the Kryo 468 CPU core complex in the Snapdragon 7c.

BrowserBench.org Jetstream 1.1 Results



In BrowserBench.org's Jetstream 1.1 test, the Snapdragon 7c platforms sit in between the Pentium Silver and Celeron. The Pentium is 4.4% faster than the Snapdragon 7c, while the Qualcomm SoC beats out the Celeron by a full 9.8%. The MT8183-based Chromebook offers the lowest performance by, with the Snapdragon 7c besting the MediaTek chip by nearly 100%.

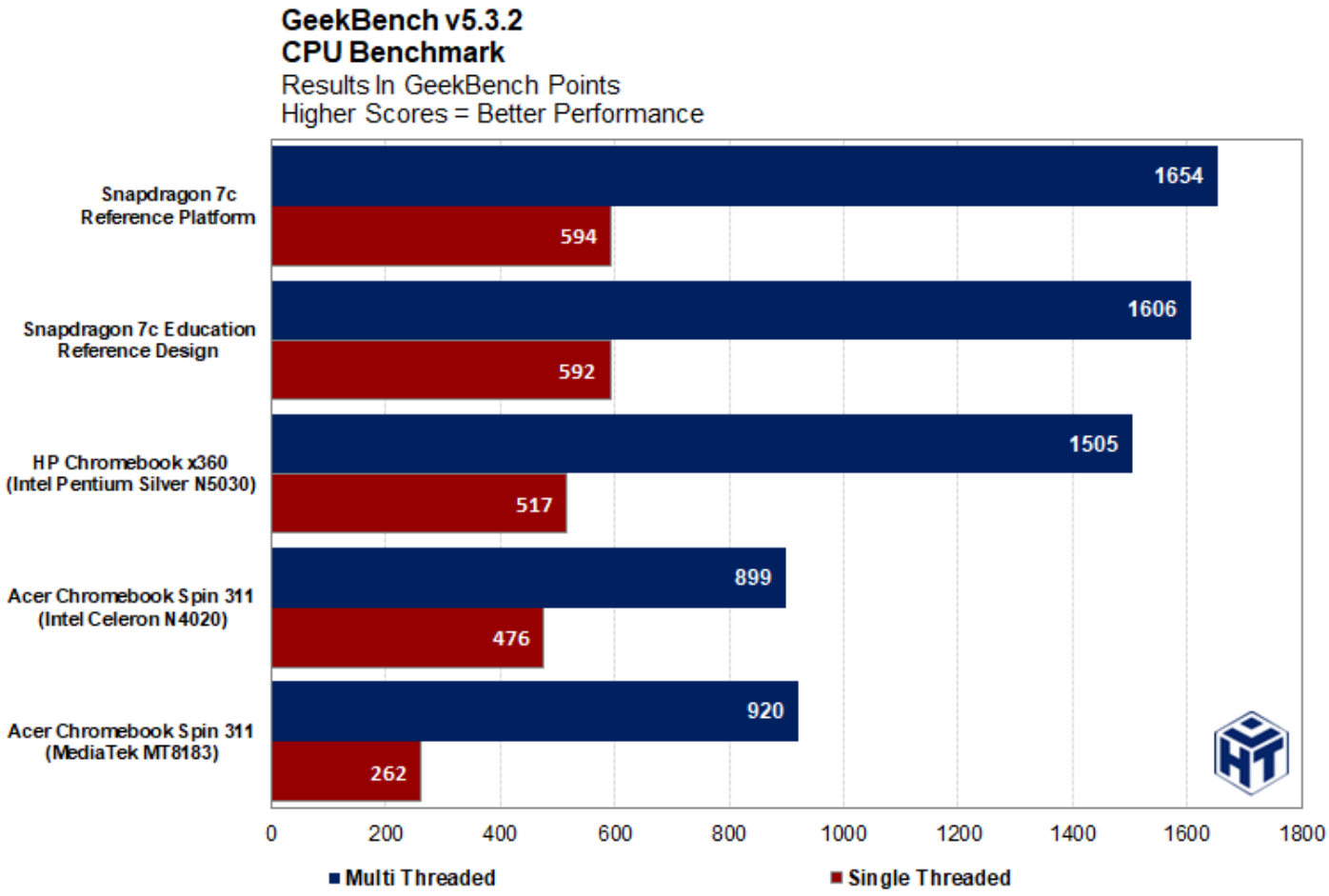
BrowserBench.org Speedometer 2.0 Results



