



GAME DEVELOPER TECHNICAL DISCLOSURE

INTEL GRAPHICS AND MULTICORE ENGINEERING

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GRAPHICS

2015-2018 Ultrabook

Power (TDP): 15W

Frequency: ~0.9 -1.1 GHz

FLOPS: 345- 440 GFLOPS

2019 Ultrabook

Power (TDP): 15W

Frequency: ~1.1GHz (TBD)

FLOPS: ~1126 GFLOPS (TBD)

Projections up to and over **2.5x graphics perf** in games and benchmarks

Series	Prev SKU	New SKU	System perf*	GPU perf*
			SysMark'14SE	3DMark11 - Graphics
Mobile U (~15W)	2018 Gen9 (WHL-U42)	2019 Gen11 (ICL-U42)	1.1x	2.5x
Desktop H (~45W)	2018 Gen9 (CFL-H62)	2019 Gen11 (ICL-H81)	1.2x	1.5x + dGPU

*Performance , Power numbers are Pre-Si projections, measured Top Bin to Top Bin, subject to change and apply to Top Bin SKUs only. IA projections are based on SYSMark'14SE. GPU performance is based on 3D Mark 11

Benchmark results were obtained prior to implementation of recent software patches and firmware updates intended to address exploits referred to as "Spectre" and "Meltdown". Implementation of these updates may make these results inapplicable to your device or system.

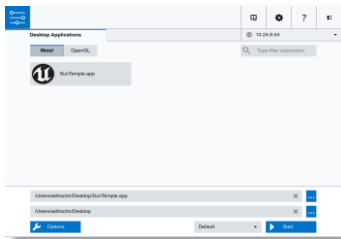
Software and workloads used in performance tests may have been optimized for performance only on Intel(R) microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors 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 information go to www.intel.com/benchmarks**

Intel® Graphics Performance Analyzers (GPA)

- GPA is a suite of graphics performance tools created by Intel for the purpose of optimizing games and real-time graphics applications.
- GPA supports DX11/DX12 and all major graphics hardware (Intel, NV, AMD).

Graphics Monitor

Launch & config tool



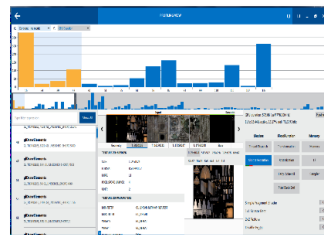
System Analyzer

In-Game Analysis



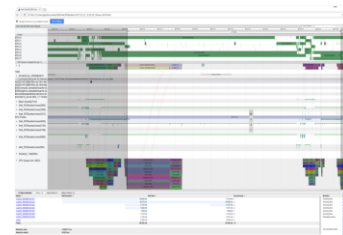
Frame Analyzer

Single Frame Analysis



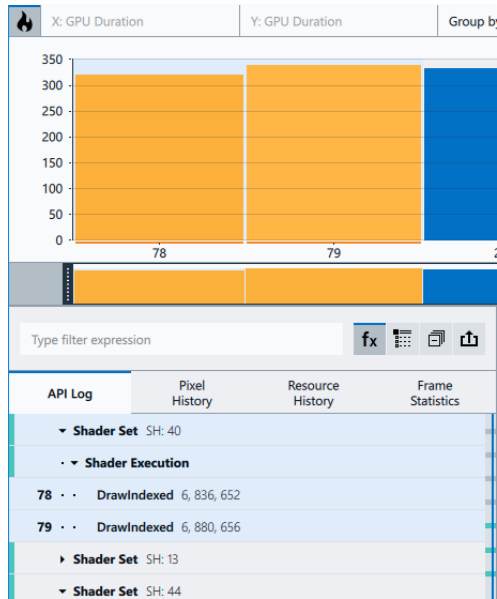
Trace Analyzer*

Timeline Analysis



* Graphics Trace Analyzer is in the early Beta quality for Ubuntu/macOS target systems

