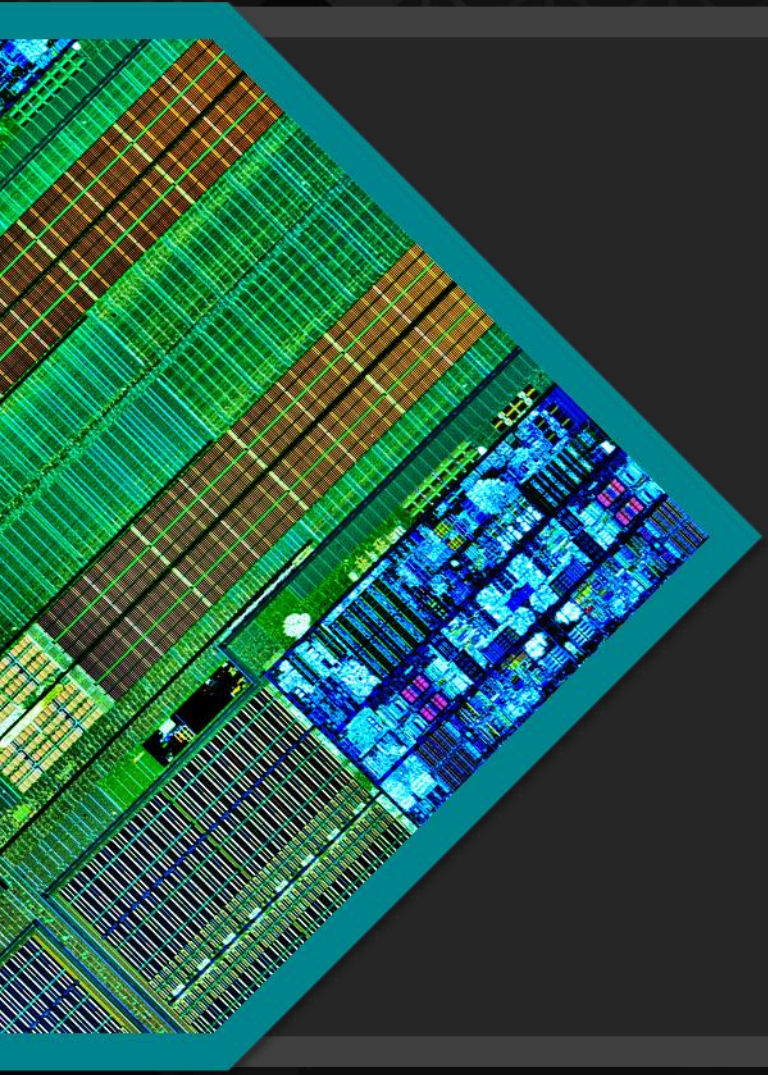




AMD RADEON™ GFX & DIRECTX® 12 ▲

ROBERT HALLOCK
AMD TECHNICAL MARKETING



THE INDUSTRY PROBLEM

- ▲ Modern CPUs unable to keep up with performance growth of graphics cards
- ▲ API/driver overhead serious problem; preventing new game designs from being explored
- ▲ Developers want direct hardware access to recover performance lost or obscured by past graphics APIs



DEVELOPERS AGREE

“Meanwhile, your PC might have 4, 8 or more CPU cores on it. And exactly 1 of them at a time can talk to the GPU.

Let’s take a pause here. I want you to think about that for a moment. Think about how limiting that is. Think about how limiting that has been for game developers. How long has your computer been multi-core?”

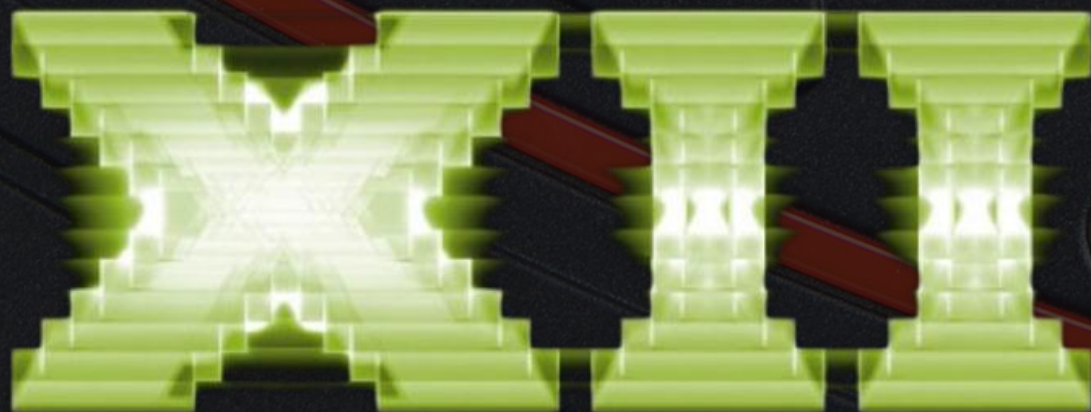
SOURCE: [Brad Wardell, Stardock Corporation](#)

DIRECTX[®] 12

CONSOLE-LIKE API FOR PC GRAPHICS

AMD

RADEON
GRAPHICS



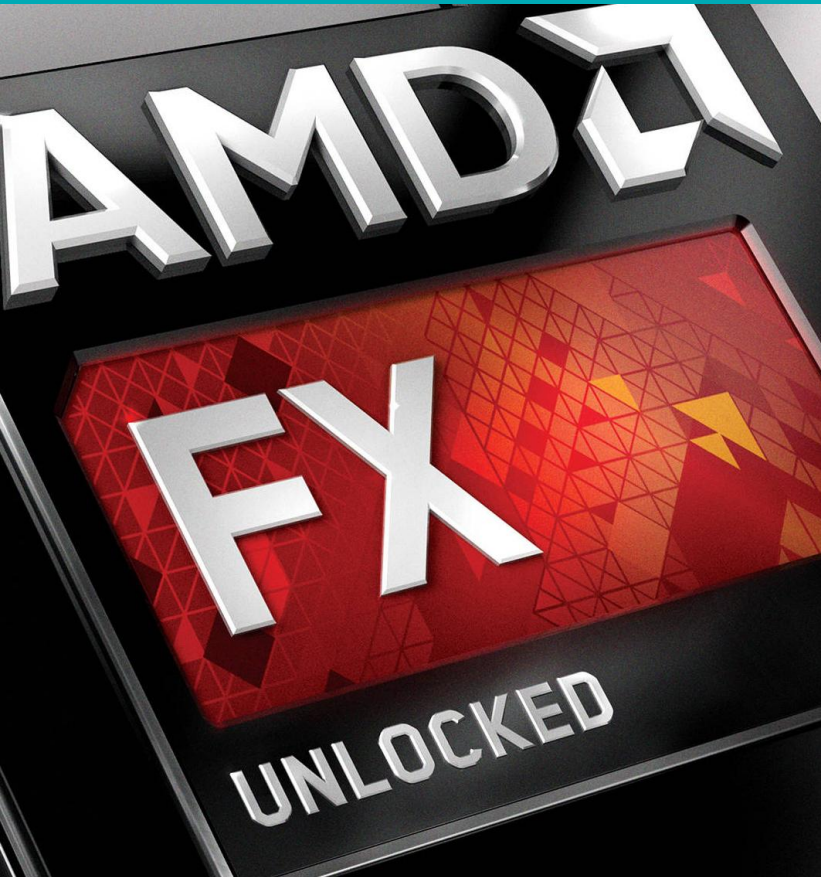
POTENTIAL BENEFITS of the DirectX® 12 graphics API

- ▲ Better use of multi-core CPUs
- ▲ More on-screen detail
- ▲ Higher min/max/avg framerates
- ▲ Smoother gameplay
- ▲ More efficient use of GPU hardware
- ▲ Reduced system power draw
- ▲ **Allows for new game designs previously considered impossible due to technical limitations of past DirectX® APIs**

