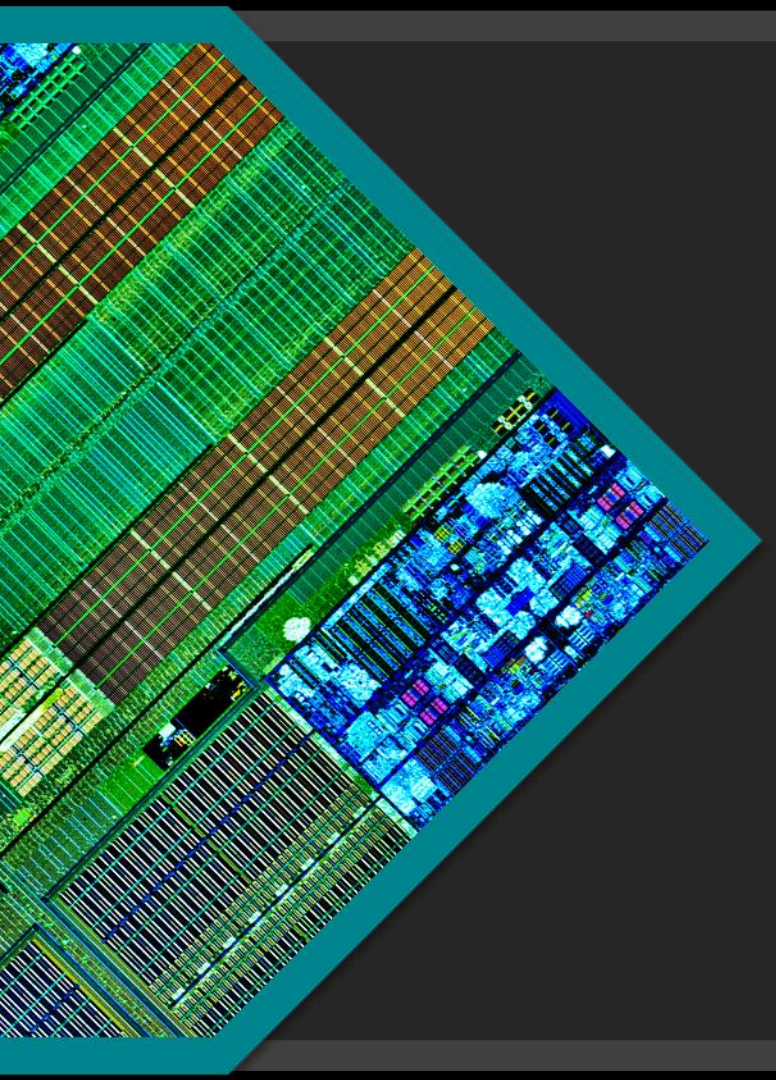
DIRECTX® 12
GRAPHICS API

APPROVED FOR ALL AUDIENCES



THE INDUSTRY PROBLEM

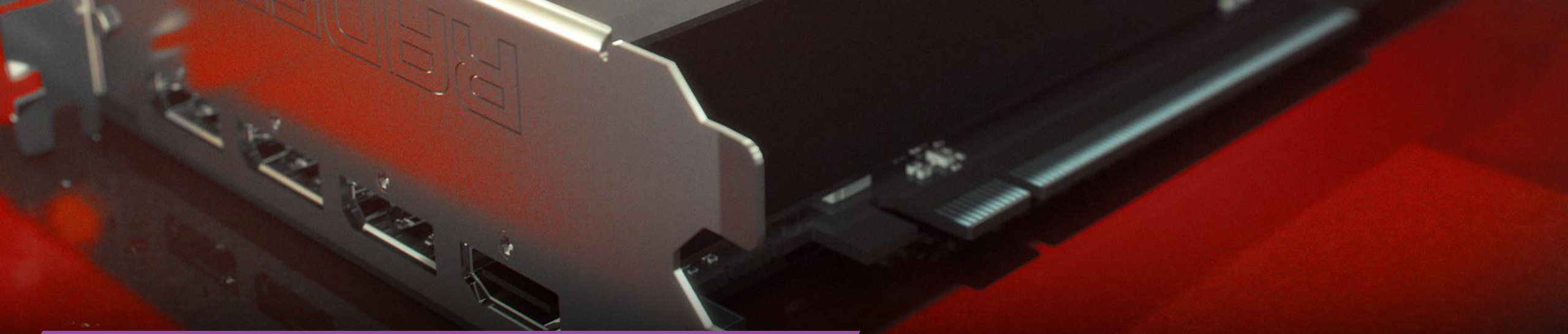
- Modern CPUs unable to keep up with performance growth of graphics cards
- API/driver overhead serious problem; preventing new game designs from being explored
- Developers want direct hardware access to recover performance lost or obscured by past graphics APIs

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.

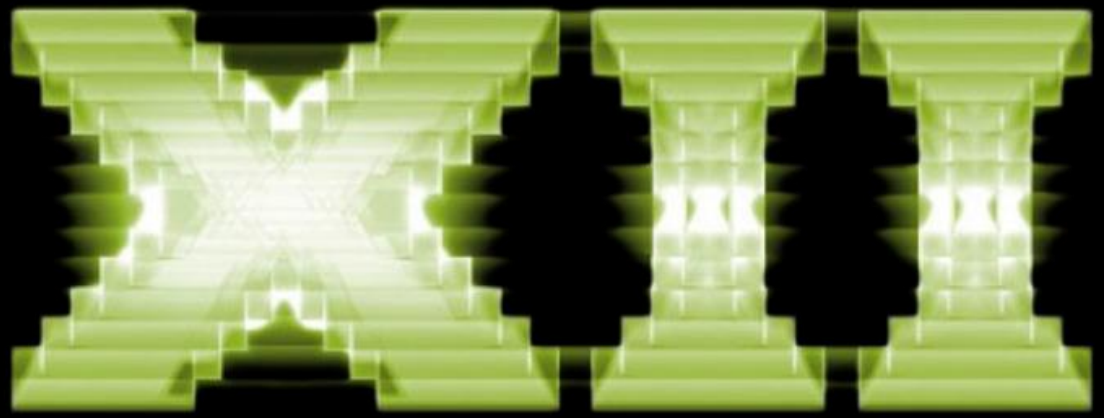
Let's take a pause here. I want you to think about that for a moment. Think about how limiting that is. Think about how limiting that has been for game developers. How long has your computer been multi-core?"

SOURCE: Brad Wardell, Stardock Corporation



DIRECTX® 12

CONSOLE-LIKE API FOR PC GRAPHICS



POTENTIAL BENEFITS
of the DirectX® 12 graphics API

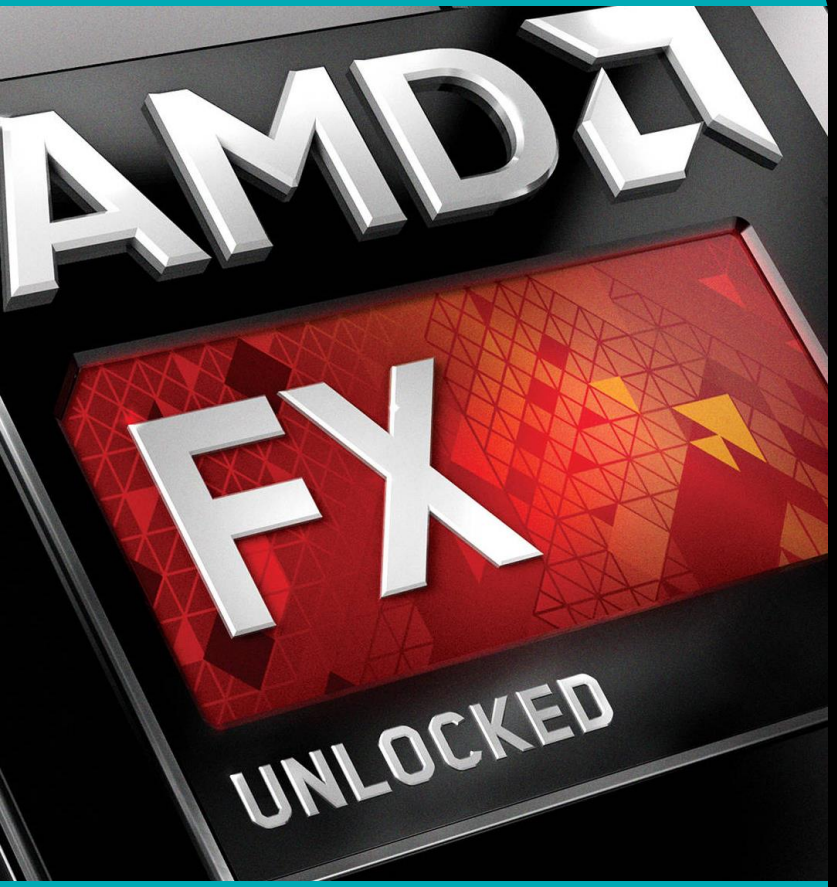
- Better use of multi-core CPUs
- More on-screen detail
- Higher min/max/avg framerates
- Smoother gameplay
- More efficient use of GPU hardware
- Reduced system power draw