GPA's Premier Performance Features



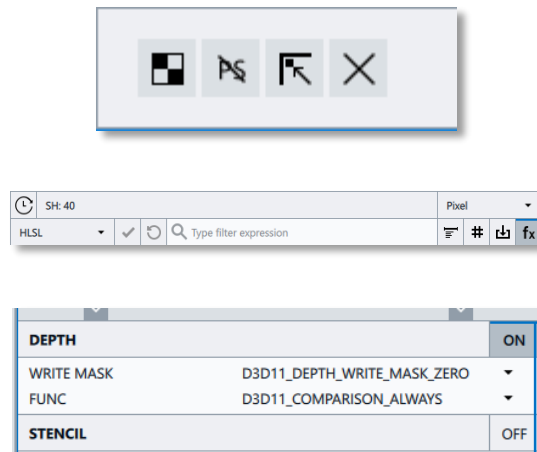
Hotspot Analysis

Identifies most expensive sets of events grouped by state and/or bottleneck

3D Pipeline	Current Selection	Full Frame			
LLC/EDRAM/DRAM					
Pixel Back-End					
Shader Execution					
Thread Dispatch	L3				
Setup Back-End	Sampler				
Early Depth / Stencil					
Rasterization					
Geometry Transformation					
Name (Units)	Current	Original	Delta%	Delta	
EU Array					
EU Active	%	87	87	0	0
EU Stall	%	7.38	7.38	0	0
EU Thread Occupancy	%	90.4	90.4	0	0
EU Array/Pipes					
EU Both FPU Pipes Active	%	67.5	67.5	0	0
EU FPU0 Pipe Active	%	71.1	71.1	0	0
EU FPU1 Pipe Active	%	82.8	82.8	0	0
EU Send Pipe Active	%	9.04	9.04	0	0
<div><div>⊗</div><div>Error: EU stall is low, but the EU occupancy is high. There is some EU execution inefficiency associated with the workload. To resolve, optimize the shader code itself. More info</div><div>↕</div></div>					

Metrics Analysis

Low-Level Intel hardware counters help you pinpoint pipeline bottlenecks



Playback Experiments

Test performance optimizations and quantify improvements

MEMORY AND STORAGE

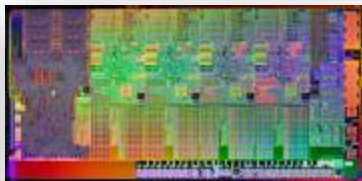
Intel® Optane™

- Optane™ is the brand name for multiple memory products by Intel
 - 3D Xpoint™ is the memory technology (as opposed to NAND or DRAM)
 - Lower latency than NAND SSDs, larger capacity than DRAM Memory
- Two classes of products currently on the market
 - Intel Optane SSD – High performance storage for workstations
 - Intel Optane Memory – Cache and scratch space for client
- Future product classes are planned
 - 2LM – High performance storage for workstations
 - Intel Optane Memory – Cache and scratch space for client

3D Xpoint™ Technology

SRAM

Latency: 1X
Size of Data: 1X



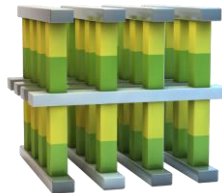
DRAM

Latency: ~10X
Size of Data: ~100X



3D XPoint™

Latency: ~100X
Size of Data: ~1,000X



NAND SSD

Latency: ~100,000X
Size of Data: ~1,000X



HDD

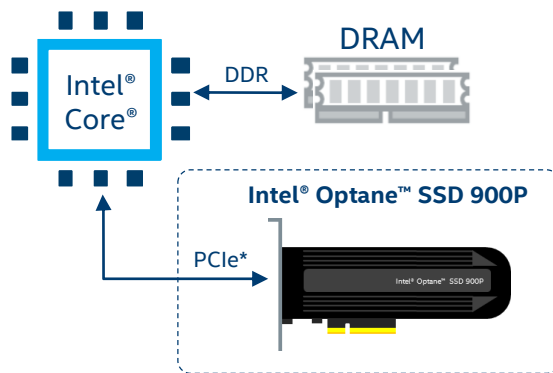
Latency: ~10 MillionX
Size of Data: ~10,000X



Technology claims are based on comparisons of latency, density and write cycling metrics amongst memory technologies recorded on published specifications of in-market memory products against internal Intel specifications.