TOP FEATURES OF DIRECTX® 12

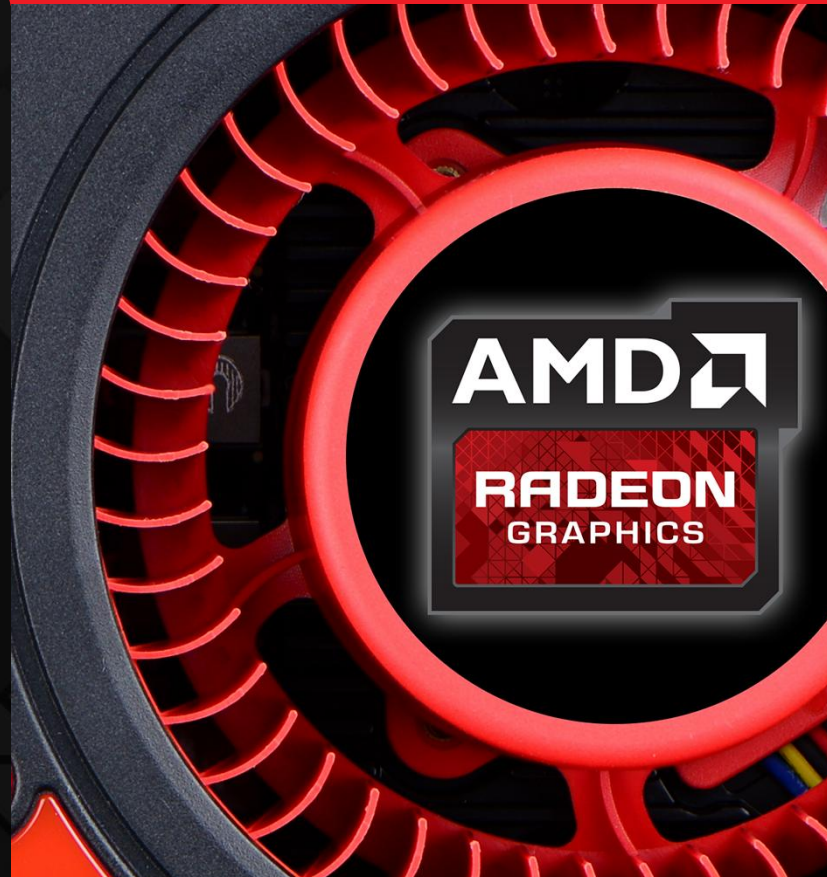


MULTITHREADED COMMAND
BUFFER RECORDING



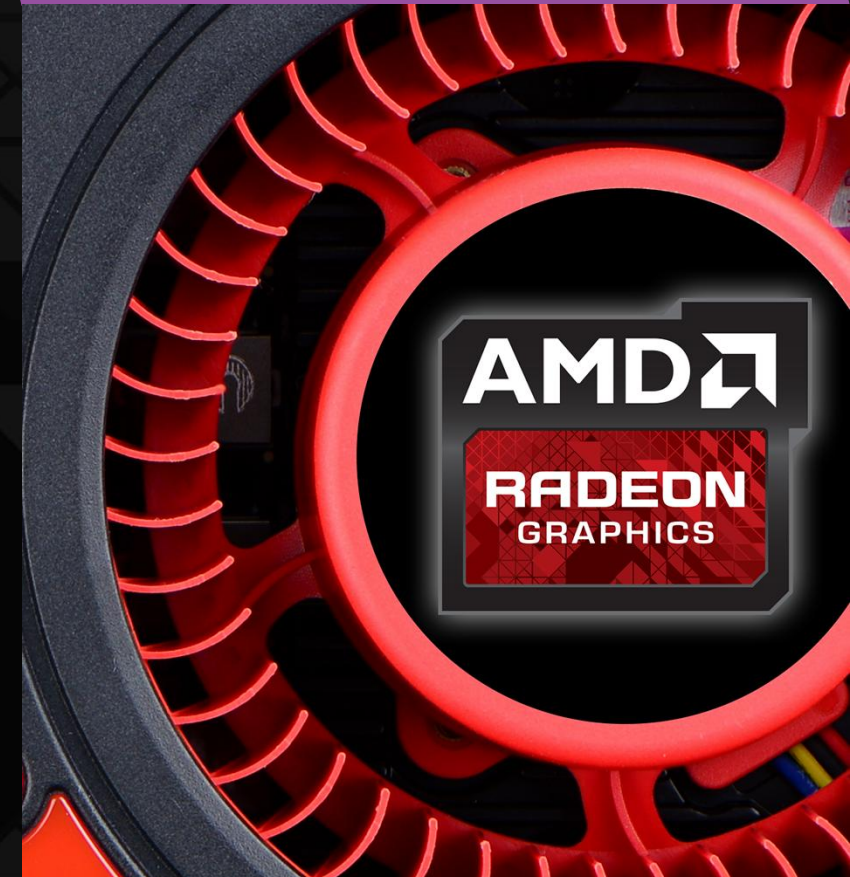
MULTI-CORE CPU PERFORMANCE ↑

ASYNC SHADERS



GPU PERFORMANCE ↑

EXPLICIT MULTIADAPTER

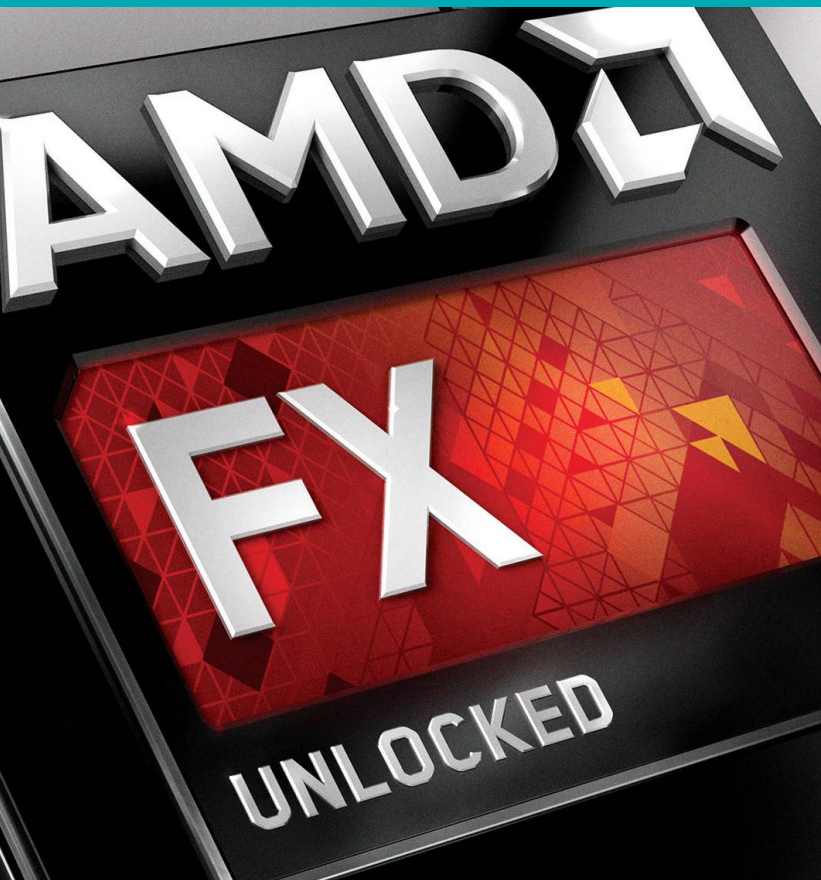


MULTI-GPU PERFORMANCE ↑

POTENTIAL BENEFITS FOR GAMERS



MULTITHREADED COMMAND
BUFFER RECORDING



HIGHER FPS

- ▲ Uses more CPU cores to finish work faster
- ▲ More CPU time spent on game code
- ▲ Allows all CPU cores to speak to GPU simultaneously

SIMPLICITY

- ▲ Game performance largely determined by user's GPU

PERFORMANCE PER WATT

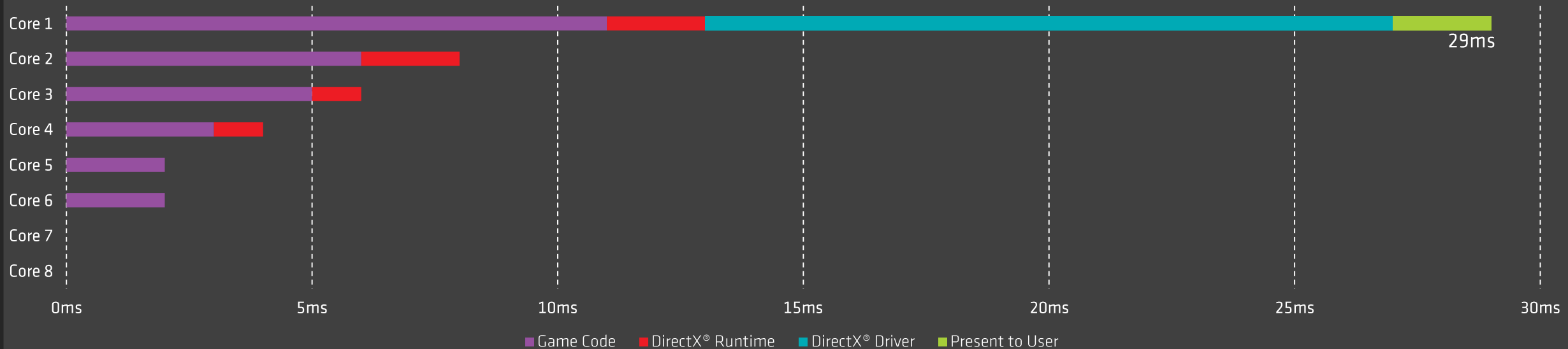
- ▲ Doing more work for gamers on the same power draw

MULTI-CORE CPU PERFORMANCE ▲

COMMAND BUFFER BEHAVIOR IN DIRECTX® 11



DirectX® 11 App Workload on 8-Core CPU*



- Frame rendered in 29ms
- 29ms = **34 frames per second**
- Cores 7 and 8 unused
- Core 1 overloaded with most of the work
- DirectX® work (red/blue) consumes disproportionate time
- This is “high API overhead”

NEW POSSIBILITIES IN GAMING



"If we were running DirectX® 11, you are not going to run [Ashes of the Singularity] at 4K. It's not even a possibility."