…AND GAMES THAT WERE ONCE IMPOSSIBLE

TOP FEATURES OF DIRECTX® 12

AMD

MULTI-THREADED COMMAND BUFFERS



MULTI-CORE CPU PERFORMANCE ↑

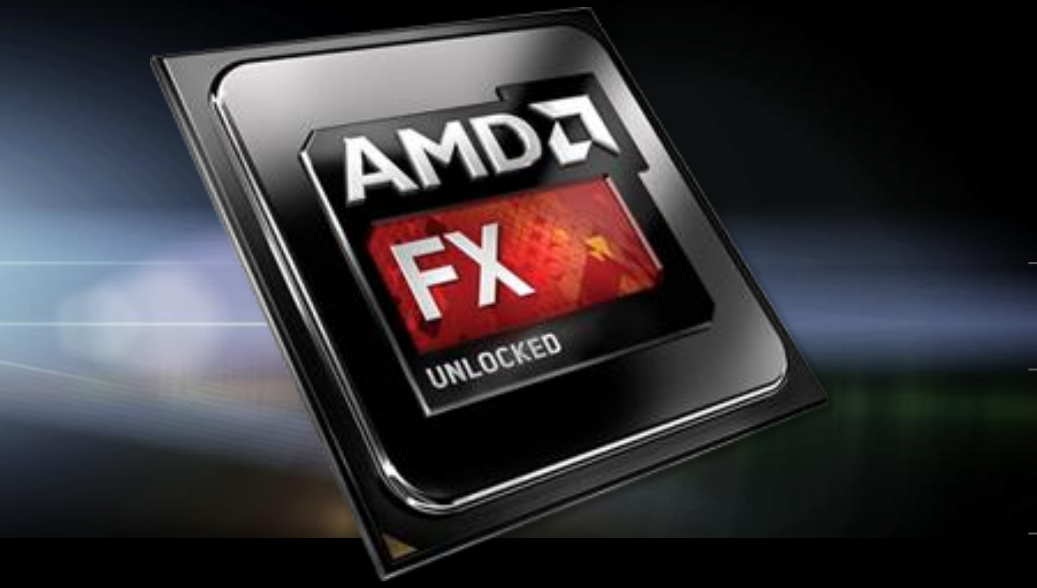
ASYNC SHADERS

GPU PERFORMANCE ↑

EXPLICIT MULTIADAPTER

MULTI-GPU PERFORMANCE ↑

MULTI-THREADED COMMAND BUFFERS
POTENTIAL BENEFITS FOR GAMERS



MULTI-CORE CPU PERFOMANCE ↑

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

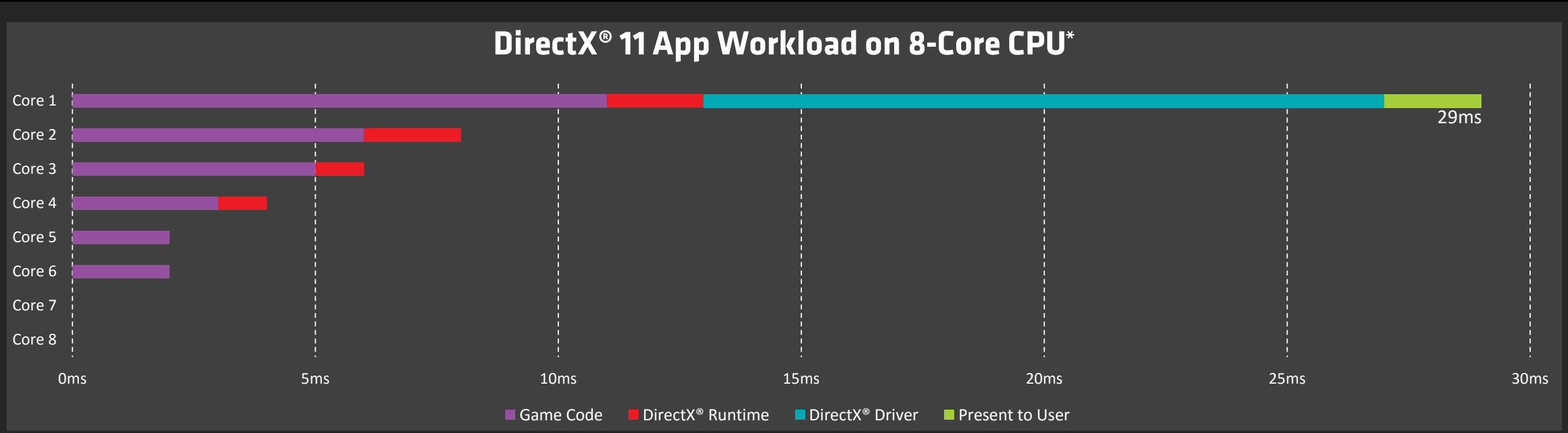
- Game performance largely determined by user's GPU

PERFORMANCE PER WATT

- Doing more work for gamers on the same power draw

COMMAND BUFFER BEHAVIOR IN DIRECTX® 11

AMD



- Frame rendered in 29ms
- 29ms = 34 frames per second
- Cores 7 and 8 unused

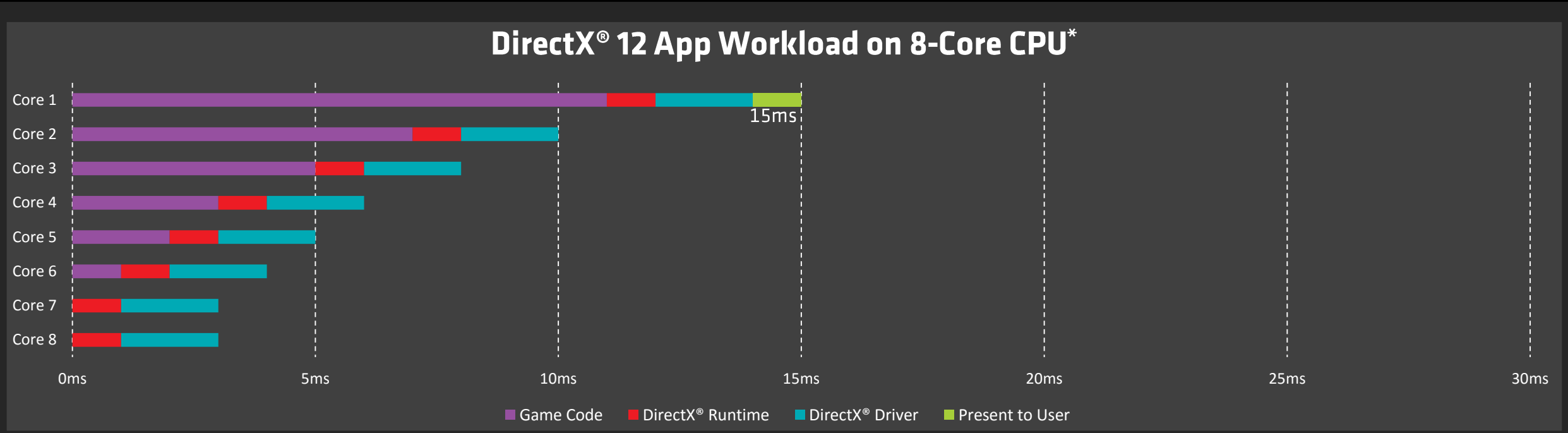
- Core 1 overloaded with most of the work
- DirectX® work (red/blue) consumes disproportionate time
- This is “high API overhead”

Q: What is a command buffer?
A: A list of things for the CPU to do when running a game. Lighting, characters, etc.