In the Speedometer 2.0 test, the Pentium Silver and Celeron outpace the Snapdragon 7c systems by about 22% and 11.5%, respectively. The Snapdragon has thus far traded wins with the Gemini Lake-based Intel processors, which will make for an interesting point of comparison when it comes to battery life. If the processors perform equally, a longer battery runtime translates to a power efficiency advantage and a better overall user experience. Also note, that in all of our web-based tests, single-threaded performance is more impactful than multi-threaded throughput, and Qualcomm's mainstream, low-power CPU design impresses.

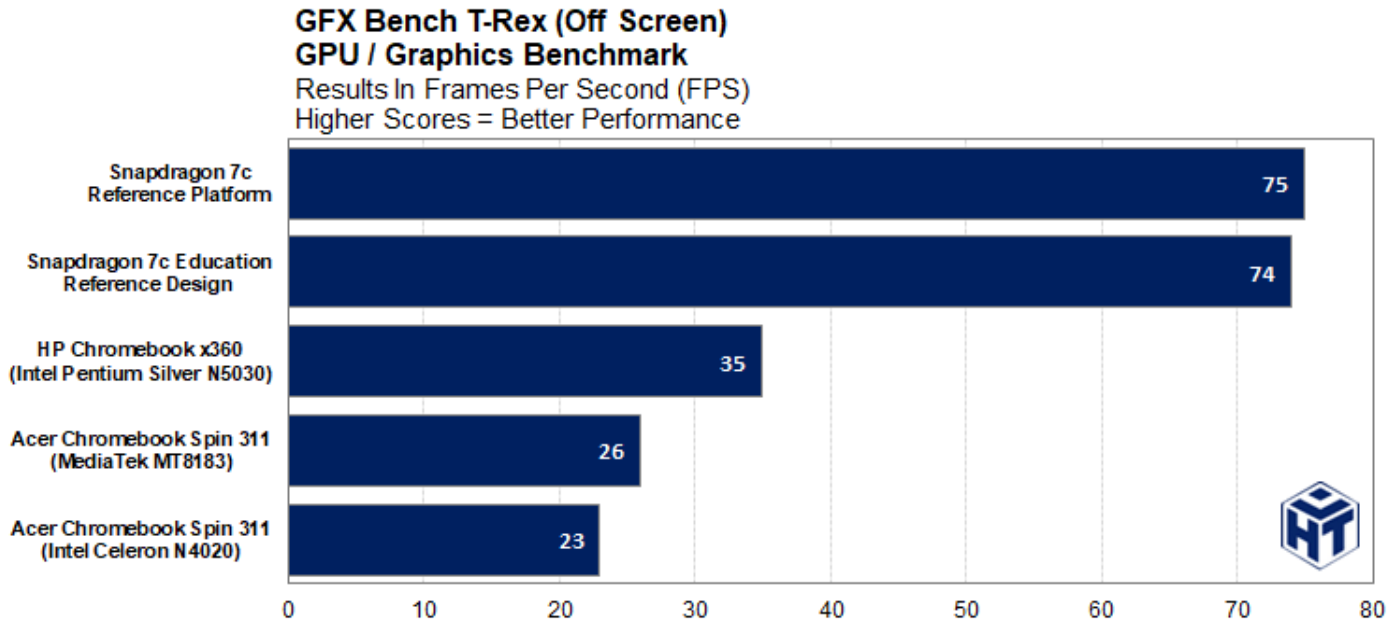
In addition, the Snapdragon 7c Reference Platform and the Snapdragon 7c Education Reference Design are both more than 70% faster than the MT8183-based system. This is a pattern that will repeat itself throughout this suite of tests.

