



Memory & Storage Day

CLIENT MEMORY AND STORAGE

David Lundell

Senior Director, Client SSD Strategic Planning and Marketing
Non-volatile Memory Solutions Group

INTEL CLIENT MEMORY AND STORAGE STRATEGY

EXCEED USER'S NEEDS

Instant On

Responsiveness

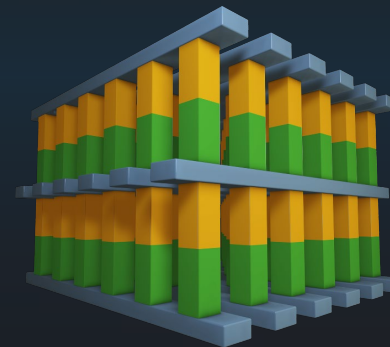
Worry Free Battery Life

Seamless Multitasking

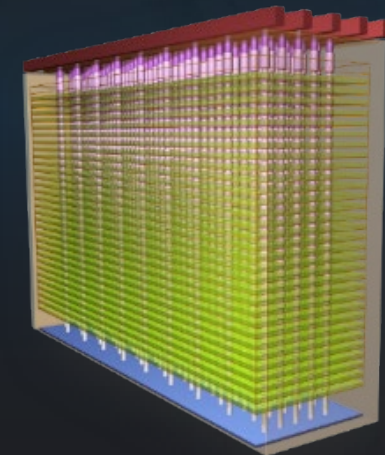
Ample Data Store

THROUGH INNOVATION

Intel® Optane™
Technology

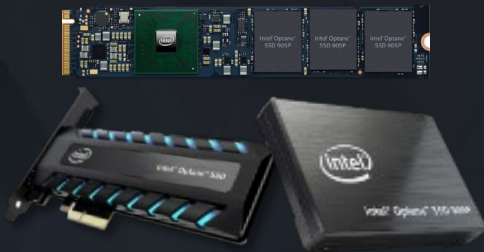


Intel® QLC 3D NAND
Technology



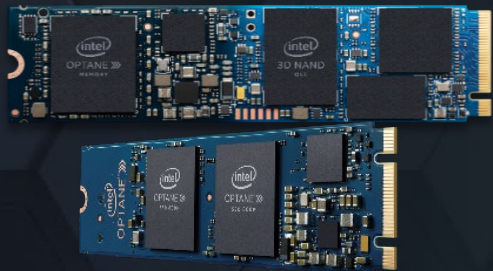
ON THE INTEL ARCHITECTURE PLATFORM

SUMMARY: 2019 CLIENT PRODUCT LINEUP



Intel® Optane SSD 905P

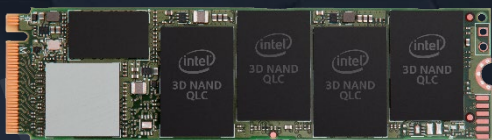
UNCOMPROMISED PERFORMANCE
WORKSTATION & ENTHUSIAST



Intel® Optane™ Memory H10
With Solid State Storage

Intel® Optane™ Memory M10

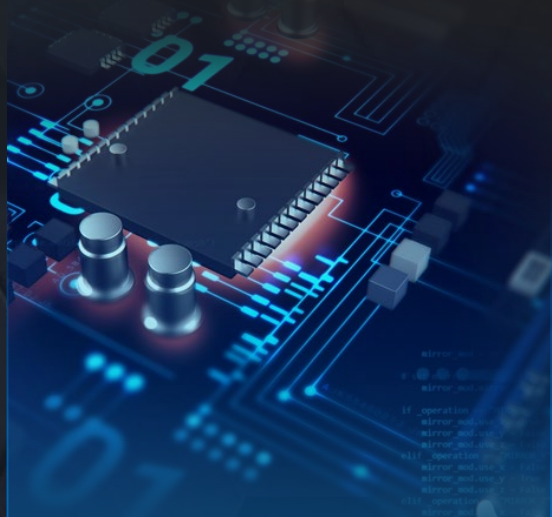
ULTIMATE RESPONSIVENESS
PERFORMANCE AND MAINSTREAM
PRODUCTIVITY, GAMING, CONTENT CREATION