** Chart for illustrative purposes only.*

COMMAND BUFFER BEHAVIOR IN DIRECTX® 12

AMD



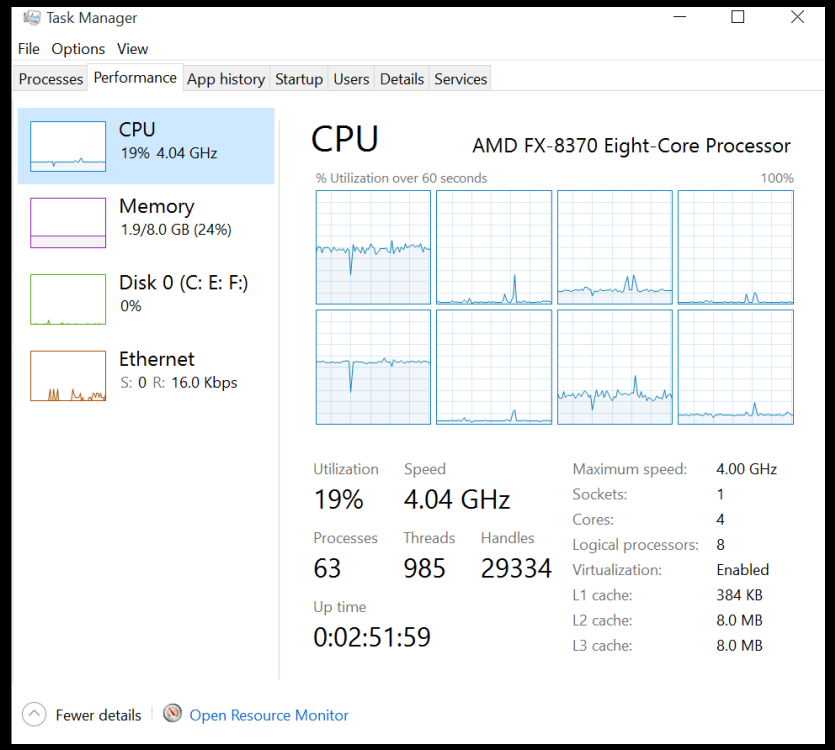
- Frame rendered in 15ms
- 15ms = 66 frames per second
- All 8 cores utilized
- Work distributed across cores
- DirectX® work (red and blue) very modest vs. game code
- This is “low API overhead”

Q: What is a command buffer?
A: A list of things for the CPU to do when running a game. Lighting, characters, etc.

** Chart for illustrative purposes only.*

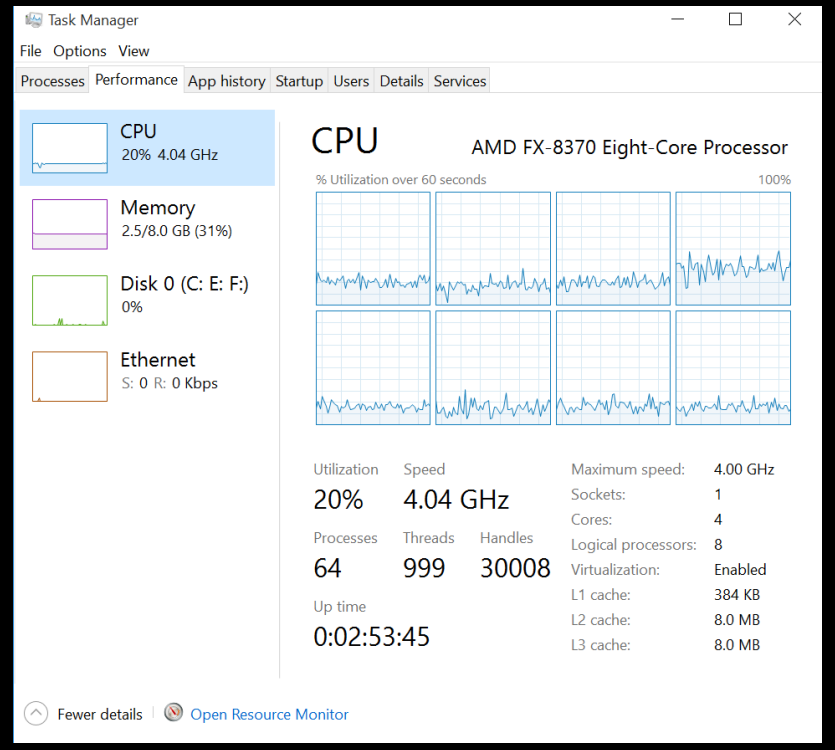
FABLE LEGENDS & DIRECTX® 12: 8-CORE SCALING

AMD FX-8370 Eight-Core Processor



DIRECTX® 11

- Three CPU cores disproportionately utilized
- *Five* CPU cores underutilized or idle
- High probability of resource conflicts on overused CPU cores



DIRECTX® 12

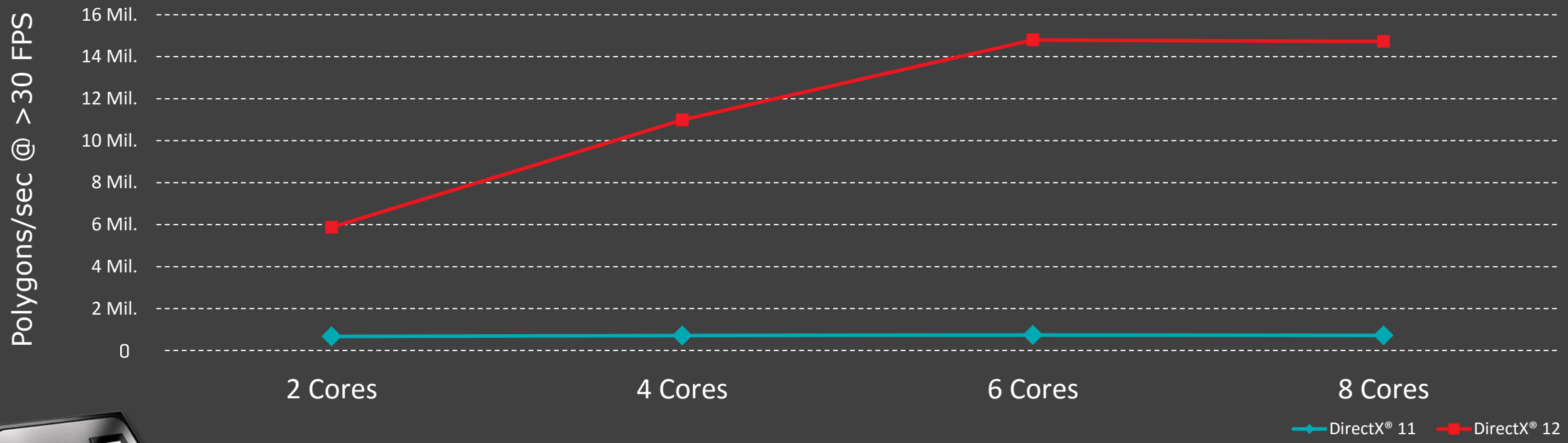
- Consistent utilization across 8 cores
- Significant parallelization of workload
- Wider flow of information to the GPU
- Reduced risk of traffic jams on cores