Brad Wardell, CEO Stardock/Oxide Games

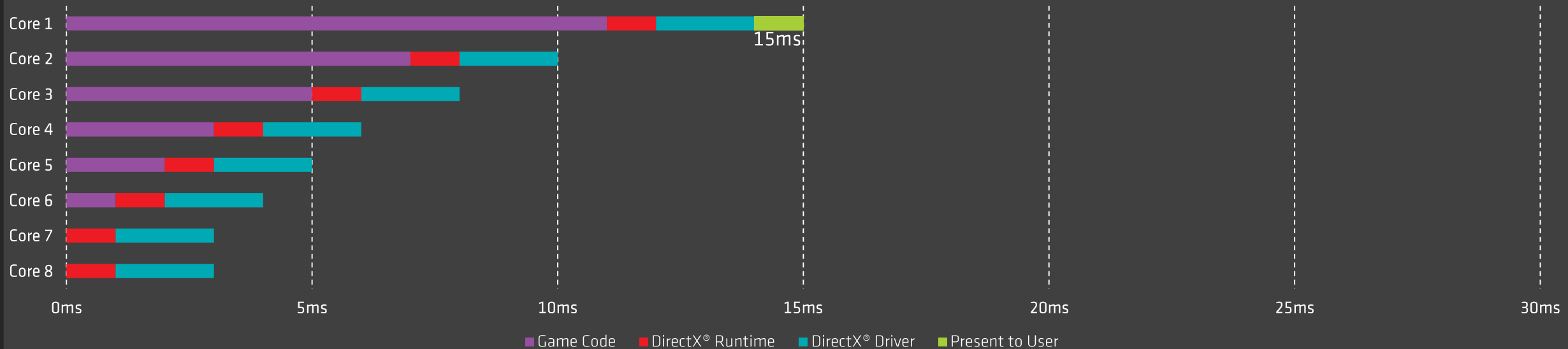


ASHES OF THE
SINGULARITY

COMMAND BUFFER BEHAVIOR IN DIRECTX® 12



DirectX® 12 App Workload on 8-Core CPU*



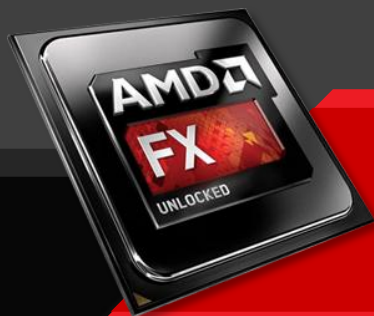
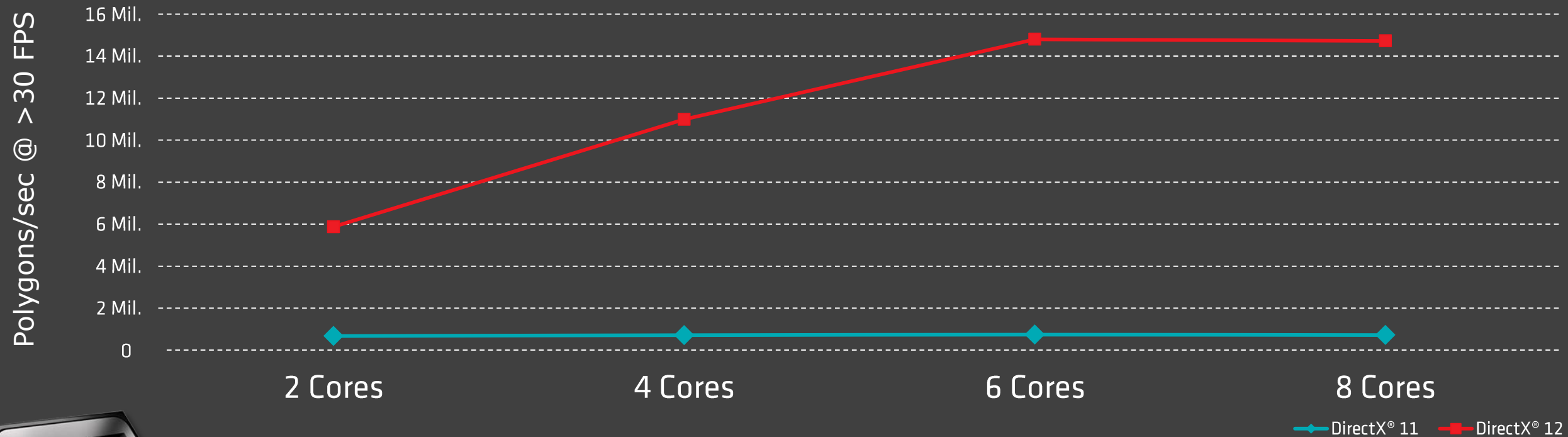
- + Frame rendered in 15ms
- + 15ms = **66 frames per second**
- + All 8 cores utilized
- + Work distributed across cores
- + DirectX® work (red and blue) very modest vs. game code
- + This is “low API overhead”

DIRECTX® 12 MULTI-CORE SCALING

3DMARK® API OVERHEAD FEATURE TEST



INCREASING DETAIL WITH CORES



AMD FX-8370

+2.9 million draw calls
per core up to 6 cores*

REAL-WORLD RESULTS



— ASHES OF THE —
SINGULARITY

"Even if your GPU could do amazing things, we just couldn't feed it fast enough. [...] But now, every single core of the CPU is being utilized."