Intel® SSD 660p with
Intel® QLC 3D NAND

MASSIVE STORAGE
EVERY DAY COMPUTING
MAINSTREAM GAMING / CONTENT CREATION

INTEL® OPTANE™ SSD 905P USAGES



ENGINEERING

Design
CAD/CAE
Simulations



MEDIA CREATION

Rendering
Hi-Res Editing
Audio Production



MEDICAL / RESEARCH

Simulations
Image Analysis



GAMING / GAME DEVELOPMENT

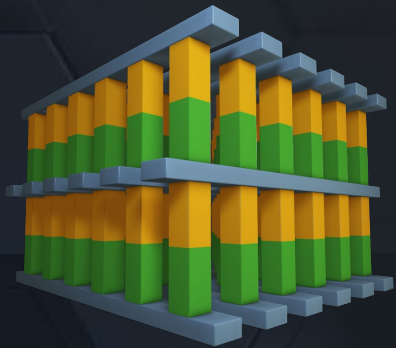
Gaming
New Gaming Exp.
Game Dev



BRINGING TOGETHER TWO REVOLUTIONARY TECHNOLOGIES

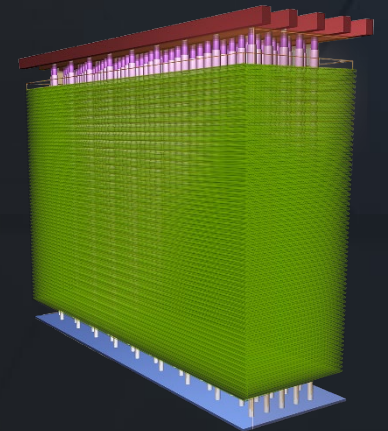
INTEL® OPTANE™ MEMORY H10 WITH SOLID STATE STORAGE