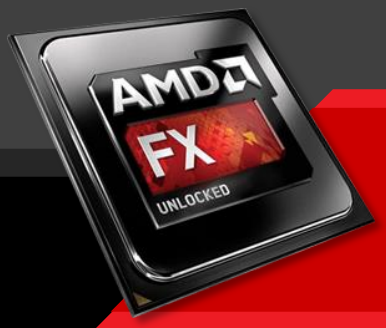
DIRECTX® 12 MULTI-CORE SCALING

3DMARK® API OVERHEAD FEATURE TEST

AMD

INCREASING DETAIL WITH CORES



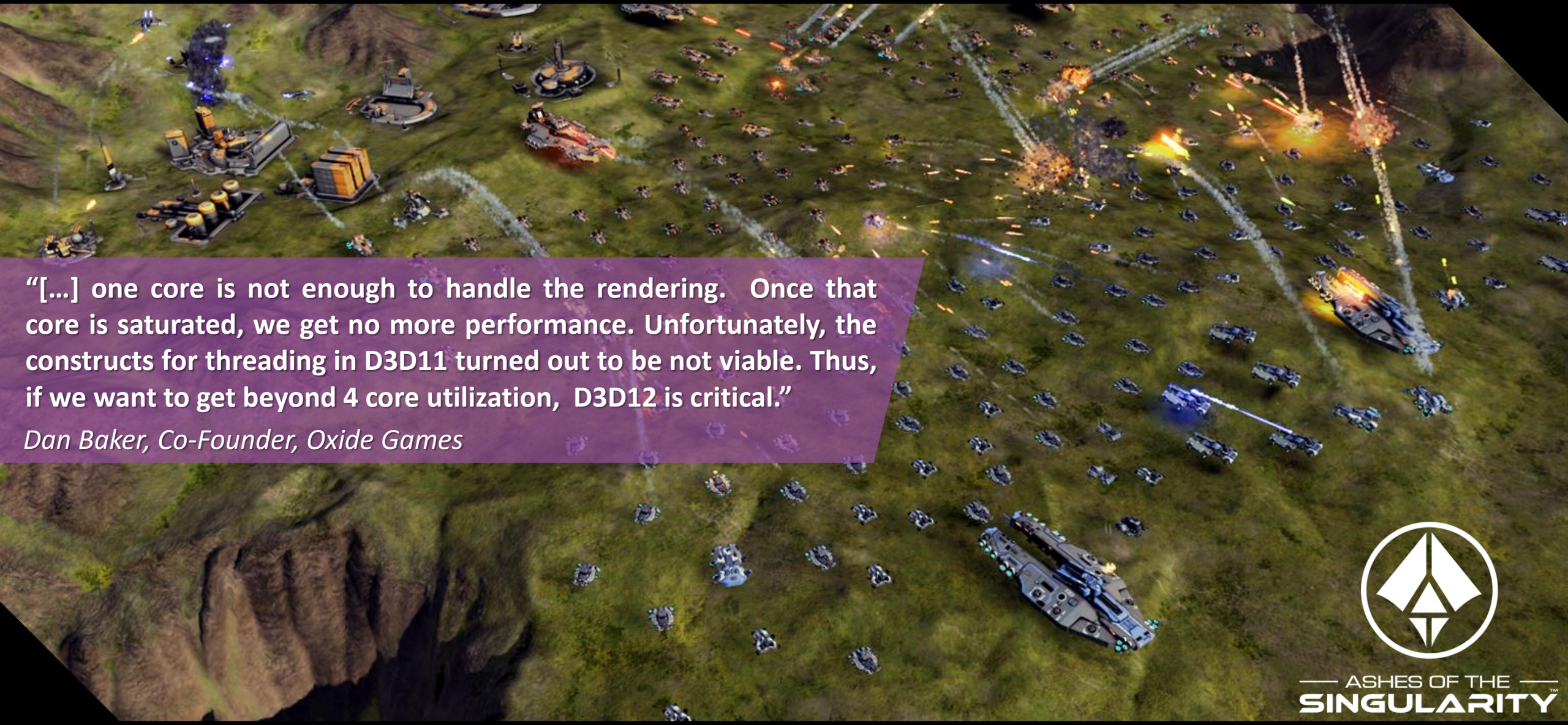


AMD FX-8370

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

** Average gain. Performance plateau characteristic of application workload. See slide 41 for system configuration.*

MULTI-THREADING IN DIRECTX® 12



ASYNC SHADERS
POTENTIAL BENEFITS FOR GAMERS

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

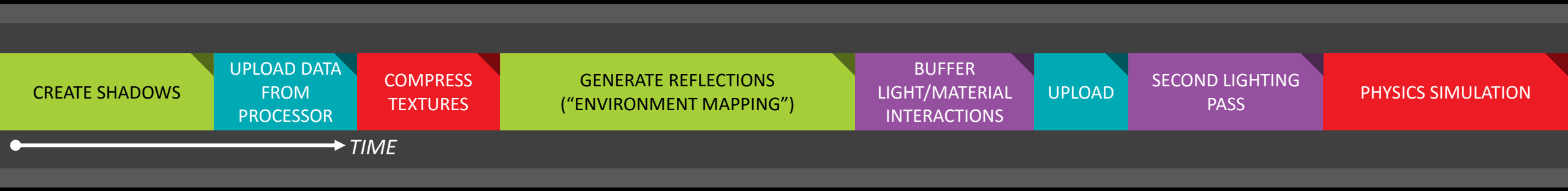
GREAT FOR VR

- More parallelism = lower latency = more responsive VR

IMAGE QUALITY

- More performance = more headroom for new graphics effects

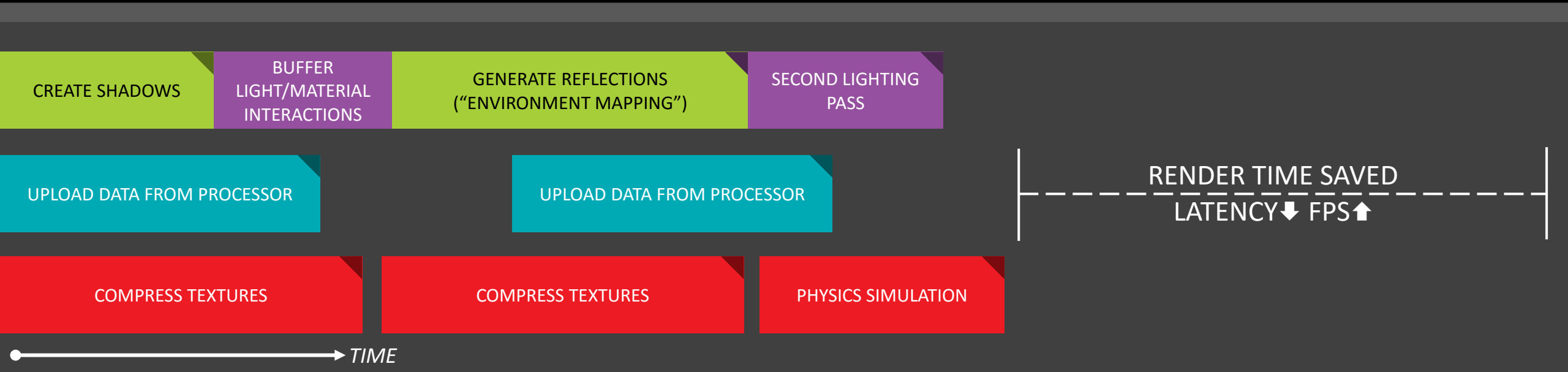
SYNCHRONOUS SHADING IN DIRECTX® 11



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

** Chart for illustrative purposes only.*

ASYNCHRONOUS SHADING IN DIRECTX® 12



THEY CAN IN DIRECTX® 12

& MORE THREADS = MORE DONE IN LESS TIME

** Chart for illustrative purposes only.*

GAME DEVS & ASYNC SHADERS

DAN BAKER, PARTNER, OXIDE GAMES

AMD

> 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

** Average FPS. See slide 41 for system config.*

GAME DEVS & ASYNC SHADERS

JOHN KLOETZLI, PRINCIPAL GFX PROGRAMMER, FIRAXIS GAMES

AMD

> 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

ONLY ON AMD RADEON™: HARDWARE FOR ASYNC SHADING

AMD Radeon™ R9 390X Graphics Card

- 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 GCN ARCHITECTURE

GAME DEVS & ASYNC SHADERS

JAYMIN KESSLER, SENIOR PROGRAMMER, Q-GAMES

AMD

> 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.

EXPLICIT MULTI-ADAPTER
POTENTIAL BENEFITS FOR GAMERS

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

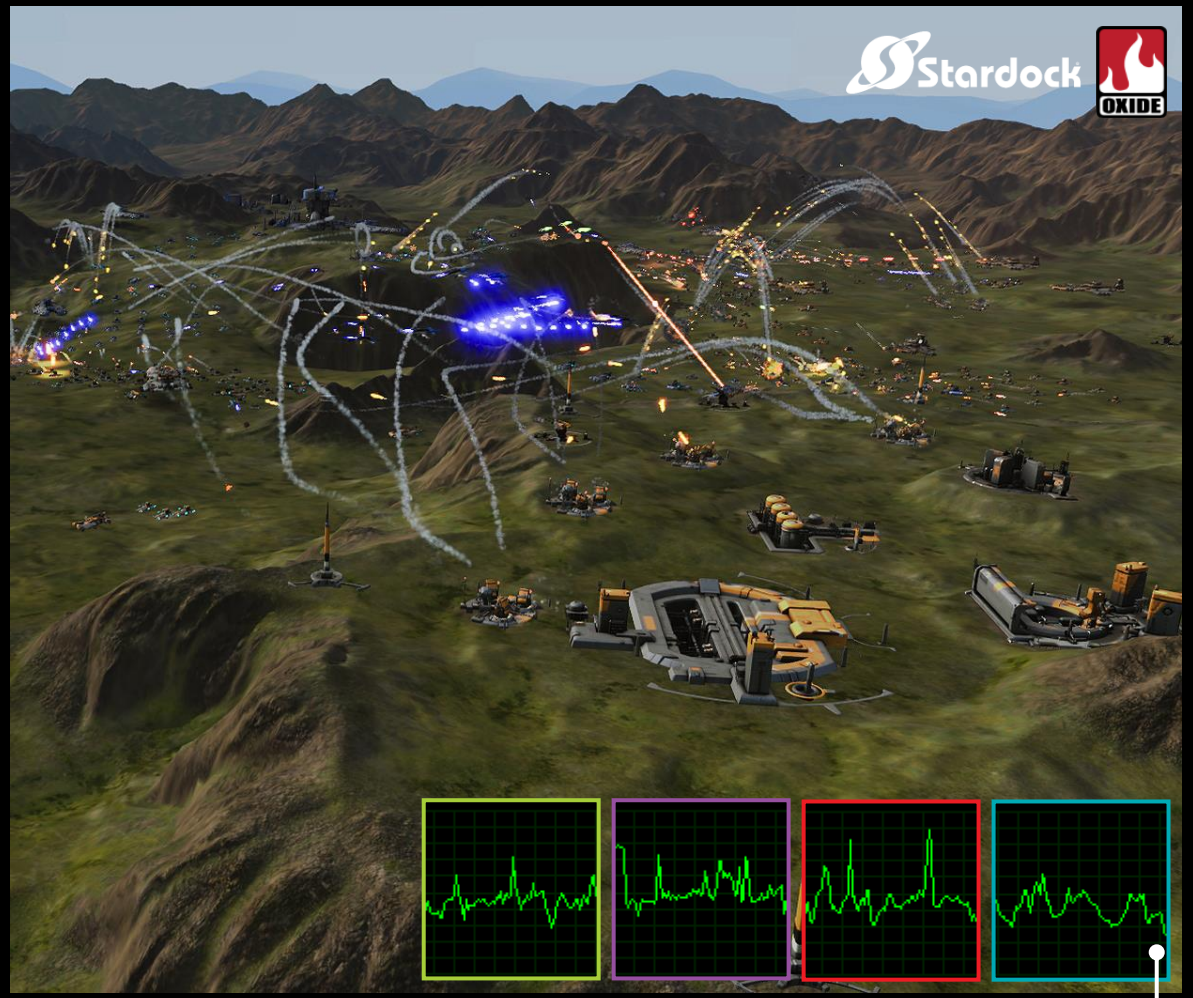
- Split-frame rendering (SFR) brings low latency to multi-GPU
- Now possible to combine GPU memory pools