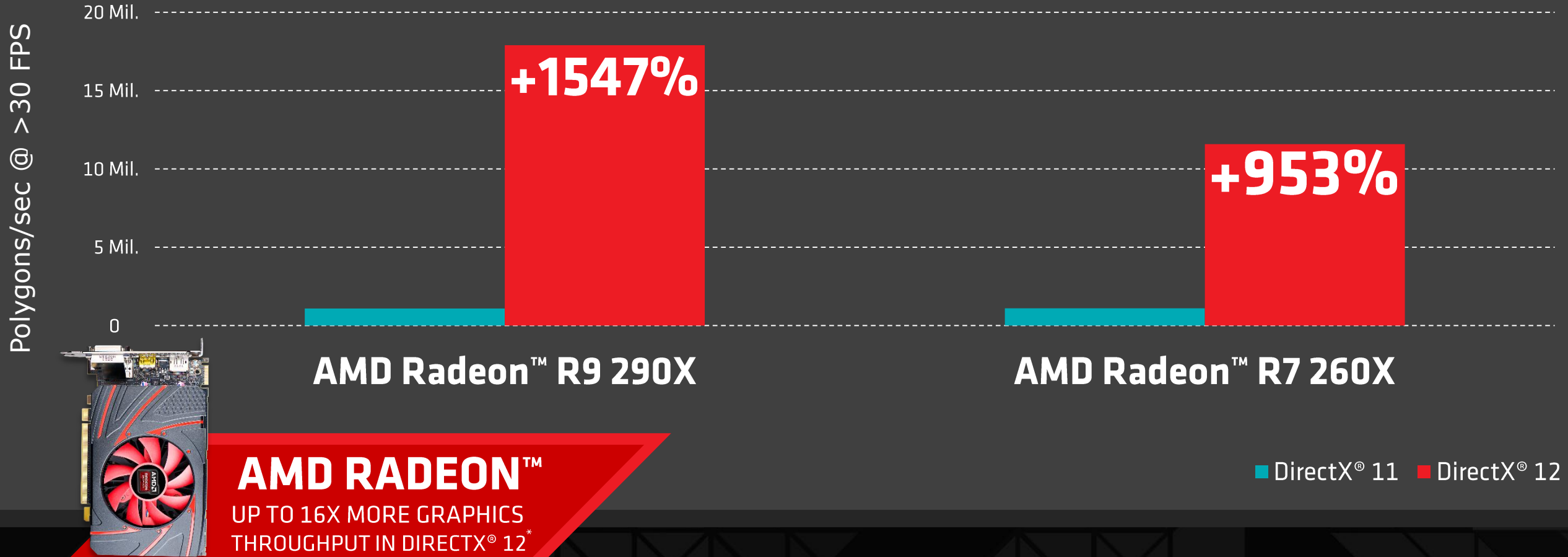
Brad Wardell, CEO Stardock/Oxide Games

DIRECTX® 12 HARDWARE EFFICIENCY

3DMARK® API OVERHEAD FEATURE TEST



SCENE DETAIL AT 4K

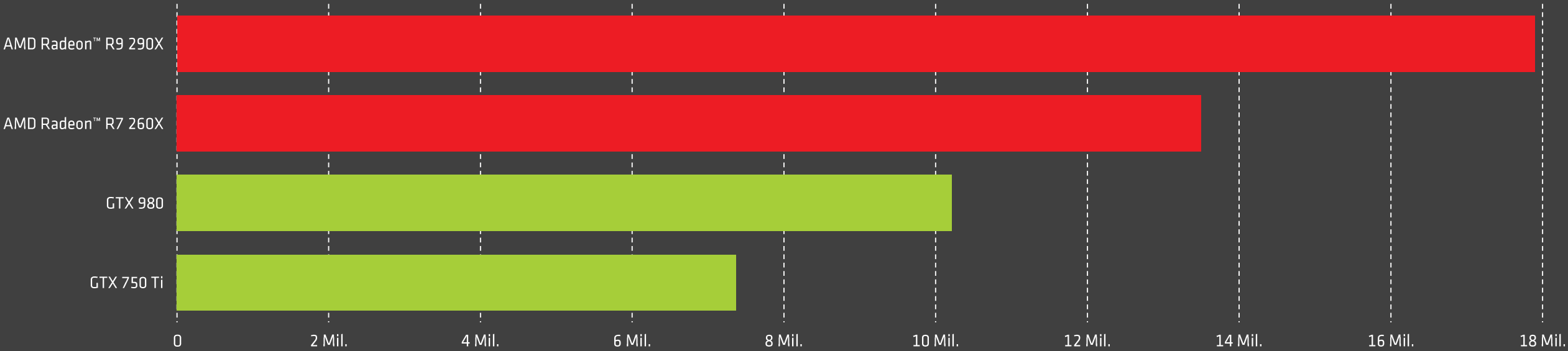


DIRECTX® 12 GPU PERFORMANCE

3DMARK® API OVERHEAD FEATURE TEST



SCENE DETAIL AT 4K



Polygons/sec @ >30 FPS



AMD RADEON™
INCREDIBLE DIRECTX® 12
HARDWARE EFFICIENCY

** See slide 36 for system config.*

DIRECTX® 12 SOC PERFORMANCE/WATT

3DMARK® API OVERHEAD FEATURE TEST



SCENE DETAIL

(1080p)

DirectX® 12

POLYGONS/SEC @ >30 FPS
3,406,327 @ 86W

DirectX® 11

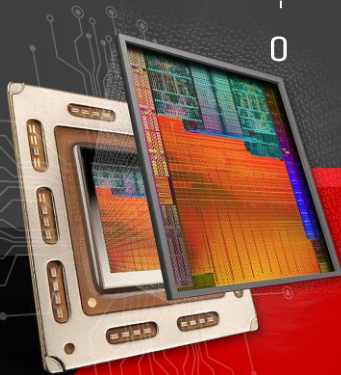
POLYGONS/SEC @ >30 FPS
556,638 @ 87W

0

1 Mil.

2 Mil.

3 Mil.



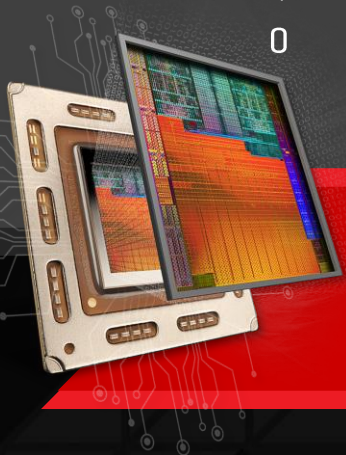
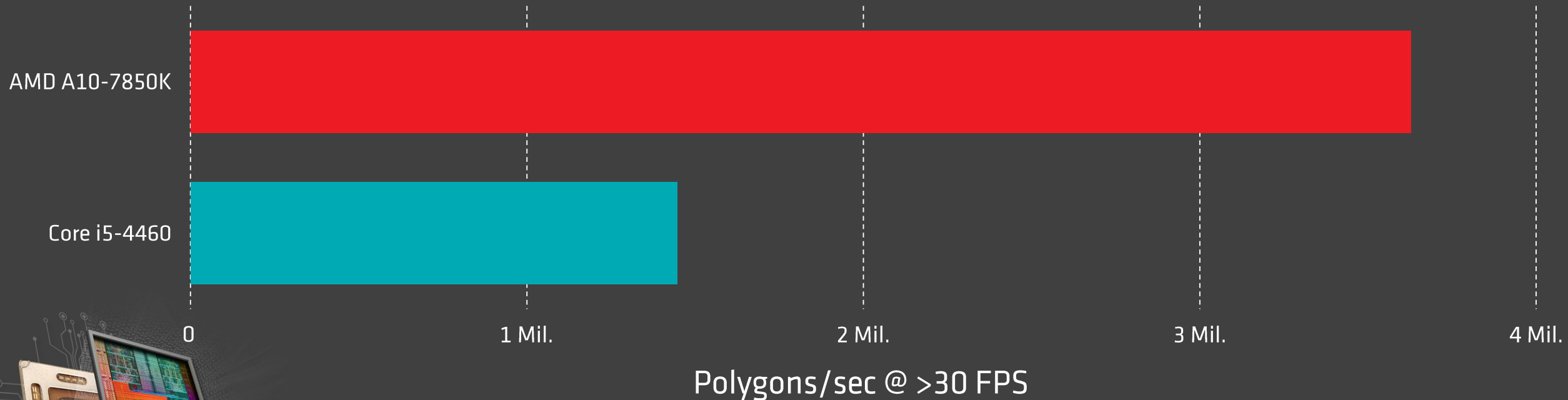
AMD A10-7850K
+511% PERF/WATT
WITH DIRECTX® 12*

DIRECTX® 12 SOC PERFORMANCE LEADERSHIP

3DMARK® API OVERHEAD FEATURE TEST



SCENE DETAIL (1080p)

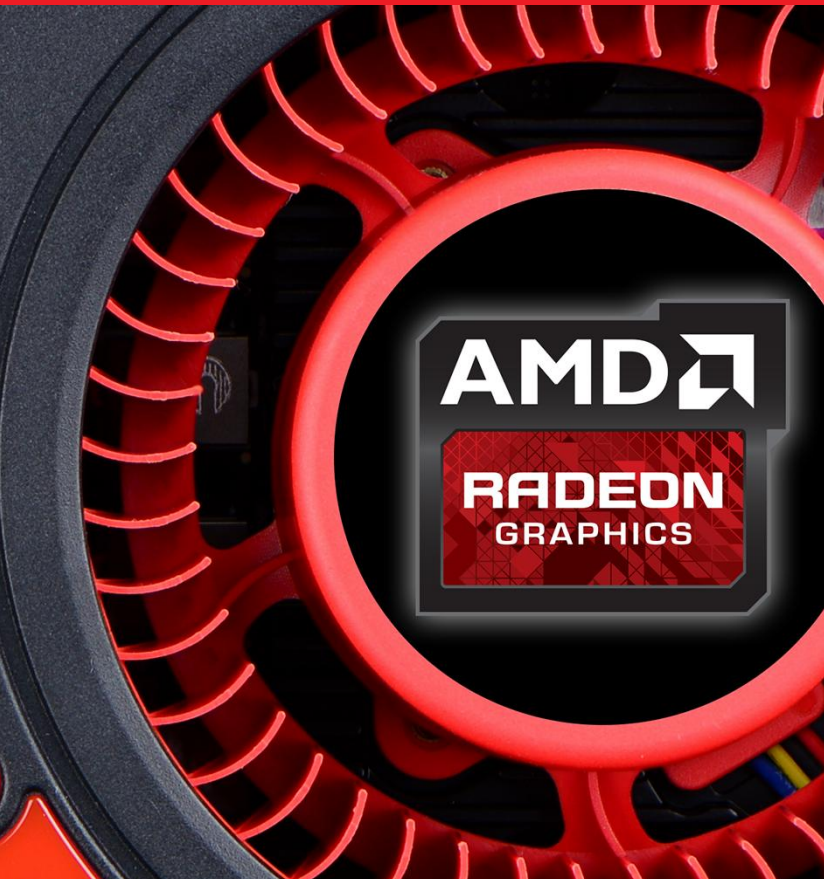


AMD A10-7850K
THE ULTIMATE SOC
FOR DIRECTX® 12

POTENTIAL BENEFITS FOR GAMERS



ASYNCHRONOUS SHADERS



GPU PERFORMANCE ↑

HIGHER FPS

- ▲ Breaks complex serial workloads into many parallel tasks
- ▲ Idle GPU resources do work instead of waiting their turn
- ▲ Parallel workloads = jobs finish faster = more performance
- ▲ Increasing granularity of the multi-threading improves performance