Intel® Optane™
Technology

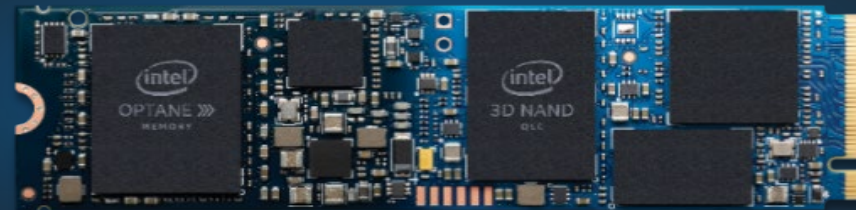


LOW LATENCY
PERFORMANCE CONSISTENCY

Intel® QLC 3D NAND
Technology



HIGH CAPACITY



+

Intel® Rapid Storage Technology Software

AMAZING PERFORMANCE & HIGH CAPACITY: AVAILABLE WORLDWIDE THROUGH OEMS AND RETAILERS

INTEL® OPTANE™ MEMORY H10 WITH SOLID STATE STORAGE

Versus Industry Drives

SSDs WITH INTEL® OPTANE™ MEMORY
ARE THE FASTEST⁶
as compared to NAND SSD

SSDs WITH INTEL® OPTANE™ MEMORY DELIVER THE
BEST REAL-WORLD PERFORMANCE⁷
as compared to NAND SSDs

In the majority of common client use cases

Versus Intel® SSD 760p

LAUNCH DOCUMENTS UP TO
2X FASTER
WHILE MULTITASKING³

LAUNCH GAMES
60% FASTER
WHILE MULTITASKING⁴

OPEN LARGE MEDIA FILES UP TO
90% FASTER
WHILE MULTITASKING⁵

INTEL® CORE™ PROCESSOR + INTEL® OPTANE™ TECHNOLOGY: BETTER TOGETHER

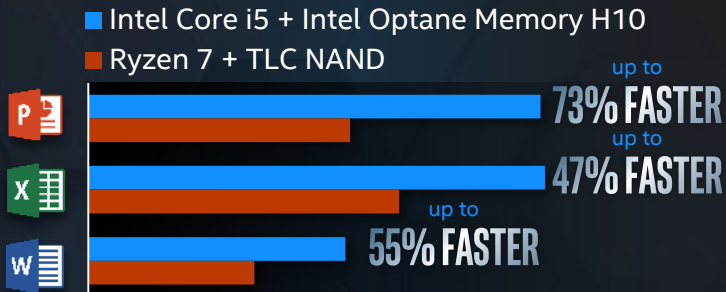
INTEL® CORE™ I5-8265U + INTEL® OPTANE™ MEMORY H10 WITH SOLID STATE STORAGE
notebook

VS. AMD RYZEN* 7 3700U + TLC NAND SSD
notebook

THE UNIQUE ADVANTAGE OF THE INTEL PLATFORM

WORK

Microsoft Office* 365 app launch
& file load while multitasking¹
Launch speed (higher is better)



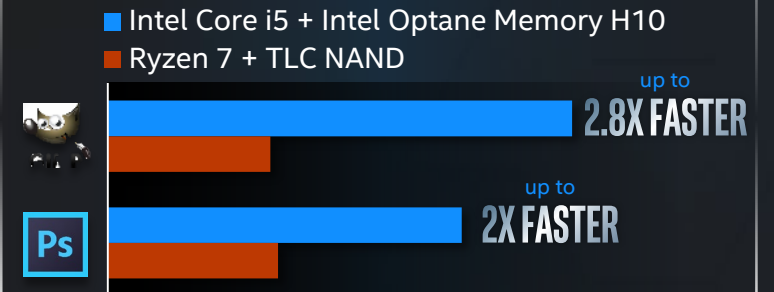
PLAY

Path of Exile* game launch
while multitasking²
Launch speed (higher is better)



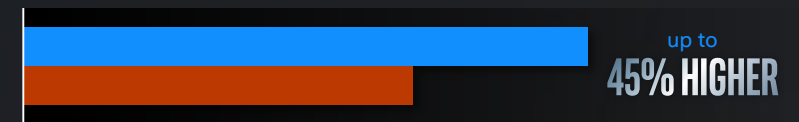
CREATE

Content creation app launch
& file load while multitasking³
Launch speed (higher is better)



PCMark 10: App start-up score⁴

Intel Core i5 + Intel Optane Memory H10
Ryzen 7 + TLC NAND



Footnotes 1, 2, 3, 4, 5: See Appendix D
For more complete information about performance and benchmark results, visit <http://www.intel.com/benchmarks>



COMPETITIVE COMPARISON



VS.



INTEL® CORE™ I5-8265U + 512GB INTEL® OPTANE™ MEMORY H10 WITH SOLID STATE STORAGE
notebook

AMD RYZEN* 7 3700U + 512GB TLC NAND SSD
notebook

INTEL[®] SSD 660P **WORLD'S 1ST PCIE QLC SSD FOR CLIENT**

Everyday user capacities from 512GB to 2TB

Exceptional **value** and **performance**,
backed by Intel **quality** and **reliability**



1

PERFORMANCE THAT MATTERS

- High capacities
- Best value for mainstream and entry storage

2

INDUSTRY LEADING INNOVATION

- Dynamic SLC caching for performance optimization
- Up to 2TB single-sided m.2 for thin & light designs

3

INTEL QUALITY AND RELIABILITY

- 5 Year Warranty

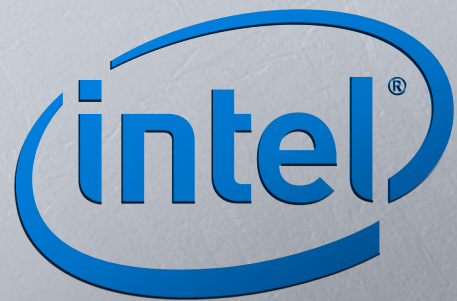
MILLIONS SOLD SINCE LAUNCH IN AUGUST 2018
200+ CONSUMER AND COMMERCIAL OEM DESIGNS