NATIVE MULTI-GPU SUPPORT

NEW TO DIRECTX® IN DIRECTX® 12

DIRECT CONTROL OF GPU RESOURCES

EASIER FOR DEVS TO EXTRACT PEAK PERFORMANCE

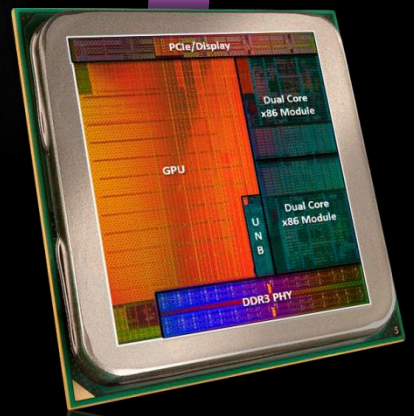


FINE CONTROL OVER APP GRAPHICS THREADS

EASIER FOR DEVELOPERS TO DISTRIBUTE WORK ACROSS GPUS

AMD RADEON™ DUAL GRAPHICS TECHNOLOGY[8]

APU+GPU NATIVELY SUPPORTED BY DIRECTX® 12



CREATE SHADOWS

BUFFER LIGHT/MATERIAL INTERACTIONS

GE
("ENV

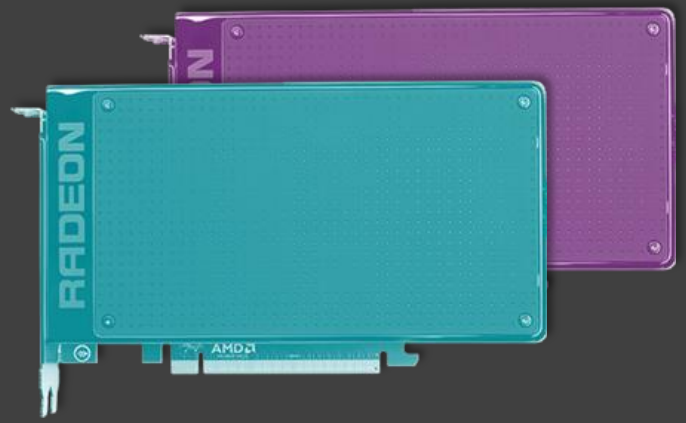
UPLOAD DATA FROM PROCESSOR

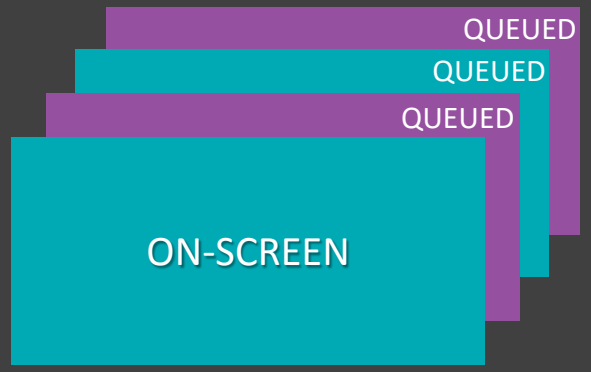
COMPRESS TEXTURES

CO

DEVS CAN
OFFLOAD GRAPHICS WORK
TO AN AMD APU

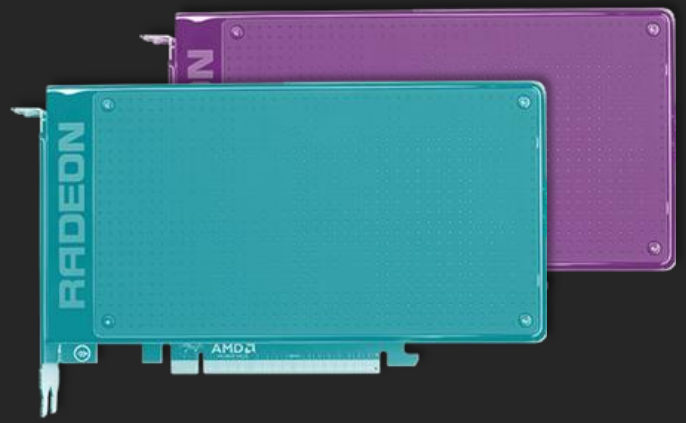
SPLIT-FRAME RENDERING
SUPREMELY RESPONSIVE MULTI-GPU GAMING

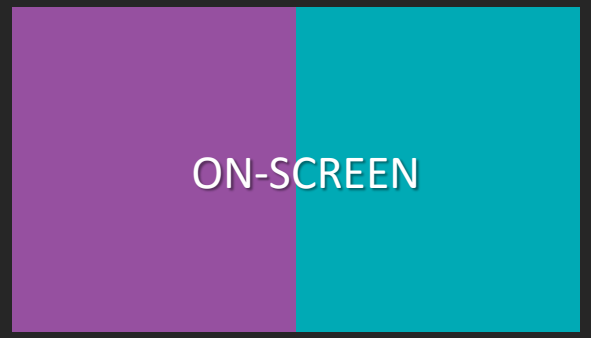




DIRECTX® 11

- 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





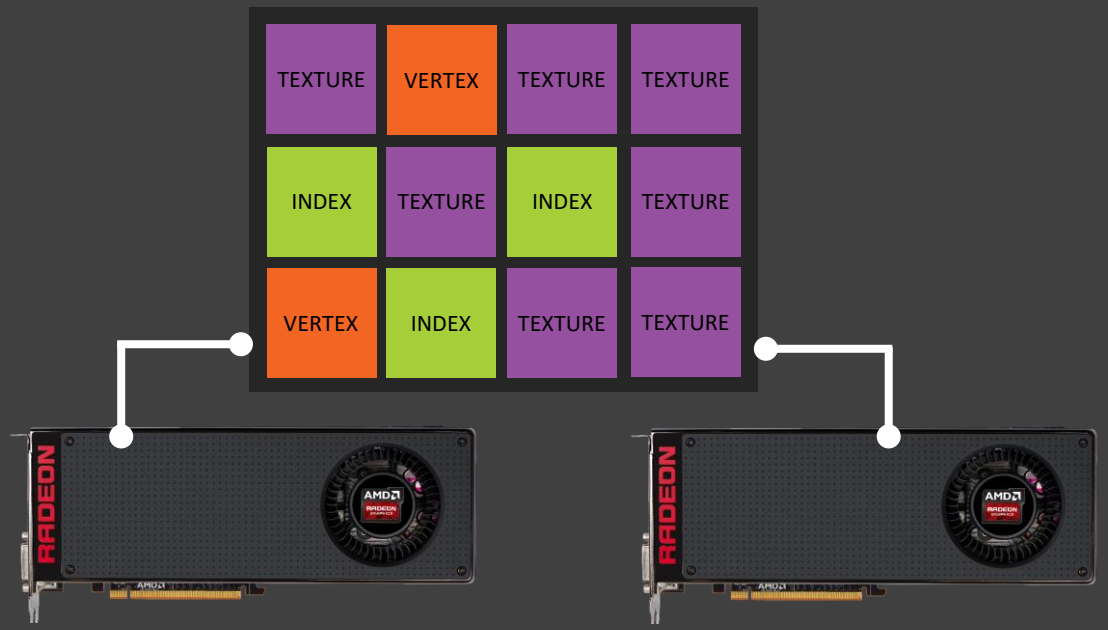
DIRECTX® 12

- 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™.