GREAT FOR VR

- ▲ More parallelism = lower latency = more responsive VR

IMAGE QUALITY

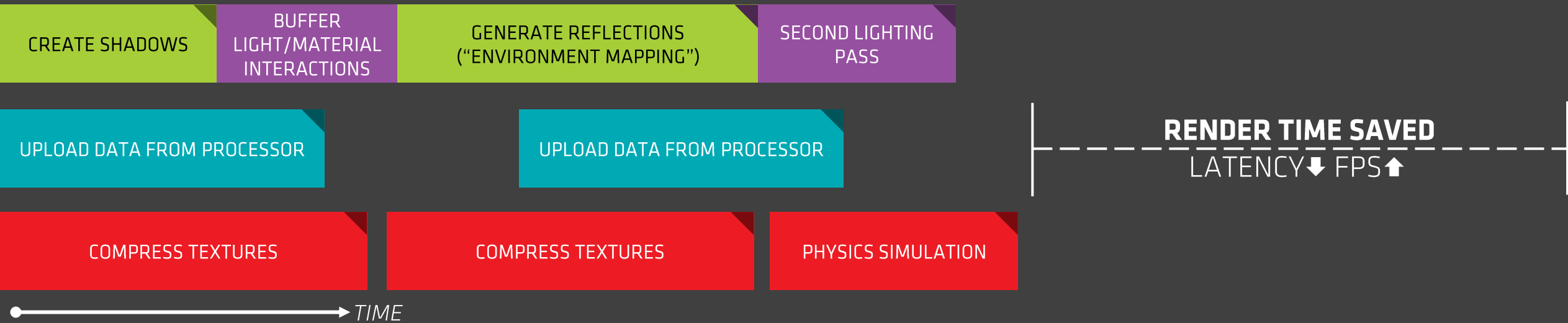
- ▲ More performance = more headroom for new graphics effects

GPU PIPELINE BEHAVIOR IN DIRECTX® 11



COMPUTE, LIGHTING & MEMORY
USE DIFFERENT GPU RESOURCES
SO WHY CAN'T THESE JOBS RUN TOGETHER?

GPU PIPELINE BEHAVIOR IN DIRECTX® 12



THEY CAN IN DIRECTX® 12
& MORE THREADS = MORE DONE IN LESS TIME

GAME DEVS & ASYNC SHADERS

DAN BAKER, PARTNER, OXIDE GAMES



“With async shaders, we can fill parts of the GPU that [would] otherwise be forced to sit idle. It's one of those features we wish we had on every GPU.”

AMD DIRECTX® 12 ASYNC SHADER DEMO



+29 FPS
WITH ASYNC SHADERS*

GAME DEVS & ASYNC SHADERS

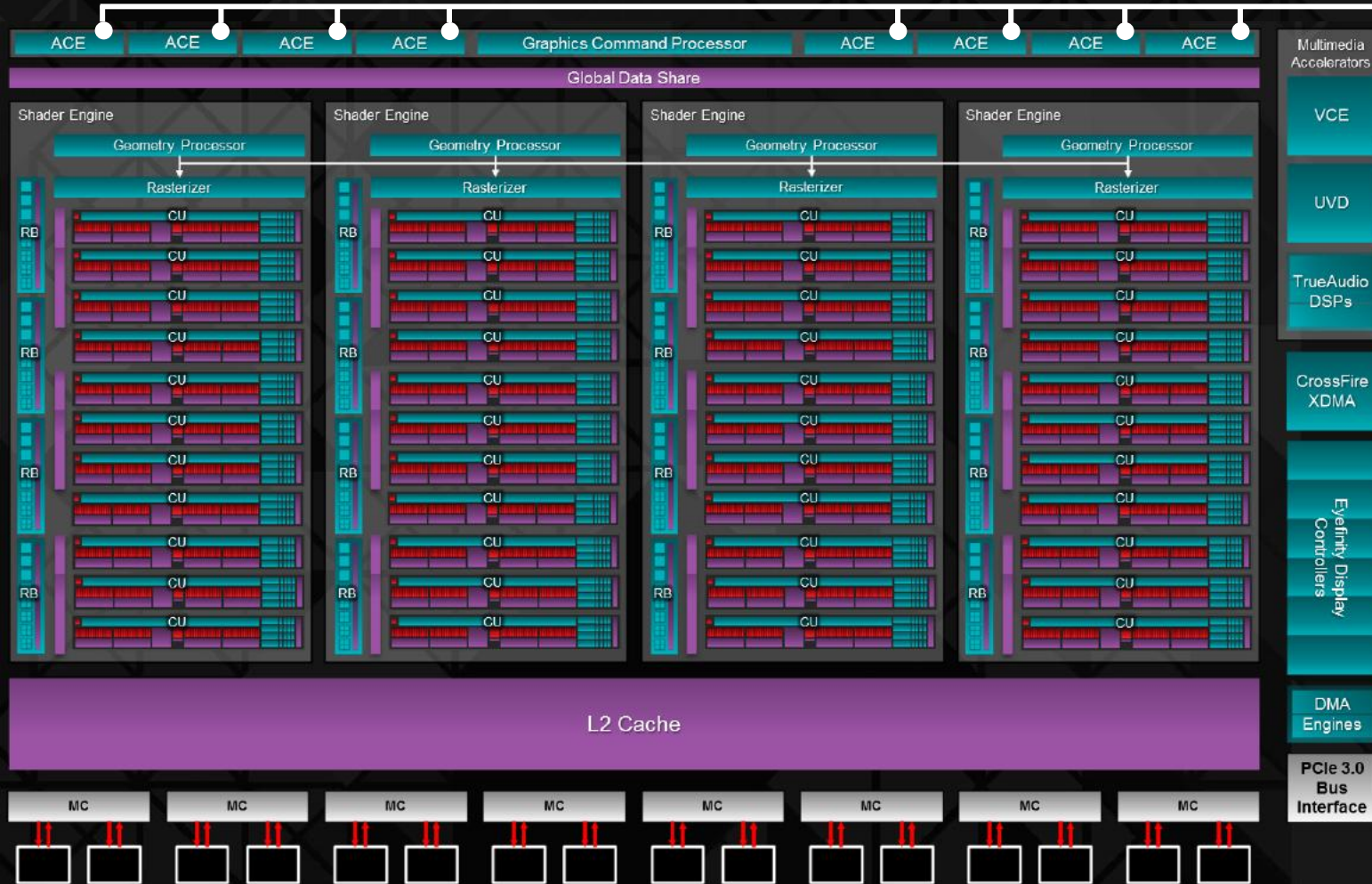
JOHN KLOETZLI, PRINCIPAL GFX PROGRAMMER, FIRAXIS GAMES



Next-gen graphics APIs like DirectX 12 and Vulkan, along with AMD hardware async shader support, give game developers the ability to fill these "cracks" in GPU utilization with useful non-rendering work such as physics, skinning, particle simulations, or game-specific solutions like the VBR (Variable Bit Rate) texture decompression technology we have in the Civilization engine. Since these tasks can fit 'in-between' existing graphics tasks they can be used to add more game features without affecting performance or to increase efficiency by performing existing work in parallel with rendering.

ASYNCHRONOUS COMPUTE ENGINES

OPTIMIZED HARDWARE FOR ASYNC SHADERS



- ▲ These are Asynchronous Compute Engines
- ▲ There are several of these in every GPU based on AMD's Graphics Core Next architecture
- ▲ ACEs are designed to accelerate workloads containing compute+graphics—like games with async shaders!