Available Now – Fast storage

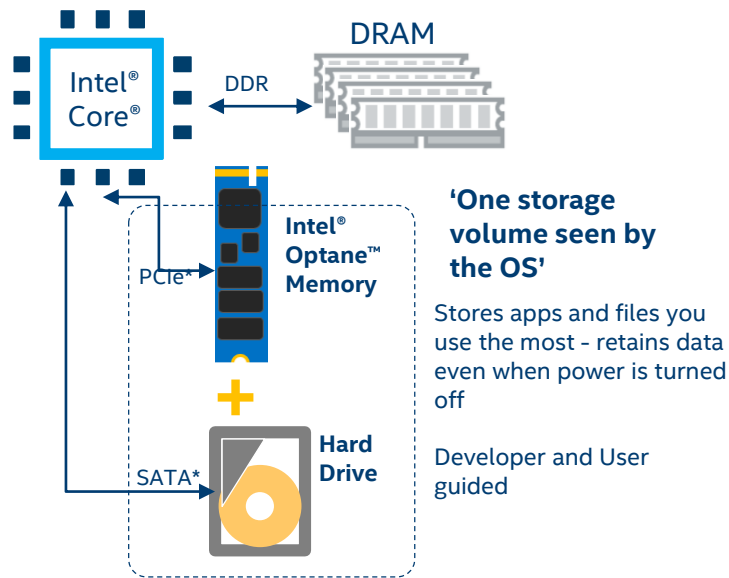
Intel® Optane™ SSD 900P



USAGE: High Performance
Storage

Available Now – System Accelerator

Intel® Optane™ Memory

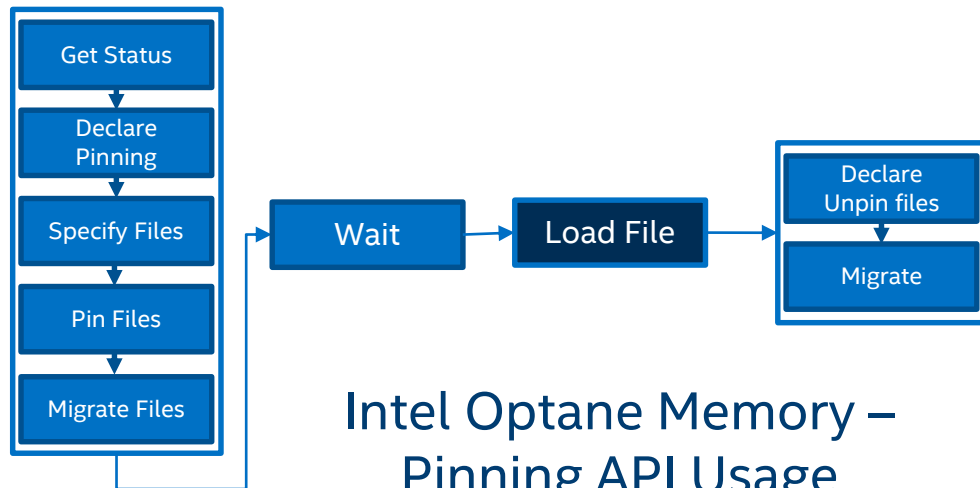


USAGE: Intelligent System Acceleration

Optane™ Memory

- **Block Cache** - employs automatic prefetching based upon past access patterns & file extension.
- **File cache** - enables user-specified file, directory, & application pinning. Enables software developers to pin files.
 - **API Pinning** - Software developer specified - explicit, replacement based upon future access patterns.
 - **User Pinning** – High priority, permanent in file cache

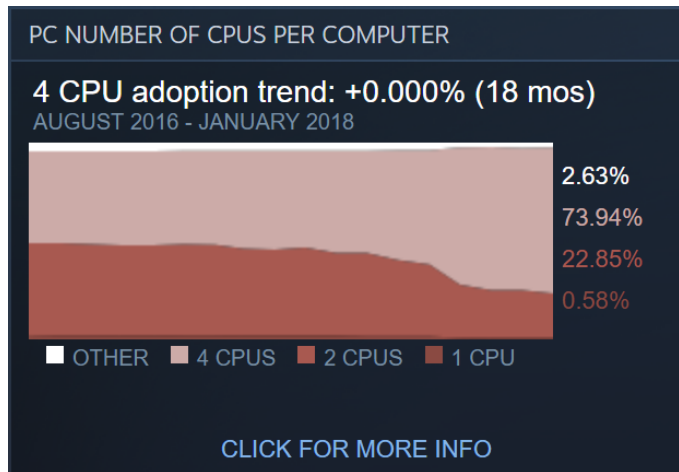
SSD	16GB	32GB	64GB
Actual Density (GB)	16	27.25	54.9
Block Cache (GB)	13.4	20	40
File Cache (GB)	0	7.25	14.9