SUMMARY

INNOVATIVE LEADERSHIP TECHNOLOGY

DELIVERED THROUGH PLATFORM SOLUTIONS

SOLVING CUSTOMER'S NEEDS



APPENDIX A

All claims below based on an 8th Gen Intel® Core™ i7 mobile platform featuring 32GB+512GB Intel® Optane™ memory H10 with solid state storage vs TLC SSD alone (Compared to: Intel® Core™ i7 8565U Processor, PL1=15W TDP, 4C8T, Turbo up to 4.60GHz on Intel Reference Platform, Graphics: Intel® UHD Graphics 620, Memory: 2x4GB DDR4, Storage: 512GB Intel SSD 760p, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0x9A)

Footnotes:

- [3. Launch documents up to 2X faster while multitasking](#)
- Performance results are based on testing as of March 21, 2019 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure. As measured by Document Launch with Background Activity (e.g. 18GB Video File Copy), comparing 8th Gen Intel® Core™ i7-8565U (512GB TLC SSD) vs. 8th Gen Intel® Core™ i7-8565U (32GB+512GB Intel® Optane™ memory H10 with solid state storage)
- Intel® Core™ i7 8565U Processor, PL1=15W TDP, 4C8T, Turbo up to 4.60GHz on Intel Reference Platform, Graphics: Intel® UHD Graphics 620, Memory: 2x4GB DDR4, Storage: 32GB+512GB Intel® Optane™ memory H10 with solid state storage, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0x9A
- [4. Launch games up to 60% faster while multitasking](#)
- Performance results are based on testing as of March 9, 2019 and may not reflect all publicly available security updates. As measured by Path of Exile* Game Launch with Background Activity (e.g. 18GB Video File Copy), comparing 8th Gen Intel® Core™ i7-8565U (512GB TLC SSD) vs. 8th Gen Intel® Core™ i7-8565U (32GB+512GB Intel® Optane™ memory H10 with solid state storage)
- Intel® Core™ i7 8565U Processor, PL1=15W TDP, 4C8T, Turbo up to 4.60GHz on Intel Reference Platform, Graphics: Intel® UHD Graphics 620, Memory: 2x4GB DDR4, Storage: 32GB+512GB Intel® Optane™ memory H10 with solid state storage, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0x9A
- [5. Open large media files up to 90% faster while multitasking](#)
- Performance results are based on testing as of March 21, 2019 (Adobe* Photoshop Project File Launch with Background Activity) and March 9, 2019 (Gimp* Project File Launch with Background Activity) and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure. As measured by Adobe* Photoshop Project File Launch with Background Activity (e.g. 18GB Video File Copy), comparing 8th Gen Intel® Core™ i7-8565U (512GB TLC SSD) vs. 8th Gen Intel® Core™ i7-8565U (32GB+512GB Intel® Optane™ memory H10 with solid state storage) .
- Intel® Core™ i7 8565U Processor, PL1=15W TDP, 4C8T, Turbo up to 4.60GHz on Intel Reference Platform, Graphics: Intel® UHD Graphics 620, Memory: 2x4GB DDR4, Storage: 32GB+512GB Intel® Optane™ memory H10 with solid state storage, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0x9A

APPENDIX B

For claims below, performance results are based on testing by Intel as of March 22, 2019 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

- Footnotes:

- [6. SSDs with Intel® Optane™ memory are the fastest as compared to NAND SSDs](#)