AMD Radeon™ R9 290X Graphics Card



GCN
ARCHITECTURE

GAME DEVS & ASYNC SHADERS

JAYMIN KESSLER, SENIOR PROGRAMMER, Q-GAMES

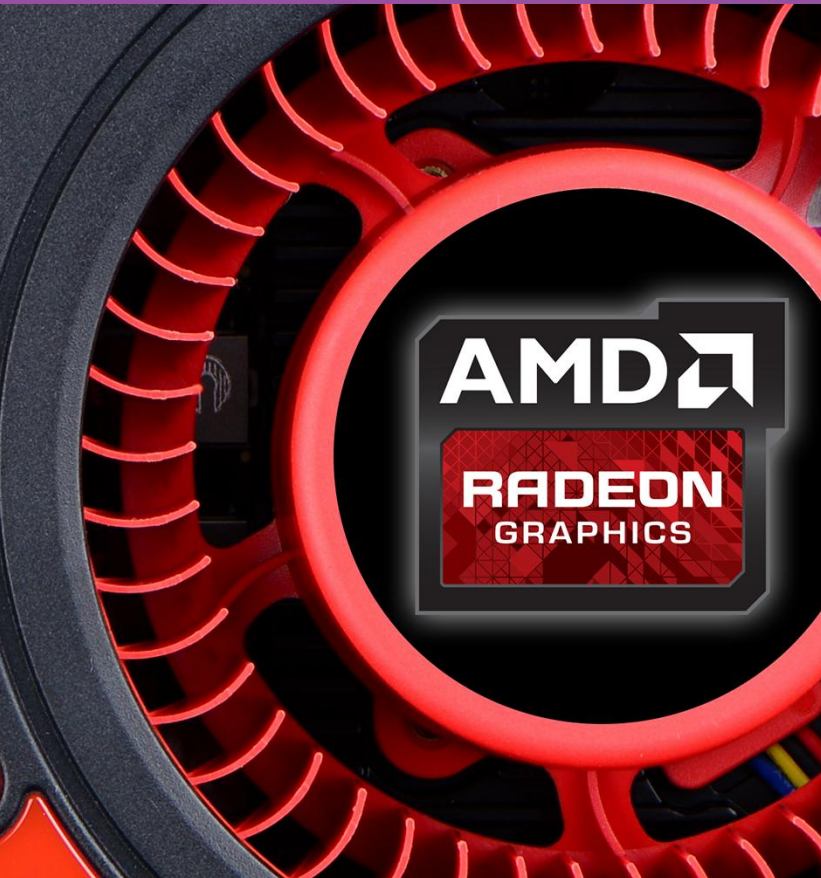


At Q-Games, we tend to shy away from traditional hyper realistic rendering styles. On The Tomorrow Children, the flexibility offered by moving the bulk of our rendering work to compute was just too great not to take advantage of. The combination of asynchronous compute filling in the gaps between graphics shaders, and the fine grained control GCN gives over work scheduling and wavefront limits means we saved between 6 and 9 milliseconds in our frame. It really made a lot of things possible that would have been incredibly difficult otherwise.

POTENTIAL BENEFITS FOR GAMERS



EXPLICIT MULTIADAPTER



MULTI-GPU PERFORMANCE ↑

HIGHER FPS

- ▲ Native support for multi-GPU now in DirectX® for the first time
- ▲ Precise dev control over app workloads to better parallelize rendering
- ▲ Precise dev control over hardware to extract higher utilization/performance

NEW MULTI-GPU CONFIGS

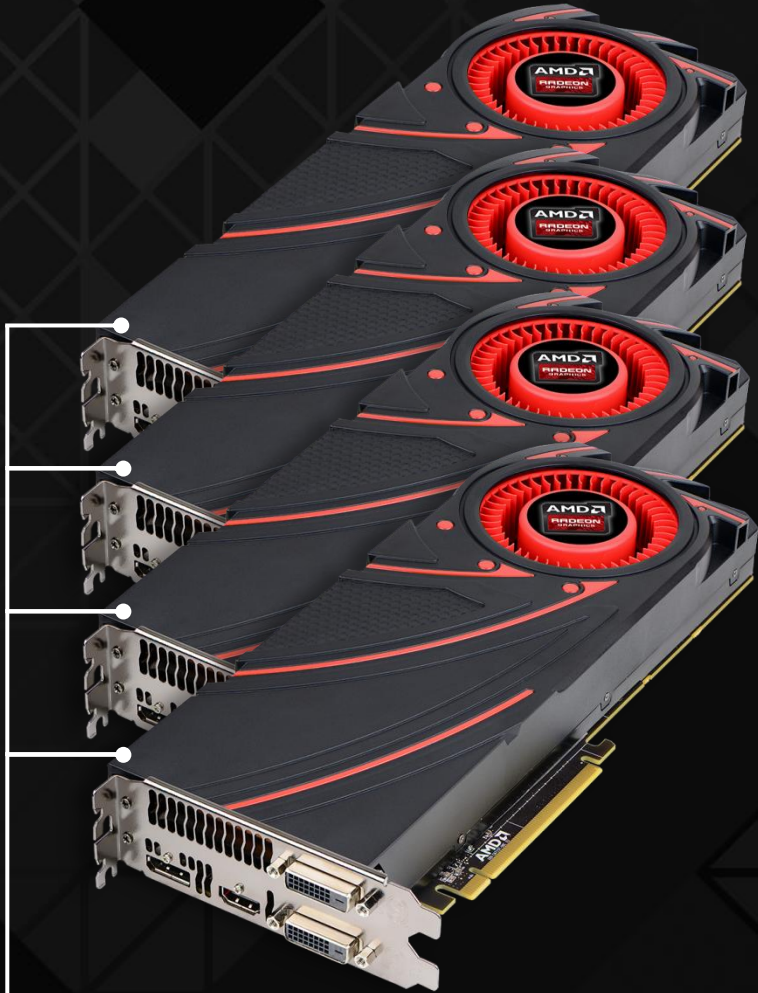
- ▲ DirectX®-standardized support for APU + GPU solutions

NEW WAYS TO RENDER

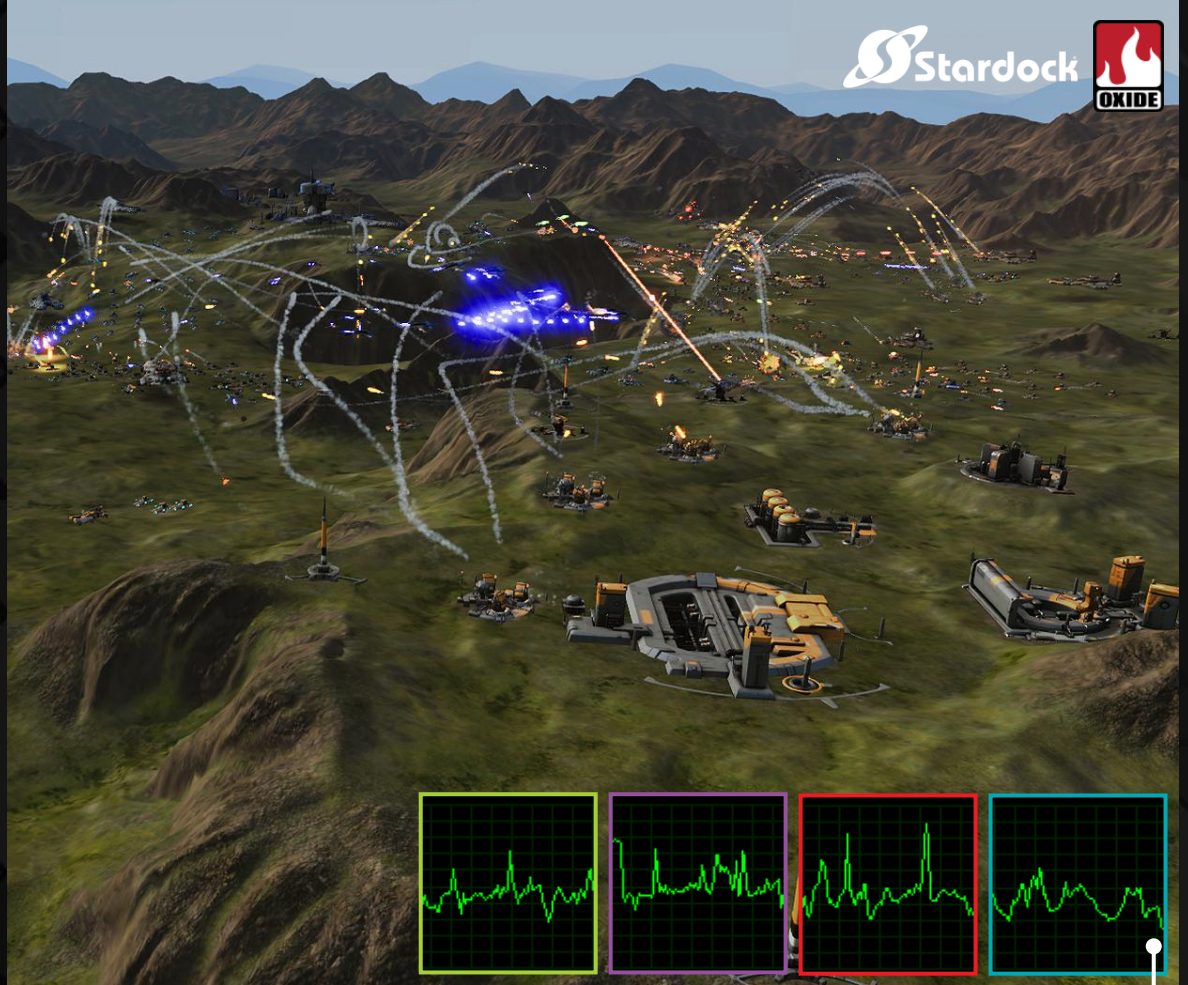
- ▲ Split-frame rendering (SFR) brings low latency to multi-GPU
- ▲ Now possible to combine GPU memory pools