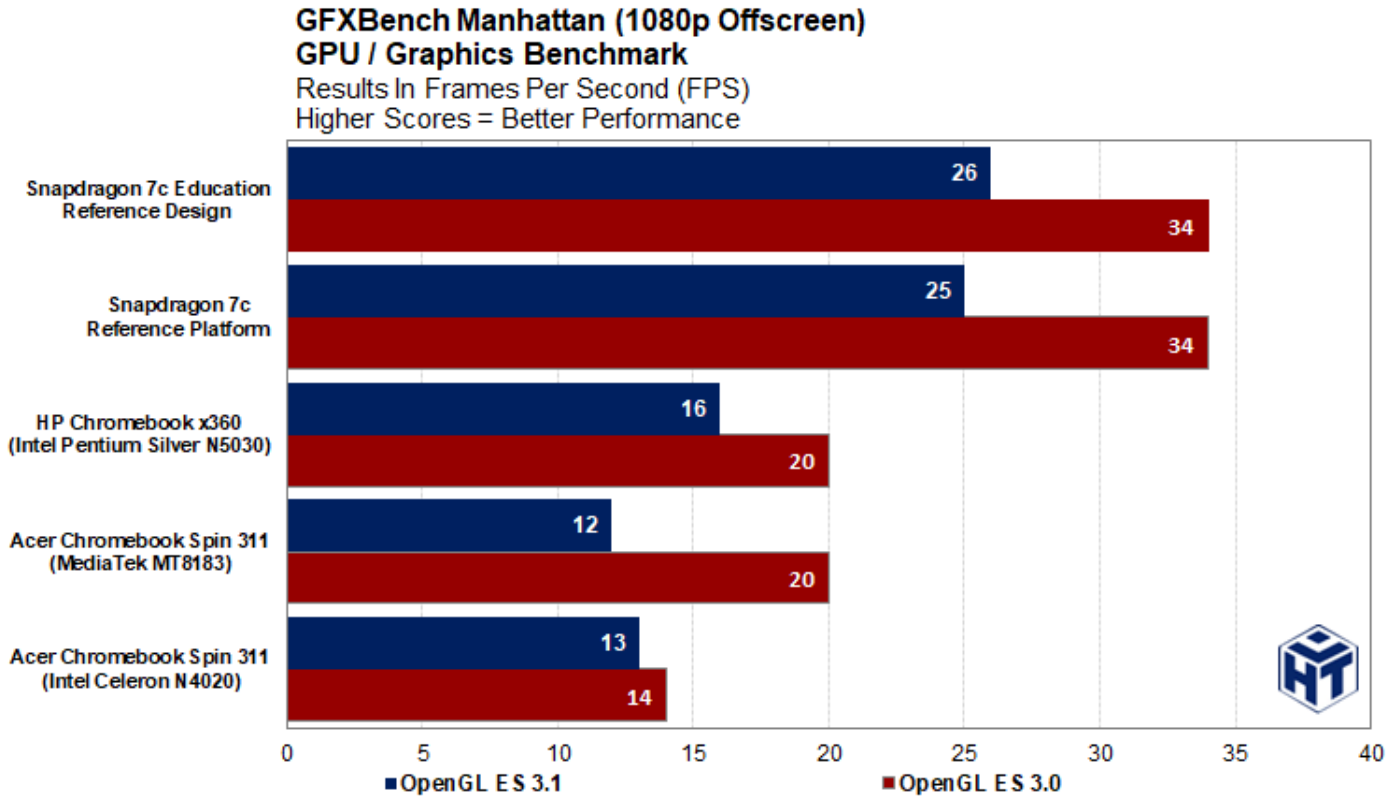
Geekbench v5.3.2 Results



When it comes to system responsiveness, single-threaded performance is the most important measure. The Geekbench chart is sorted by single-threaded scores for that reason. The Snapdragon 7c beats out the Pentium Silver by 14.8%, while besting the Celeron N4020 by 24.3% in the same test.

Here we can also get a glimpse as to why the MT8183's performance was so low in our web tests compared to all of the other systems. Incidentally, using the Chromebook with the MT8183 processor was a chore. By comparison, the Snapdragon 7c systems were responsive to user input, never dropped clicks or keystrokes and scrolled web pages more smoothly in the browser.