- As compared to NAND SSDs in the majority of the following common client use cases: as measured by a collection of benchmarks and real-world workloads with drives at 50% prefill including PCMark* 10 Benchmark (App Startup), PCMark* 8 Benchmark: Storage Bandwidth Test, Presentation Launch, Email Launch, Document Launch, Web Browser Launch, Total War* Warhammer II Game Launch, World of Warcraft* Game Launch, Fortnite* Game Launch, Total War* Warhammer II Level Load, World of Warcraft* Level Load, Multitasking Workload, and Adobe* Premier Pro Launch with Background Activity, also by Iometer with drives at base install and 50% prefill separately for QD1 and QD2, running various combination of sequential and random read and write scenarios, in both single and mixed modes at a span size of 1GB. The SSDs compared with are 1TB Samsung* 970 PRO, 1TB 970 EVO, 1TB 970 EVO Plus, 1TB Western Digital* Black, 1TB Intel SSD 660p, 1TB 760p, 1TB OCZ* RD4000, 1TB HP* EX920, 1TB Toshiba* XG5, and 960GB Corsair* MP510. Configuration: 9th Gen Intel® Core™ i9 9900K Processor, PL1= 95W TDP, 8C16T, Turbo up to 5.00GHz on ASUS* Prime Z390-A platform, Graphics: NVIDIA* GeForce RTX 2080 TI, Memory: 2x8GB DDR4, Storage: 1TB Intel® Optane™ Memory H10 with Solid State Storage, Storage Driver: Intel® Rapid Storage Technology 17.2.0.1009 driver, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0xA0; SSD Configurations: Same configuration with the comparison SSD as storage and Microsoft* Inbox NVMe driver as the storage driver. Results: Intel® Optane™ Memory H10 with Solid State Storage prevails for the majority (more than 50%) of the Iometer tests (including both single and mixed modes) combined, for the majority of the collection of benchmarks and real-world workloads combined, and for the majority of all above tests combined.

- [7. SSDs with Intel® Optane™ memory deliver the best real-world performance as compared to NAND SSDs](#)

- As compared to NAND SSDs in the majority of the following common client use cases: as measured by a collection of benchmarks and real-world workloads with drives at 50% prefill including PCMark* 10 Benchmark (App Startup), PCMark* 8 Benchmark: Storage Bandwidth Test, Presentation Launch, Email Launch, Document Launch, Web Browser Launch, Total War* Warhammer II Game Launch, World of Warcraft* Game Launch, Fortnite* Game Launch, Total War* Warhammer II Level Load, World of Warcraft* Level Load, Multitasking Workload, Adobe* Premier Pro Launch with Background Activity. The SSDs compared with are 1TB Samsung* 970 PRO, 1TB 970 EVO, 1TB 970 EVO Plus, 1TB Western Digital* Black, 1TB Intel SSD 660p, 1TB 760p, 1TB OCZ* RD4000, 1TB HP EX920, 1TB Toshiba* XG5, and 960GB Corsair* MP510. Configuration: 9th Gen Intel® Core™ i9 9900K Processor, PL1= 95W TDP, 8C16T, Turbo up to 5.00GHz on ASUS* Prime Z390-A platform, Graphics: NVIDIA* GeForce RTX 2080 TI, Memory: 2x8GB DDR4, Storage: 1TB Intel® Optane™ Memory H10 with Solid State Storage, Storage Driver: Intel® Rapid Storage Technology 17.2.0.1009 driver, OS: Windows* 10 RS5 Version 1809, Build 17763.253, MCU 0xA0; SSD Configurations: Same configuration with the comparison SSD as storage and Microsoft* Inbox NVMe driver as the storage driver. Results: Intel® Optane™ Memory H10 with Solid State Storage prevails for the majority (more than 50%) of all above tests combined.

- Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information about performance and benchmark results, visit <http://www.intel.com/benchmarks> *Other names and brands may be claimed as the property of others.

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APPENDIX C

Workload Details

- RUG 1043 - Document Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch an ~8MB DOCX file with Microsoft* Word 365 while copying an 18GB video file.
- RUG 1042 - Workbook Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch a ~15MB XLSX file with Microsoft* Excel 365 while copying an 18GB video file.
- RUG 1036 - Gimp* Project File Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch a ~87MB GIMP* project file while copying an 18GB video file.
- RUG 1040 Adobe* Photoshop Project File Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch a ~300MB Adobe* Photoshop CC project file while copying an 18GB video file.
- RUG 1045 PUBG* Game Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch PLAYERUNKNOWN'S BATTLEGROUNDS*, while copying an 18GB video file.
- RUG 1044 Path of Exile* Game Launch with Background Activity: Workload developed by Intel measuring the time elapsed to launch Path of Exile*, while copying an 18GB video file

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information about performance and benchmark results, visit <http://www.intel.com/benchmarks> *Other names and brands may be claimed as the property of others.