Intel Optane Memory –
Pinning API Usage

CPU

State of the CPU Ecosystem

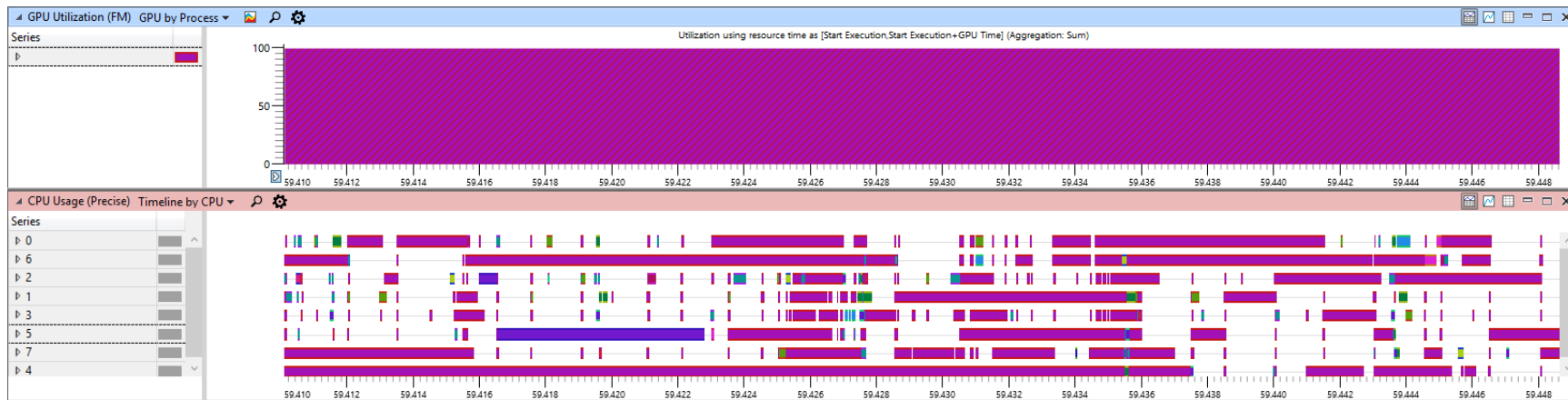


<http://store.steampowered.com/hwsurvey/>

- Steam reports that 4 core CPUs make up ~74% of the PC gaming market, up from 47.4% in Jan'17.
- This translates to 8 logical cores in CPUs with hyperthreading.
- 6c/12t desktop CPUs (e.g. i7-8700K) were made available in Q4'2017.
- 8c/16t CPUs will be coming next.

We anticipate that this trend will continue, with 6- and 8-core CPUs becoming the most popular CPUs for gamers over the coming years.

Utilizing the CPU



Going Wide: Distribute tasks to achieve better power and performance scaling.

Load Balancing: Offload work from a busy GPU to an otherwise idle CPU.

Content Enhancements: Turn up the dial on simulation, audio, etc.

Partnership Case Study – Epic Games



- **Cloth System**

Removed unused attributes from the vertex data structures and took advantage of prefetch instructions to improve vertex throughput of the system by 18%, from 5.5M to 7M simulated vertices per frame.

- **Job Manager**

Increased the maximum number of worker threads available to scale with core count and hyperthreading.

- **Intel Compiler**

Integrated into engine build process and seeing good performance impact: Improved the frame time of the Infiltrator workload by 1.5ms/frame on a GTX 980.

- **Instrumentation**

Integrated VTune ITT markers into the engine to improve profiling capabilities.