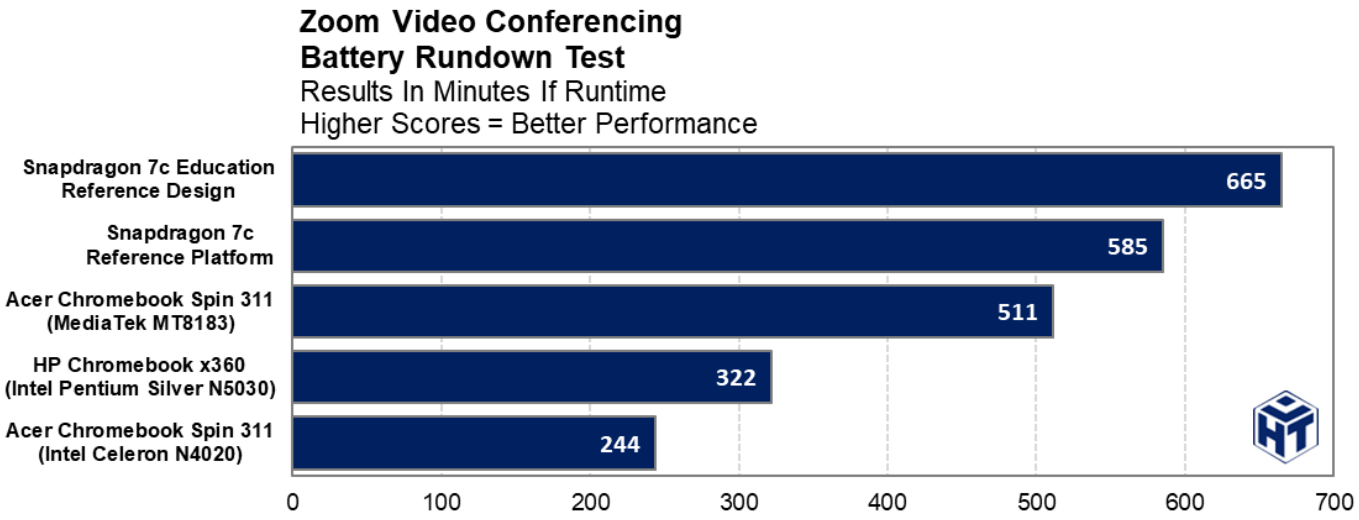




These GFXBench tests evaluate 3D graphics performance. The Snapdragon 7c systems were much faster and more responsive in these tests than any of the other systems. In the T-Rex benchmark, the Snapdragon 7c-based systems were more than twice as fast as the nearest competing system, which was based on the Pentium Silver N5030.

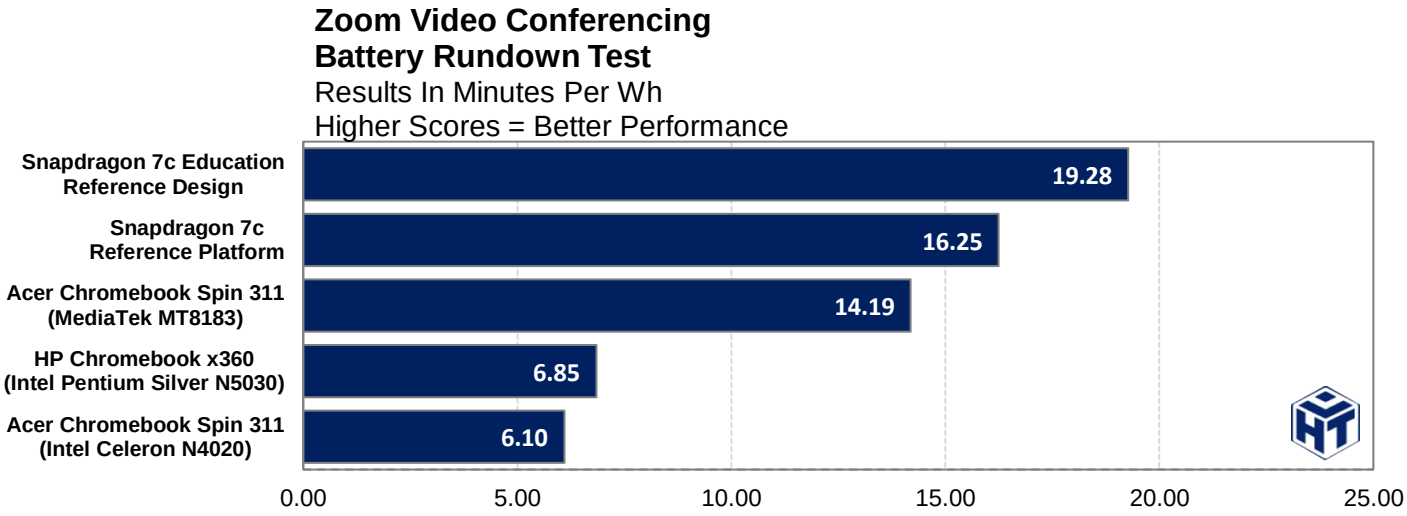
The margin of victory narrowed slightly in the Manhattan tests, which uses advanced lighting capabilities not tested with T-Rex. Again, the Snapdragon 7c-based systems won out. With the OpenGL ES 3.0 test, the Qualcomm-based systems beat the Pentium Silver N5030 by 62%. In the more taxing OpenGL ES 3.1 version, the Snapdragons extended their lead to 70%.