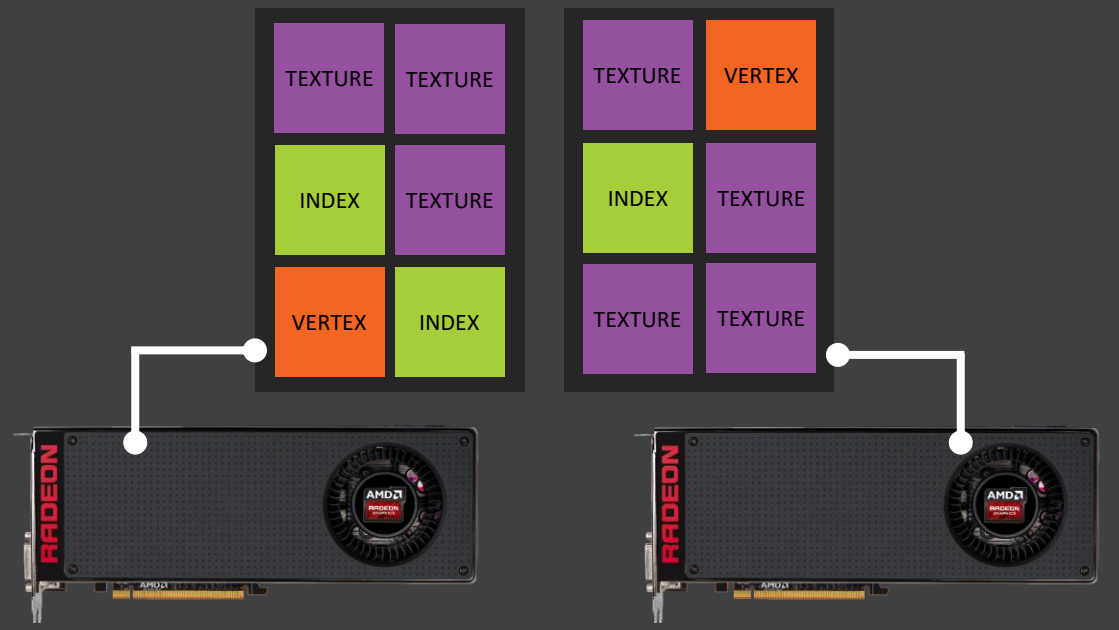
COMBINED MEMORY POOLS
POSSIBLE WITH DIRECT HARDWARE CONTROL

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.

AMD | Enabling today. Inspiring tomorrow.

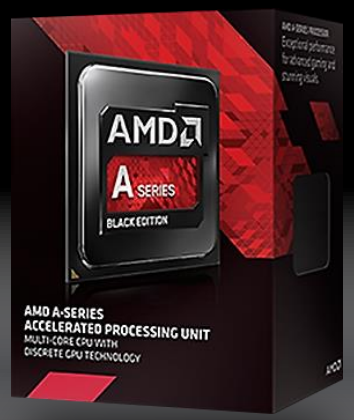
DIRECTX® 12
GAMES & HARDWARE

AMD

AMD GCN ARCHITECTURE

DIRECTX® 12-READY FOR GAMERS

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



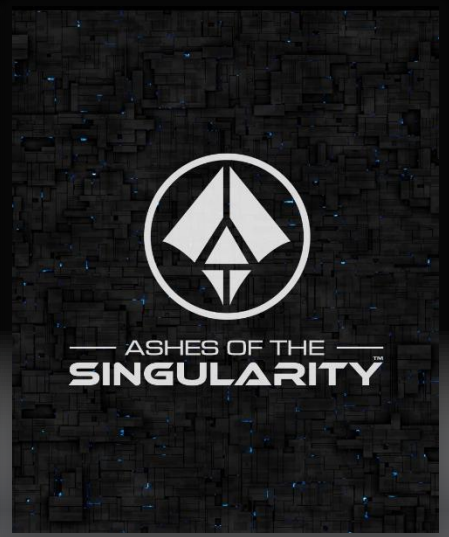
** DirectX® 12 enablement requires Windows 10 Technical Preview (or later) and AMD Catalyst™ 15.20 (or later) from Windows Update*

AMD

DIRECTX® 12-READY

GAMES OPTIMIZED FOR AMD

- Deus Ex: Mankind Divided™
- Ashes of the Singularity
- Many more TBA



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

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

OPTIMIZED FOR GRAPHICS CORE NEXT

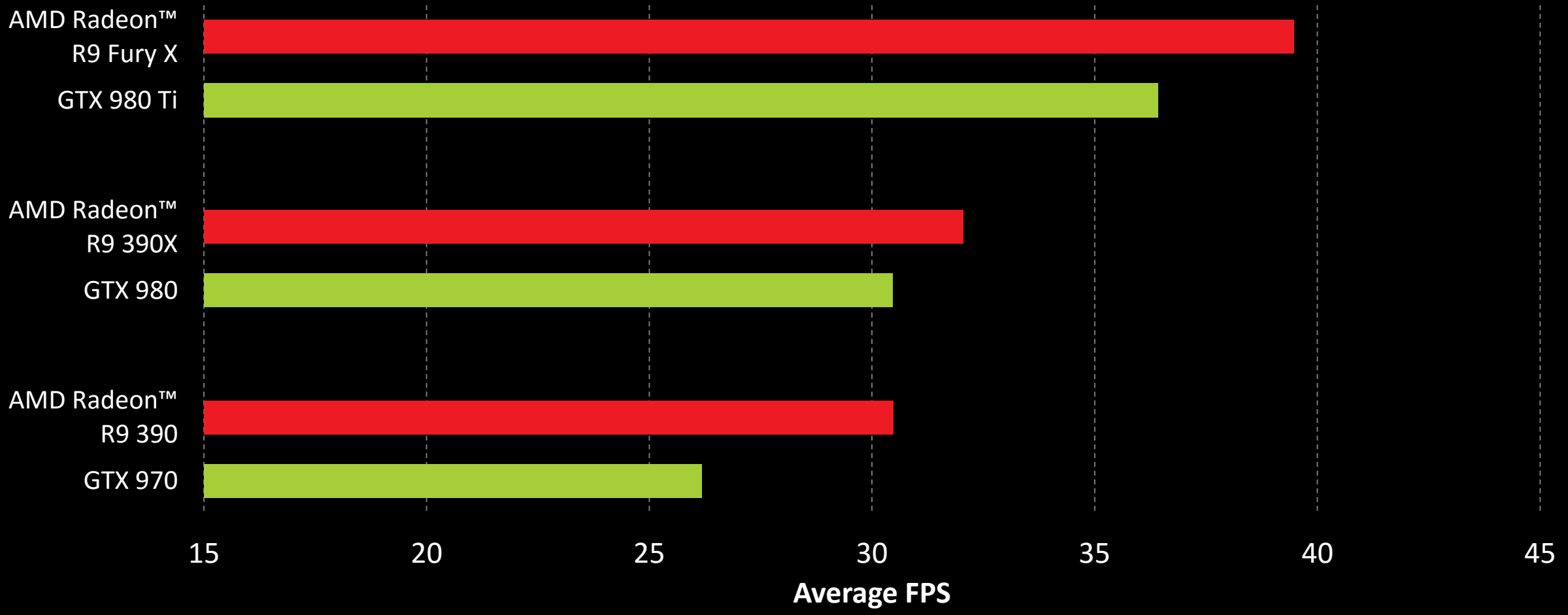
- Built with the Nitrous® Engine
  - Supports DirectX® 12
  - Supports Mantle
  - MT Command Buffer Recording
  - *More features TBA*
- See the gameplay
- Visit the website