APPENDIX D

- Slide title: “Intel® Core™ Processor + Intel® Optane™ Technology: Better Together”
- Footnote 1. As measured by Office 365* application launch with background activity (18 GB file copy). Configuration: CPU: Intel® Core™ i5-8265U CPU (4 cores, 8 threads, 1.6 GHz base frequency, 3.9 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DR0011DX (BIOS F.03) with Intel® UHD 620 graphics and Intel® Optane™ Memory H10 (512 GB) vs. AMD* Ryzen 7 3700U CPU (4 cores, 8 threads, 2.3 GHz base frequency, 4.0 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DS0012DX (BIOS F.07) with Radeon* Vega 10 graphics and Toshiba XG5 (512 GB), both with 8 GB DDR4 RAM. Storage Driver: Intel® Rapid Storage Technology 17.2.0.1009 for H10, Windows inbox driver for XG5. OS: Windows* 10 RS5 Version 1809, Build 17763. MS Office 365 Version 1902 Build 11328.
- Footnote 2. As measured by Path of Exile* game launch with background activity (18GB local file copy), comparing AMD Ryzen* 7 3700U on HP Envy x360 2-in-1 15.6" 15M-DS0012DX (BIOS F.07) with Toshiba XG5 (TLC NAND SSD) 512GB vs. Intel® Core i7-8565U on HP Envy x360 2-in-1 15.6" 15M-DR0012DX (BIOS F.03) with Toshiba XG5 512GB vs. Intel® Core™ i7-8565U with Intel® Optane™ Memory H10 512GB; all configs with 8GB RAM. H10 configs tested with RST driver 17.2.0.1009; XG5 configs with Windows inbox driver. All configs used Windows 10 Home 64-bit version 1809, build 17763. Path of Exile version 3.6.6c.
- Footnote 3. As measured by Photoshop CC 2019 and GIMP application launch with background activity (18 GB file copy). Configuration: CPU: Intel® Core™ i5-8265U CPU (4 cores, 8 threads, 1.6 GHz base frequency, 3.9 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DR0011DX (BIOS F.03) with Intel® UHD 620 graphics and Intel® Optane™ Memory H10 (512 GB) vs. AMD* Ryzen 7 3700U CPU (4 cores, 8 threads, 2.3 GHz base frequency, 4.0 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DS0012DX (BIOS F.07) with Radeon* Vega 10 graphics and Toshiba XG5 (512 GB), both with 8 GB DDR4 RAM. Storage Driver: Intel® Rapid Storage Technology 17.2.0.1009 for H10, Windows inbox driver for XG5. OS: Windows* 10 RS5 Version 1809, Build 17763. Photoshop CC 2019 Version 20.0.4. GIMP Version 2.10.8.
- Footnote 4. As measured by PCMark 10 Standard Benchmark (App Start-up score). Configuration: CPU: Intel® Core™ i5-8265U CPU (4 cores, 8 threads, 1.6 GHz base frequency, 3.9 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DR0011DX (BIOS F.03) with Intel® UHD 620 graphics and Intel® Optane™ Memory H10 (512 GB) vs AMD* Ryzen 7 3700U CPU (4 cores, 8 threads, 2.3 GHz base frequency, 4.0 GHz max turbo frequency) on HP Envy x360 2-in-1 15.6" 15M-DS0012DX (BIOS F.07) with Radeon* Vega 10 graphics and Toshiba XG5 (512 GB), both with 8 GB DDR4 RAM. Storage Driver: Intel® Rapid Storage Technology 17.2.0.1009 for H10, Windows inbox driver for XG5. OS: Windows* 10 RS5 Version 1809, Build 17763. PCMark 10 GUI version 2.0.2115. SystemInfo version 5.18.705. System benchmarks version 1.1.