NATIVE MULTI-GPU SUPPORT

NEW TO DIRECTX® IN DIRECTX® 12



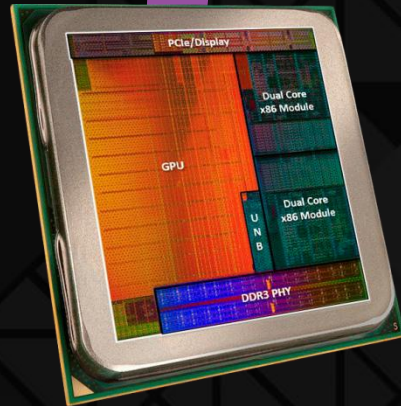
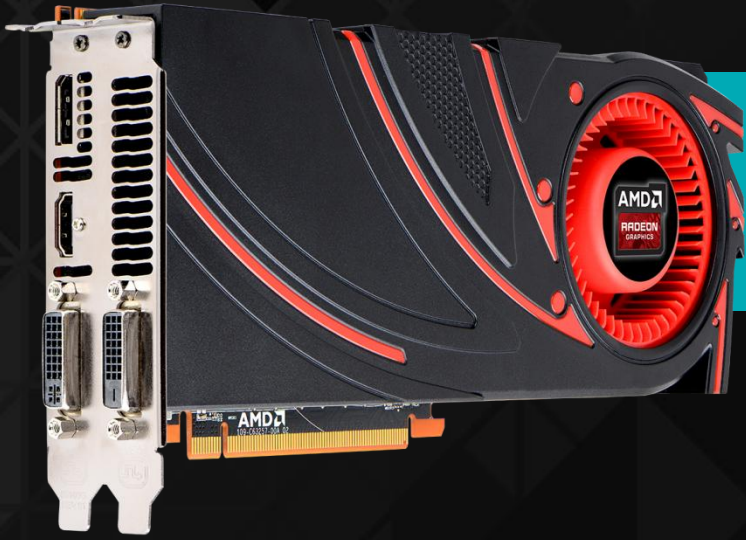
DIRECT CONTROL OF GPU RESOURCES
EASIER FOR DEVS TO EXTRACT PEAK PERFORMANCE



FINE CONTROL OVER APP GRAPHICS THREADS
EASIER FOR DEVELOPERS TO DISTRIBUTE WORK ACROSS GPUS

AMD RADEON™ DUAL GRAPHICS TECHNOLOGY⁷

APU+GPU NATIVELY SUPPORTED BY DIRECTX® 12



CREATE SHADOWS

BUFFER
LIGHT/MATERIAL
INTERACTIONS

GEN
("ENV

UPLOAD DATA FROM PROCESSOR

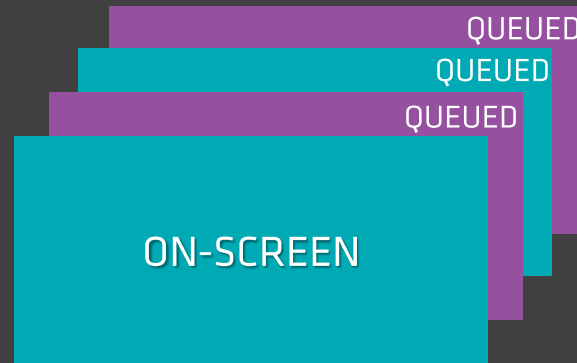
COMPRESS TEXTURES

COM

DEVS CAN
OFFLOAD GRAPHICS WORK
TO AN AMD APU

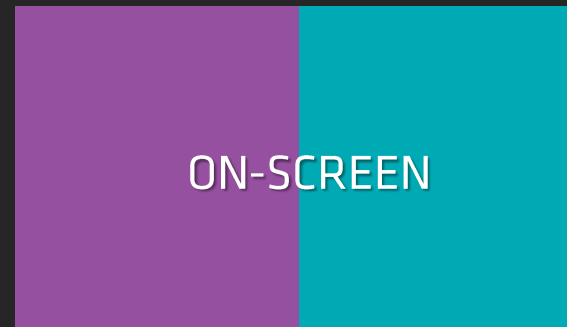
SPLIT-FRAME RENDERING

SUPREMELY RESPONSIVE MULTI-GPU GAMING



DIRECTX® 11

- ▲ Multi-GPU uses alternate-frame rendering (AFR)
- ▲ GPU_A renders even frames, GPU_B renders odd
- ▲ As a frame is shown to the user, the other GPU is already placing a new frame into a queue
- ▲ Preparing multiple frames in a queue raises FPS, but reduces game responsiveness as the frames wait in line



DIRECTX® 12

- ▲ New mode available to devs: split-frame rendering (SFR)
- ▲ Each frame of a game is split into a tile
- ▲ Each GPU in the system renders one tile
- ▲ Frames no longer need to be queued; time between frame completion and user viewing reduced by 2-3x
- ▲ Using the GPUs in parallel to work on one frame allows multiple GPUs to behave like one much more powerful GPU

DID YOU KNOW?

AMD pioneered SFR for the modern era with Mantle. It was used in Sid Meier's Civilization®: Beyond Earth™.

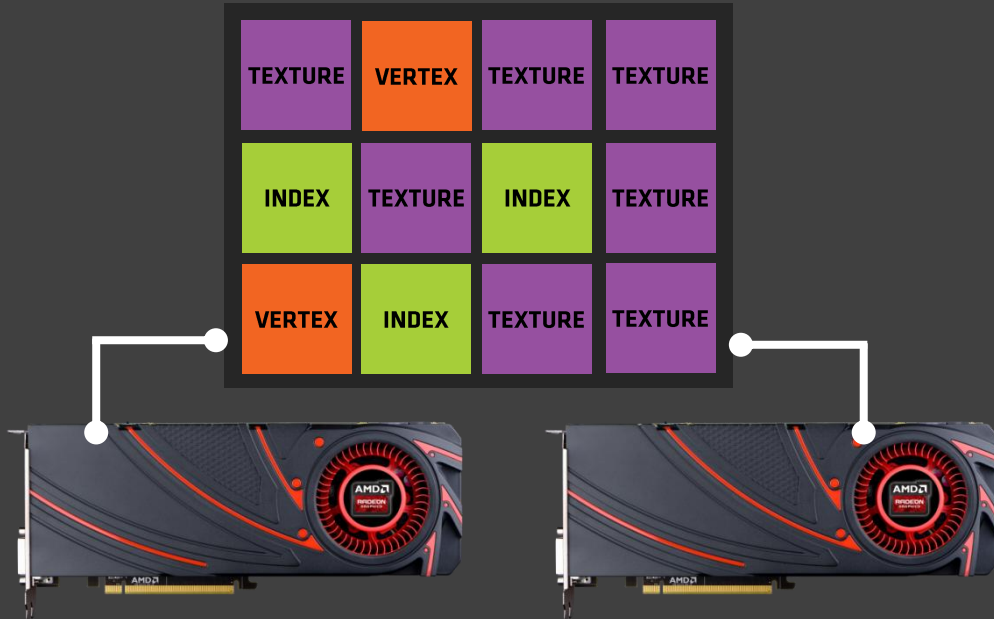
COMBINED MEMORY POOLS

POSSIBLE WITH DIRECT HARDWARE CONTROL



MULTI-GPU ON DIRECTX® 11

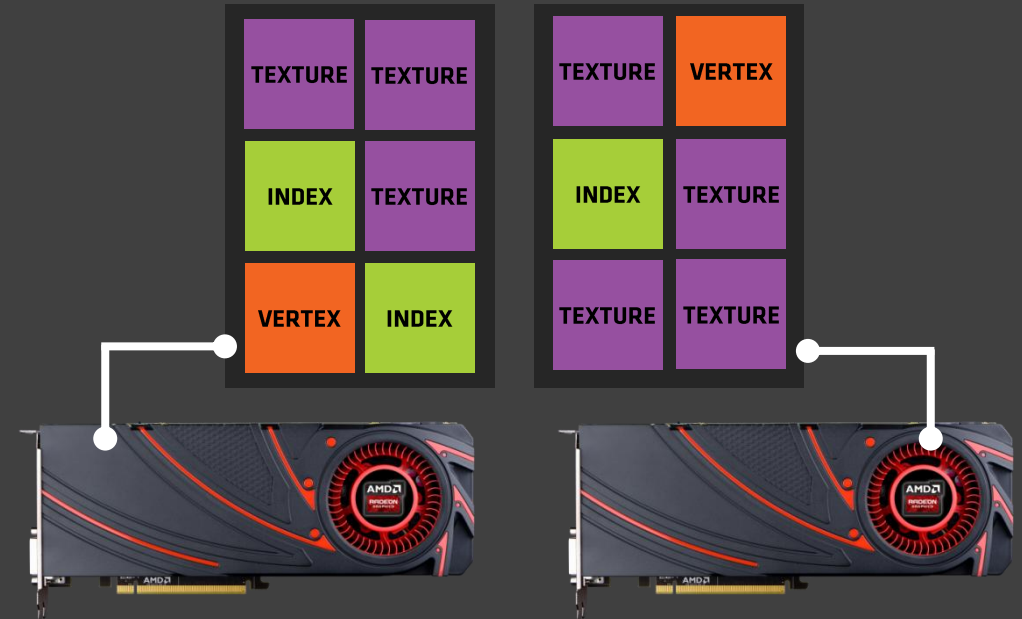
4GB+4GB=4GB



DirectX® 11 AFR forces each GPU to maintain a copy of the same data in RAM to ensure the GPUs remain synchronized. There are no mechanisms to better divide and assign a game's workload. This is what prevents games from combining GPU memory into one larger pool.