Stardock

OXIDE

ASHES OF THE SINGULARITY

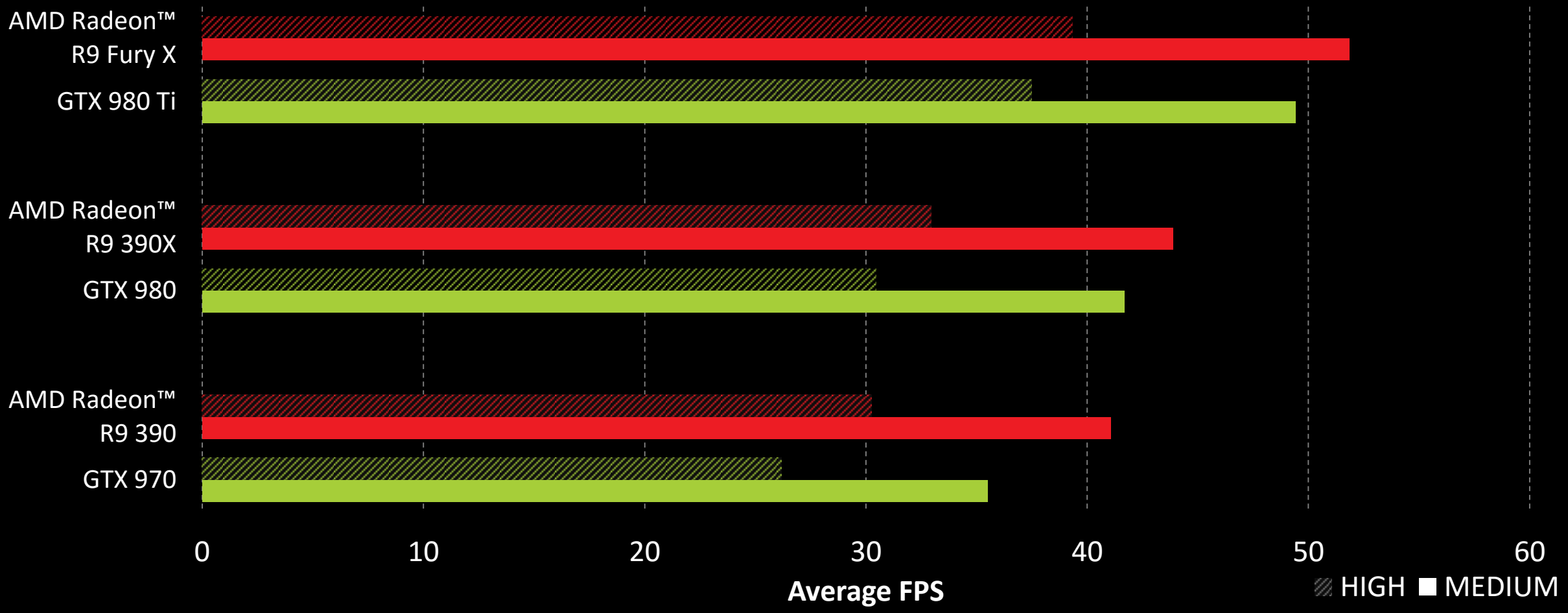
ULTRAHD 4K, MEDIUM PRESET, DIRECTX® 12



SYSTEM CONFIG:
Intel Core i7-5960X
Gigabyte X99-UD4
16GBG DDR4-2666
Windows 10 x64
AMD Catalyst™ 15.20.1061 Beta 3
NVIDIA 355.60 WHQL

ASHES OF THE SINGULARITY

1440p, MEDIUM & HIGH PRESETS, DIRECTX® 12



SYSTEM CONFIG:
Intel Core i7-5960X
Gigabyte X99-UD4
16GBG DDR4-2666
Windows 10 x64
AMD Catalyst™ 15.20.1061 Beta 3
NVIDIA 355.60 WHQL

- API Overhead Feature Test
  - Supports DirectX® 12, Mantle & DirectX® 11
  - Evaluates a GPU's geometric throughput ("scene detail") at >30 FPS
  - Multi-threaded command buffers
- See the trailer
- Visit the website
- Read the technical guide

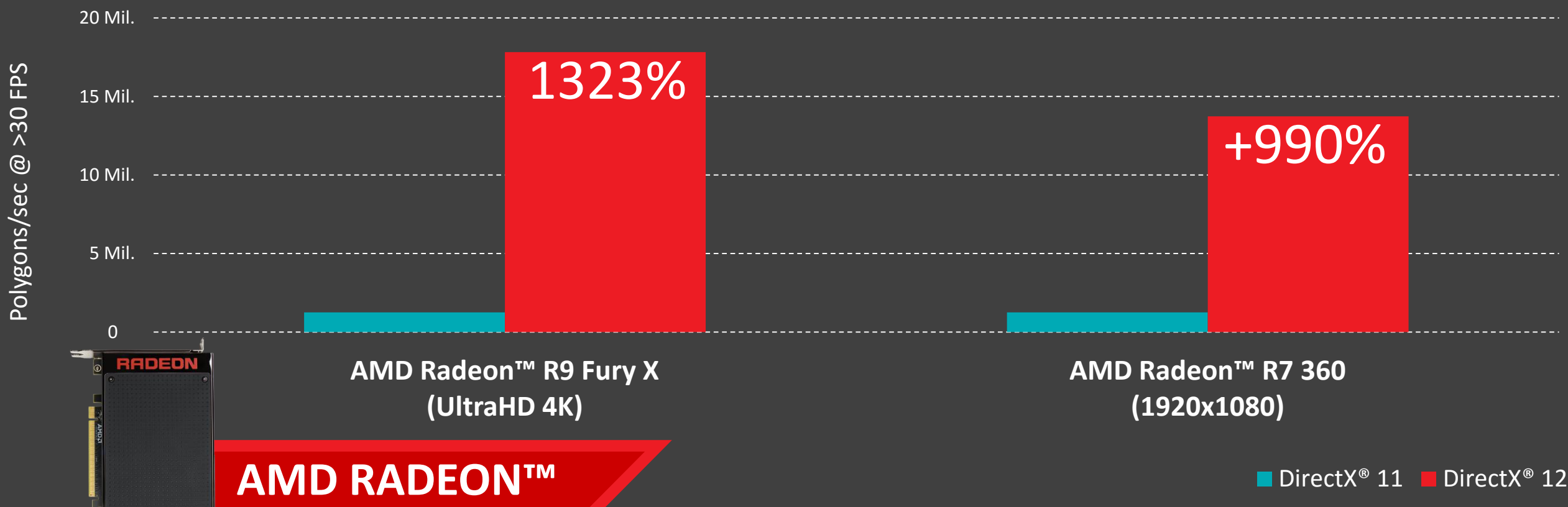
FUTUREMARK®

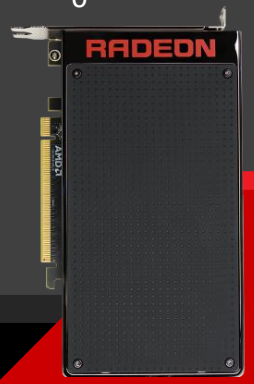
3DMARK® API OVERHEAD FEATURE TEST

SCENE DETAIL UPLIFT WITH DIRECTX® 12

AMD

GEOMETRIC SCENE DETAIL





AMD RADEON™

UP TO 14X MORE GRAPHICS THROUGHPUT IN DIRECTX® 12*

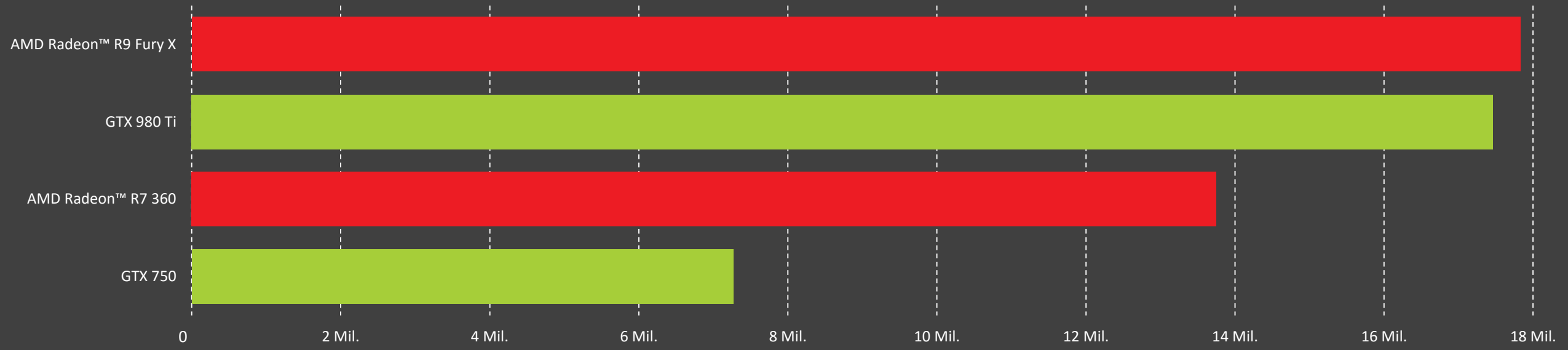
** See slide 41 for system configuration.*

3DMARK® API OVERHEAD FEATURE TEST

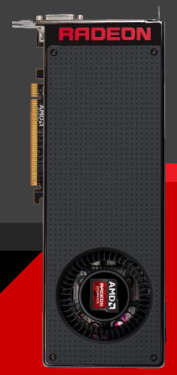
DIRECTX® 12 GPU PERFORMANCE

AMD

GEOMETRIC SCENE DETAIL AT 4K



Polygons/sec @ >30 FPS



AMD RADEON™

INCREDIBLE DIRECTX® 12
HARDWARE EFFICIENCY

** See slide 41 for system config.*

3DMARK® API OVERHEAD FEATURE TEST

3DMARK® API OVERHEAD FEATURE TEST

AMD

SCENE DETAIL

(1080p)

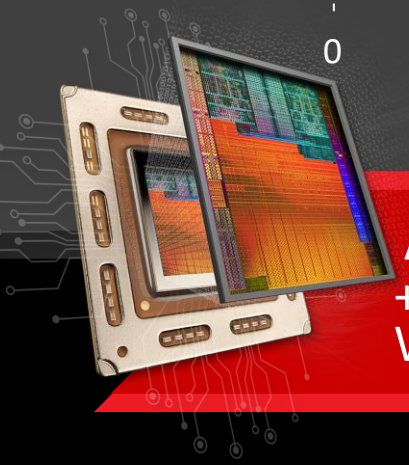
DirectX® 12

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*

* Total system power. See slide 41 for system config.