Zoom Video Conferencing Battery Rundown Test Results



Our battery test sought to replicate a real-world scenario of videoconferencing with screen sharing. We configured each system's display to 150 nits to normalize for screen brightness. Each of the test systems joined the same Zoom meeting hosted on another system that wasn't part of the test group. The host streamed a video feed to the Zoom meeting and all systems had their cameras enabled until all participant systems' batteries had expired. There are two components to this test: qualitative and quantitative.

In terms of quantity, the two Snapdragon 7c systems were unsurpassed. Both far outlasted the MediaTek 8183-powered Chromebook, despite the MediaTek's systems lackluster overall performance. The Snapdragon 7c Education Reference Design lasted more than twice the duration of the Pentium Silver system, despite the latter having a 36% larger battery.



When normalized based on battery capacity, the Pentium Silver would only have lasted approximately 206 minutes. The Snapdragon 7c Education Reference Design would have lasted nearly three times as long, as evidenced by the minutes of uptime per Wh data we've detailed here.

Qualitatively speaking, not all of the test systems were able to stream the video from the Zoom meeting smoothly on battery power. Both the Celeron N4020 and the MediaTek MT8183 had a noticeable amount of dropped frames that persisted throughout the entire Zoom meeting until their batteries were depleted. Neither of those machines were up to the task of streaming 1080p video from a host computer, while simultaneously showing other participants' webcams. The two Snapdragon 7c-based systems handled those same video streams flawlessly, as did the HP Chromebook x360.

Qualcomm Snapdragon 7c Performance Summary

In summary, our test results show that the Snapdragon 7c is roughly equivalent to the Pentium Silver N5030 in terms of single-threaded CPU performance, but the Snapdragon 7c featured a significantly higher performance GPU for graphics rendering workloads. In many cases, particularly graphics tests, the Snapdragon's performance far exceeded Intel's low-power chip. The Snapdragon 7c was also about twice as fast as the MediaTek MT8183 system on the whole, with the Celeron N4020 ending up somewhere in the middle. These benchmark wins also translate into a tangible user experience benefit.