Partnership Case Study: Total War: WARHAMMER II

"The Laboratory offers a brand new free game mode for Total War: WARHAMMER II, designed in collaboration with Intel®. It introduces a custom battle playground with 16 different sliders to tinker and play with to push your battles to new and ridiculous levels of mayhem." -

<https://www.totalwar.com/blog/skaven-labs>

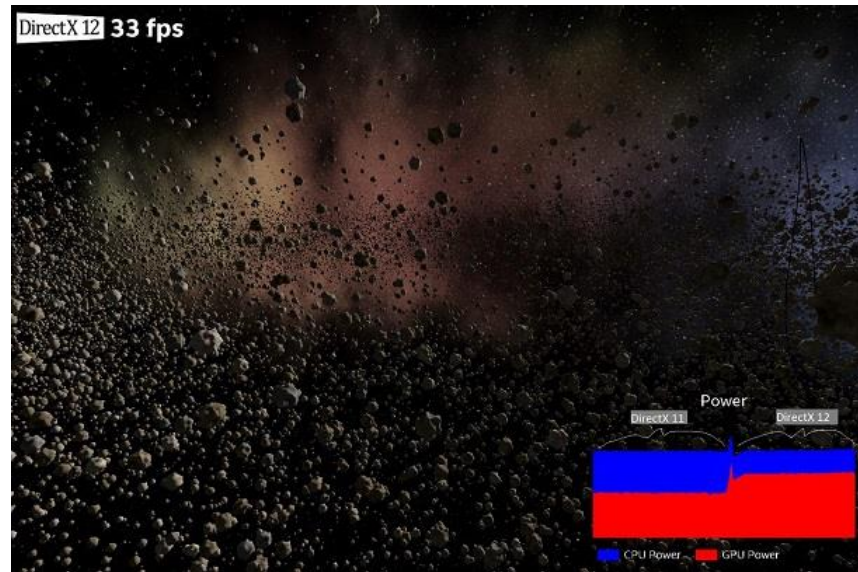
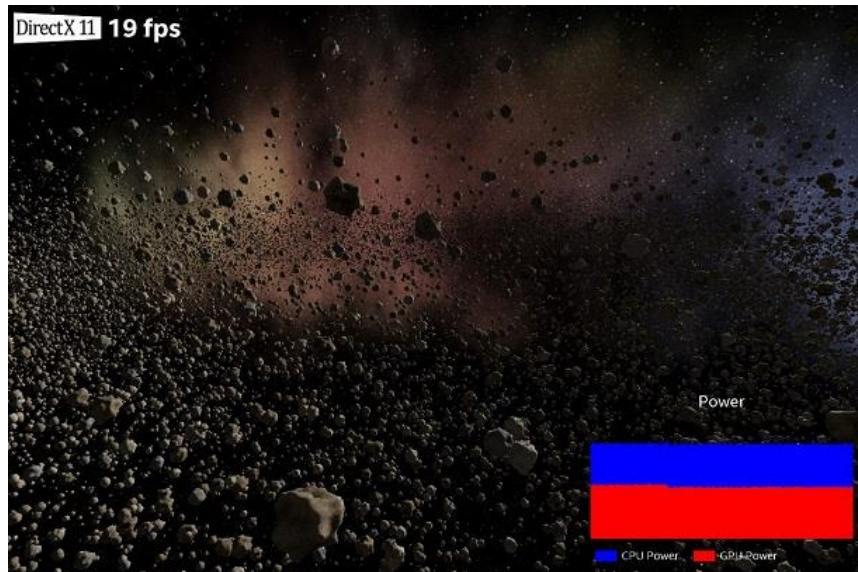


Intel helped with performance analysis to identify bottlenecks and contention between the main thread and the worker threads.

Content Enhancement Opportunities

- Particle Physics
- Realtime GI
- Destructible Meshes
- Weather Simulation
- Ragdoll Physics
- Cloth Simulation
- Fluid Simulation
- 3D Spatialized Audio

DX12 / Vulkan



Explicit rendering APIs support the distribution of work to multiple threads, which can significantly improve CPU/GPU performance and power utilization.

GPU Detect Code Sample



- Correctly configure OOTB settings with Intel Device IDs
- Query platform information like:
 - GT Generation
 - Frequency range
 - Fill rate
 - Video memory
 - Package TDP & more
- Simple ready-to-use code that queries IDXGIAAdapter

Get The Source!

<https://github.com/GameTechDev/gpudetect>