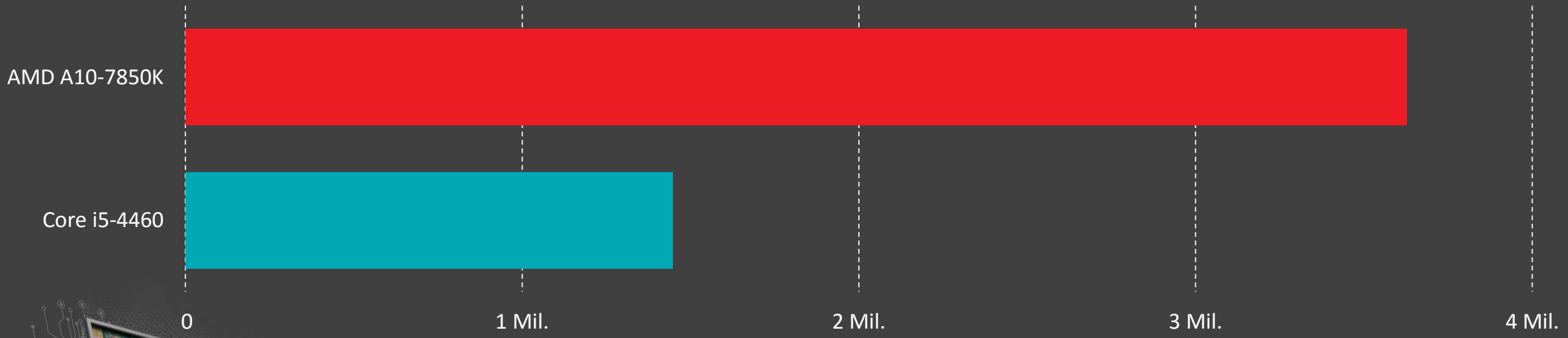
DIRECTX® 12 SOC PERFORMANCE LEADERSHIP

3DMARK® API OVERHEAD FEATURE TEST

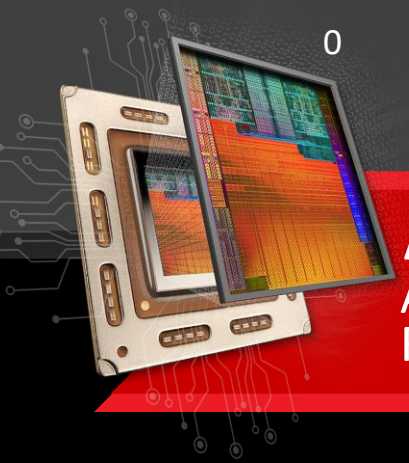
AMD

SCENE DETAIL

(1080p)



Polygons/sec @ >30 FPS



AMD A10-7850K

A SUPERIOR CPU
FOR DIRECTX® 12

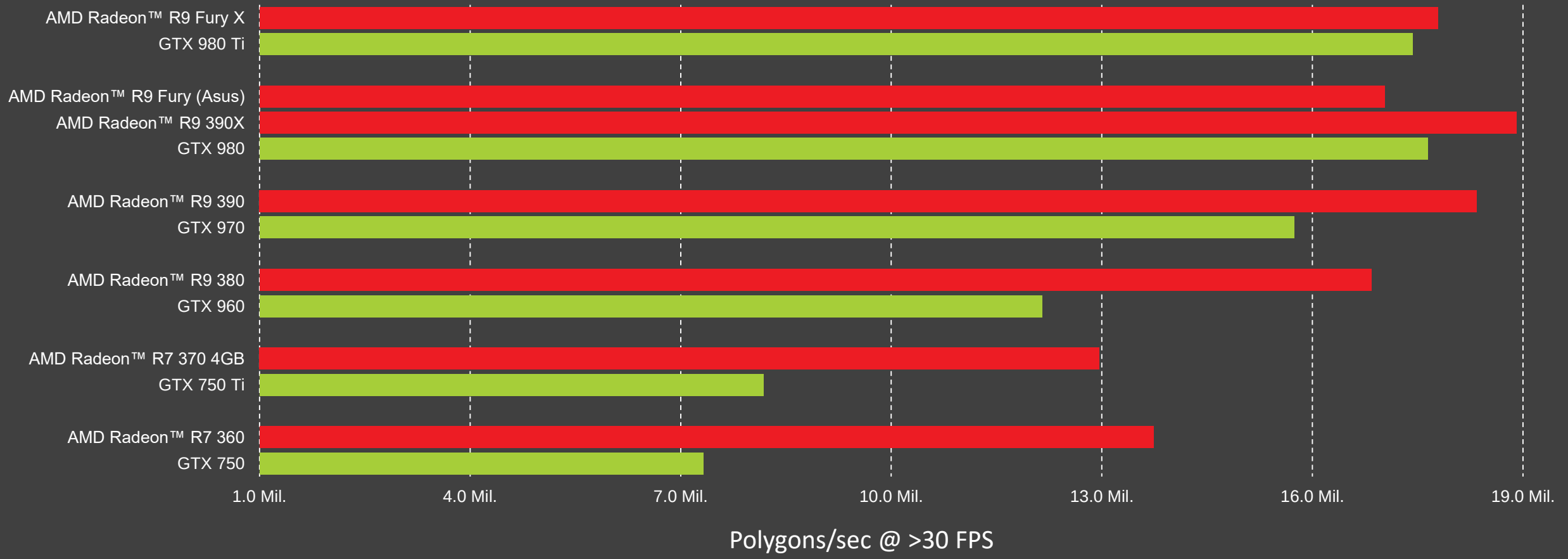
** See slide 41 for system config.*

3DMARK® API OVERHEAD FEATURE TEST

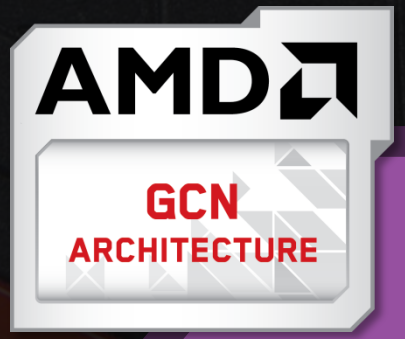
FULL DGPU STACK PERFORMANCE

AMD

GEOMETRIC SCENE DETAIL AT 1080P



** See slide 41 for system config.*



DIRECTX® 12-READY
IT'S THAT SIMPLE

MULTI-THREADED COMMAND BUFFERS
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 12: AMD FX-8370, 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.

2. SLIDE 18: AMD FX-8370, Gigabyte 990FXA-UD5, AMD Radeon™ R9 290X GPU, 8GB DDR3-1866, Windows® 10 Technical Preview 2 (Build 10041), AMD Catalyst™ driver 15.7.1. Async Shaders Off: 221 FPS Average. Async Shaders On: 250 FPS Average.

3. SLIDE 35: Core i7-5960X, Gigabyte X99-UD4, 16GB DDR4-2666, Windows 10® x64 (Build 10240), AMD Catalyst™ driver 15.7.1. DirectX® 11 multi-threaded vs. DirectX® 12 multi-threaded.

4. SLIDE 36: Core i7-5960X, Gigabyte X99-UD4, 16GB DDR4-2666, Windows 10® x64 (Build 10240), AMD Catalyst™ driver 15.20 Beta 19, ForceWare 353.62. DirectX® 12 multi-threaded. 3840x2160 resolution.

5. SLIDE 37: 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.

6. SLIDE 38: (AMD A10-7850K/Asus A88X-Pro/16GB DDR3-2133) vs. (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.

7. SLIDE 39: Core i7-5960X, Gigabyte X99-UD4, 16GB DDR4-2666, Windows 10® x64 (Build 10240), AMD Catalyst™ driver 15.20 Beta 19, ForceWare 353.62. DirectX® 12 multi-threaded. 1080p resolution.

8. 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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