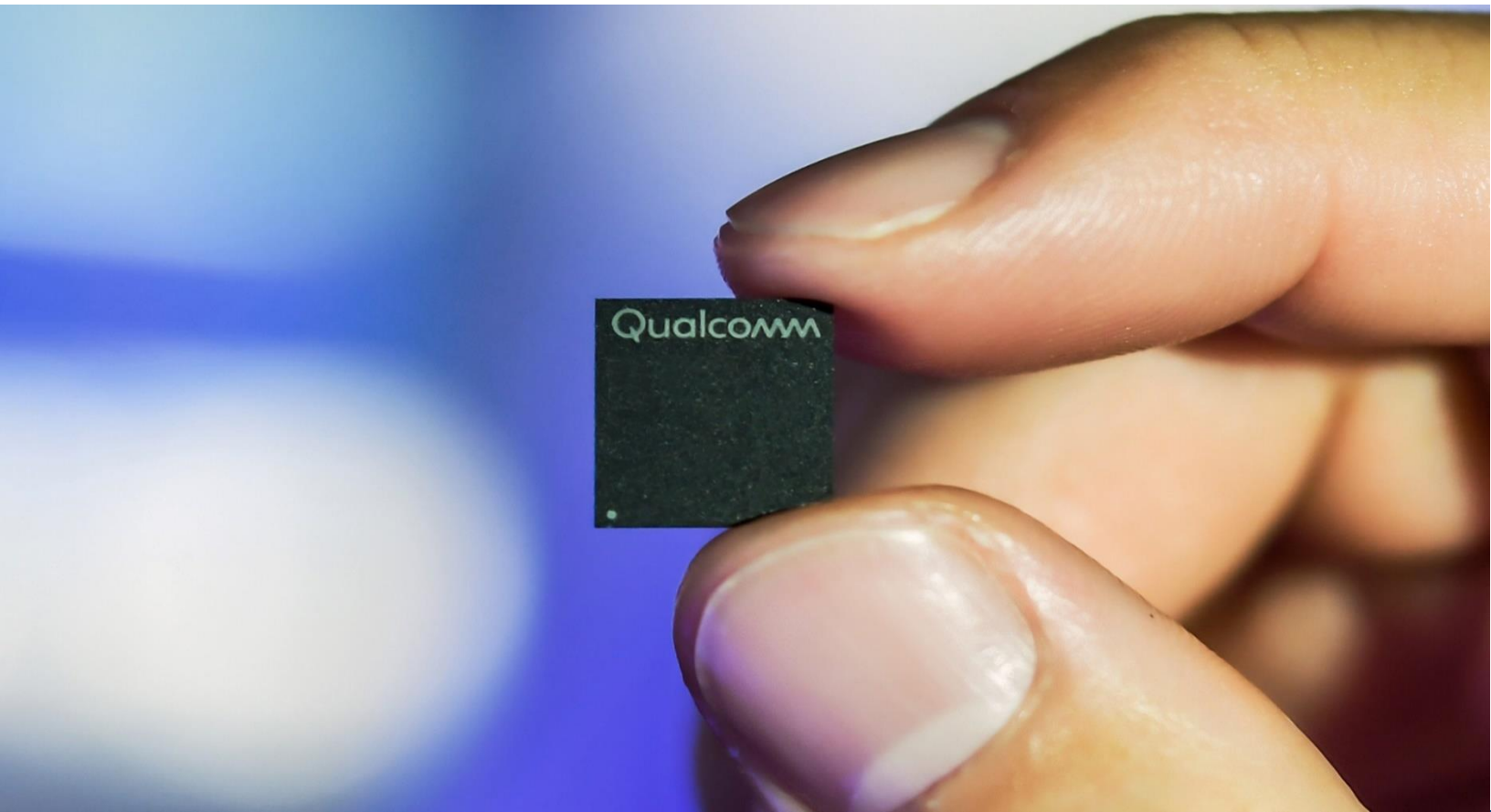
Both the Snapdragon 7c Education Reference Design and the Snapdragon 7c Reference Platform were smooth, stable, and responsive. We never had issues with missed clicks or keystrokes. Switching tabs in the Chrome browser was a seamless experience, and web pages behaved as expected on the systems.

The Snapdragon 7c systems also far exceeded all of the Intel-based systems in the Zoom web conferencing battery life test. Both Snapdragon-based Chromebooks lasted twice the duration of the Pentium Silver and Celeron systems, even though the Intel-based Chromebooks are equipped with larger batteries. Getting 10 to 11 hours of constant web conferencing battery life out of thin-and-light machines like the Snapdragon 7c-based platforms is impressive.

More impressive is the light weight at which the Qualcomm-based systems could achieve that. Nothing is stopping manufacturers from making Intel or MediaTek-based Chromebooks with higher capacity batteries, but doing so will come at the cost of size and weight, which is also an important part of the user experience.

Qualcomm Snapdragon 7c Conclusions

The efficient silicon architecture of the Qualcomm Snapdragon 7c compute platform offers strong performance and an overall user experience that is superior to the competitive Intel and MediaTek low-power processors we tested, while lasting more than twice as long on battery power. Our results and excellent experiences with the Snapdragon 7c-based reference platforms are encouraging early indicators that bode well for upcoming Chromebook products from Qualcomm partners, like Acer and Sharp. Businesses with mobile workforces and institutions with one-to-one device programs, like K-12 school systems, for example, can all benefit from the combination of solid performance, flexible wireless connectivity, which includes optional LTE cellular connectivity, and all-day battery life offered by the Qualcomm Snapdragon 7c Compute Platform.