MULTI-GPU ON DIRECTX® 12

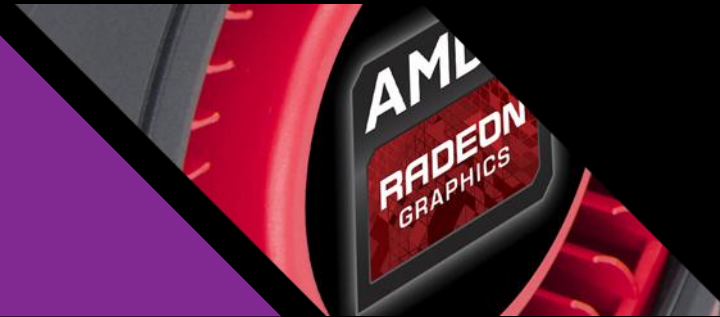
4GB+4GB=8GB



DirectX® 12 explicit multiadapter allows developers to individually see and control available GPU hardware, along with what gets allocated to that hardware. This can allow each GPU to offer its full memory for use, enabling interesting multi-GPU use cases beyond AFR or SFR.



*Enabling today.
Inspiring tomorrow.*

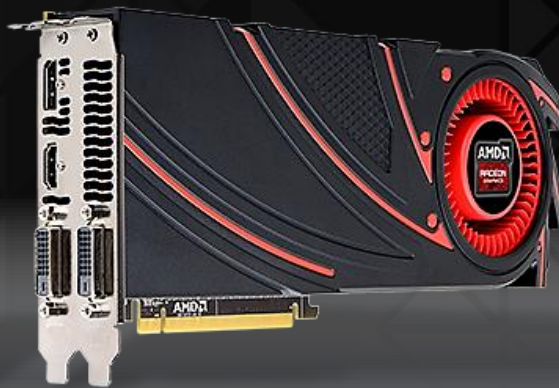


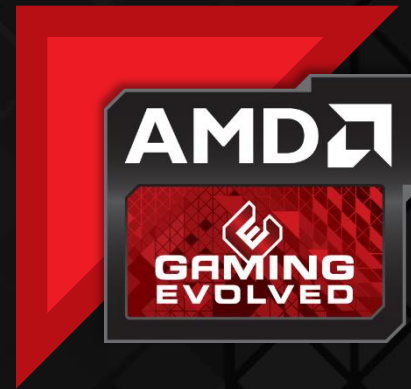
GAMES AND HARDWARE 



DIRECTX[®] 12-READY FOR GAMERS

- Little gaming PCs ▲
- Big gaming PCs ▲
- Cheap gaming rigs ▲
- Extreme gaming rigs ▲
- Laptops big & small ▲
- Xbox One[™] ▲
- Tablets ▲
- & MORE ▲





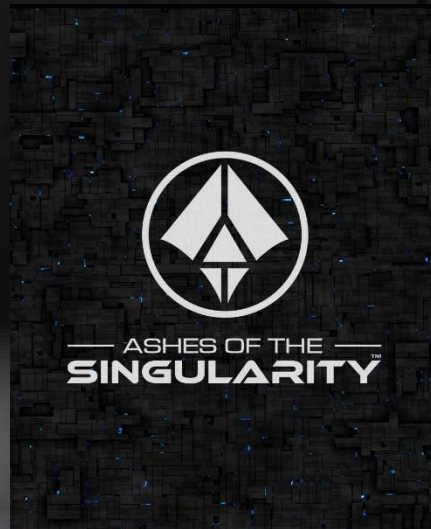
DIRECTX® 12-READY

GAMES OPTIMIZED FOR AMD

Deus Ex: Mankind Divided™ ▲

Ashes of the Singularity ▲

Many more TBA ▲





DEUS EX

MANKIND DIVIDED™

OPTIMIZED FOR GRAPHICS CORE NEXT

- ▲ Built with the Dawn Engine™
 - ▲ Supports DirectX® 12
 - ▲ Features TressFX Hair 3.0
 - ▲ More features TBA
- ▲ [Watch the trailer](#)
- ▲ [Visit the website](#)





ASHES OF THE
SINGULARITY™

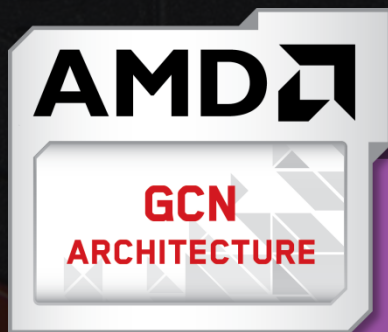
OPTIMIZED FOR GRAPHICS CORE NEXT

- ▲ Built with the Nitrous® Engine
- ▲ Supports DirectX® 12
- ▲ Supports Mantle
- ▲ MT Command Buffer Recording
- ▲ More features TBA
- ▲ [See the gameplay](#)
- ▲ [Visit the website](#)



 **Stardock**





DIRECTX® 12-READY

IT'S THAT SIMPLE

MULTI-THREADED COMMAND BUFFER

Fully utilize multi-core processors for better framerates, better performance-per-watt, and higher image quality.

ASYNC SHADERS

Allow GPU compute and graphics hardware to run simultaneously, improving GPU utilization and framerates.

EXPLICIT MULTIADAPTER

Provide precise control over the resources of multiple GPUs to improve the performance or flexibility of multi-GPU systems.

* DirectX® 12 enablement requires Windows 10 Technical Preview (or later) and AMD Catalyst™ 15.20 (or later) from Windows Update

FOOTNOTES



1. SLIDE 11: AMD FX-8350, AMD Radeon™ R9 290X, Gigabyte 990FXA-UD5, 8GB DDR3-1866, Windows® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012. DirectX® 11 multi-threaded vs. DirectX® 12 multi-threaded. 3840x2160 resolution.
2. SLIDE 13: Core i7-4960X, Asus X79 Sabertooth, 16GB DDR3-1866, Windows 10® Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012. DirectX® 11 multi-threaded vs. DirectX® 12 multi-threaded. 1920x1080 resolution.
3. SLIDE 14: Core i7-4960X, Asus X79 Sabertooth, 16GB DDR3-1866, Windows 10® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012, ForceWare 349.90. DirectX® 12 multi-threaded. 3840x2160 resolution.
4. SLIDE 15: AMD A10-7850K, Asus A88X-Pro, 8GB DDR3-1866, Windows® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012. DirectX® 11 multi-threaded vs. DirectX® 12 multi-threaded. 1920x1080 resolution.
5. SLIDE 16: AMD A10-7850K/Asus A88X-Pro/16GB DDR3-2133, i5-4460/Gigabyte Z97X-UD3H/8GB DDR3-1600, Windows® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012. Intel driver 10.18.15.4124. DirectX® 12 multi-threaded. 1920x1080 resolution.
6. SLIDE 21: AMD FX-8350, Gigabyte 990FXA-UD5, AMD Radeon™ R9 290X GPU, 8GB DDR3-1866, Windows® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.20.1012. Async Shaders Off: 221 FPS Average. Async Shaders On: 250 FPS Average.
7. AMD Radeon™ Dual Graphics requires one of select AMD A-Series APUs plus one of select AMD Radeon™ discrete graphics cards and is available on Windows® 7 and/or Windows 8 OS. Linux OS supports manual switching which requires restart of X-Server to engage and/or disengage the discrete graphics processor for dual graphics capabilities. With AMD Radeon™ Dual Graphics, full enablement of all discrete graphics video and display features may not be supported on all systems and may depend on the master device to which the display is connected. Check with your component or system manufacturer for specific mode capabilities and supported technologies.

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