System	Snapdragon 7c Reference Design	Acer Chromebook Spin 311 (Intel)	Acer Chromebook Spin 311 (MTK)	Snapdragon 7c Education Reference Design	HP Chromebook x360 (Intel)
Processor	Qualcomm Snapdragon 7c	Intel Celeron N4020	MediaTek MT8183	Qualcomm Snapdragon 7c	Intel Pentium Silver N5030
Core Count (Threads)	8 (8)	2 (2)	8 (8)	8 (8)	4 (4)
Frequency (Base/Boost)	Up to 2.4 GHz	1.1 GHz base, 2.8 GHz boost	Up to 2 GHz	Up to 2.4 GHz	1.1 GHz base, 3.1 GHz boost
Memory	8 GB	4 GB	4 GB	4 GB	4 GB
Memory Type	LPDDR4X	LPDDR4	LPDDR4X	LPDDR4X	LPDDR4-2400
Storage	128 GB	64 GB	32 GB	32 GB	64 GB
Wireless Connectivity	802.11ac / Bluetooth 5.1 (Optional LTE)	802.11ac / Bluetooth 5.0	802.11ac / Bluetooth 4.2	802.11ac / Bluetooth 5.1 (Optional LTE)	802.11ac / Bluetooth 5.0
Display Size	13.3"	11.6"	11.6"	11.6"	14"
Native Resolution	1920 x 1080	1366 x 768	1366 x 768	1366 x 768	1366 x 768
Dimensions (WxLxD)	12.8 x 8.9 x 0.82 inches	11.7 x 8.1 x 0.79 inches	11.4 x 8.1 x 0.74 inches	11.3 x 8.1 x 0.78 inches	12.7 x 8.9 x 0.71 inches
Weight	2.95 lbs.	2.65 lbs.	2.65 lbs.	2.98 lbs.	3.48 lbs.
OS	Chrome OS	Chrome OS	Chrome OS	Chrome OS	Chrome OS
Build / Version	88	88	88	88	88
Power Plan	Keep Screen On	Keep Screen On	Keep Screen On	Keep Screen On	Keep Screen On
Power Mode (On AC)	Keep Screen On	Keep Screen On	Keep Screen On	Keep Screen On	Keep Screen On
Web Browser	Chrome 88	Chrome 88	Chrome 88	Chrome 88	Chrome 88
Battery Capacity	36 Wh	40 Wh	36 Wh	34.5 Wh	47 Wh

Appendix B: Testing Prerequisites

Prior to running any benchmarks, all test machines were updated fully. As of the time of this writing, the latest Chrome OS available was version 88. Apps installed from Google Play were also updated to the latest versions available. For all web-based benchmarks, the default Chrome browser was used.

Unless otherwise noted, all tests were run five times at minimum. The highest and lowest result of each test was discarded, and the reported scores represent the average of the remaining runs. Each system was allowed a cooldown period between runs to ensure that thermal limits were not a factor.

Octane v2:

1) Navigate to http://chromium.github.io/octane/
2) Run the Octane test to completion
3) Upon completion, record the result

Speedometer v2:

1) Navigate to https://browserbench.org/Speedometer2.0/
2) Run the Speedometer test to completion
3) Upon completion, record the result

JetStream v1.1:

1) Navigate to https://browserbench.org/JetStream1.1/
2) Run the JetStream test to completion
3) Upon completion, record the result

Geekbench 5:

1) Install the latest version of Geekbench from Google Play
2) Launch the Geekbench application
3) Choose to run the try-out version
4) Run the CPU test
5) Upon completion, record the result

GFXBench T-Rex and Manhattan:

1) Install the latest version of GFXBench from Google Play
2) Run the T-Rex 1080p Off-Screen Test
3) Upon completion, record the result
4) Run the Manhattan 1080p Off-Screen Test
5) Upon completion, record the result

Battery Test (*results represent runtime from single run):

1) Ensure all systems have the battery fully charged.
2) From a desktop computer, navigate to http://zoom.us and begin a meeting.
3) Calibrate all systems' displays to a brightness of ~150 nits
4) Disable automatic sleep and automatic brightness adjustments
5) Join the Zoom meeting with all devices to be tested.
6) Disconnect power from each
7) Each hour, record the battery percentage
8) Note the full runtime for a system when it automatically shuts down as its battery is depleted

** Qualcomm provided the test systems utilized in this research effort*

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