DELIVERING A NEW LEVEL OF VISUAL PERFORMANCE IN AN SOC
AMD "RAVEN RIDGE" APU

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Presented by:

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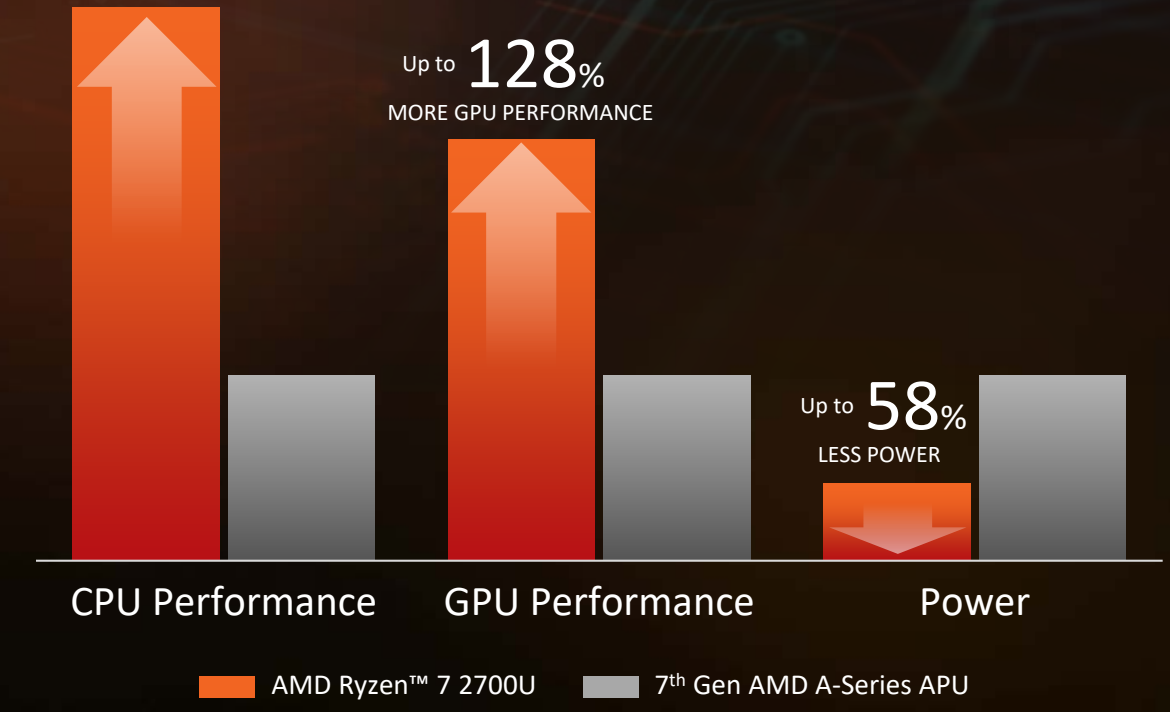
RAISING THE BAR FOR THE APU VISUAL EXPERIENCE

FIRST
"Zen"-based APU

HIGH-PERFORMANCE
On-die "Vega"-based graphics

LONG BATTERY LIFE
Premium form factors

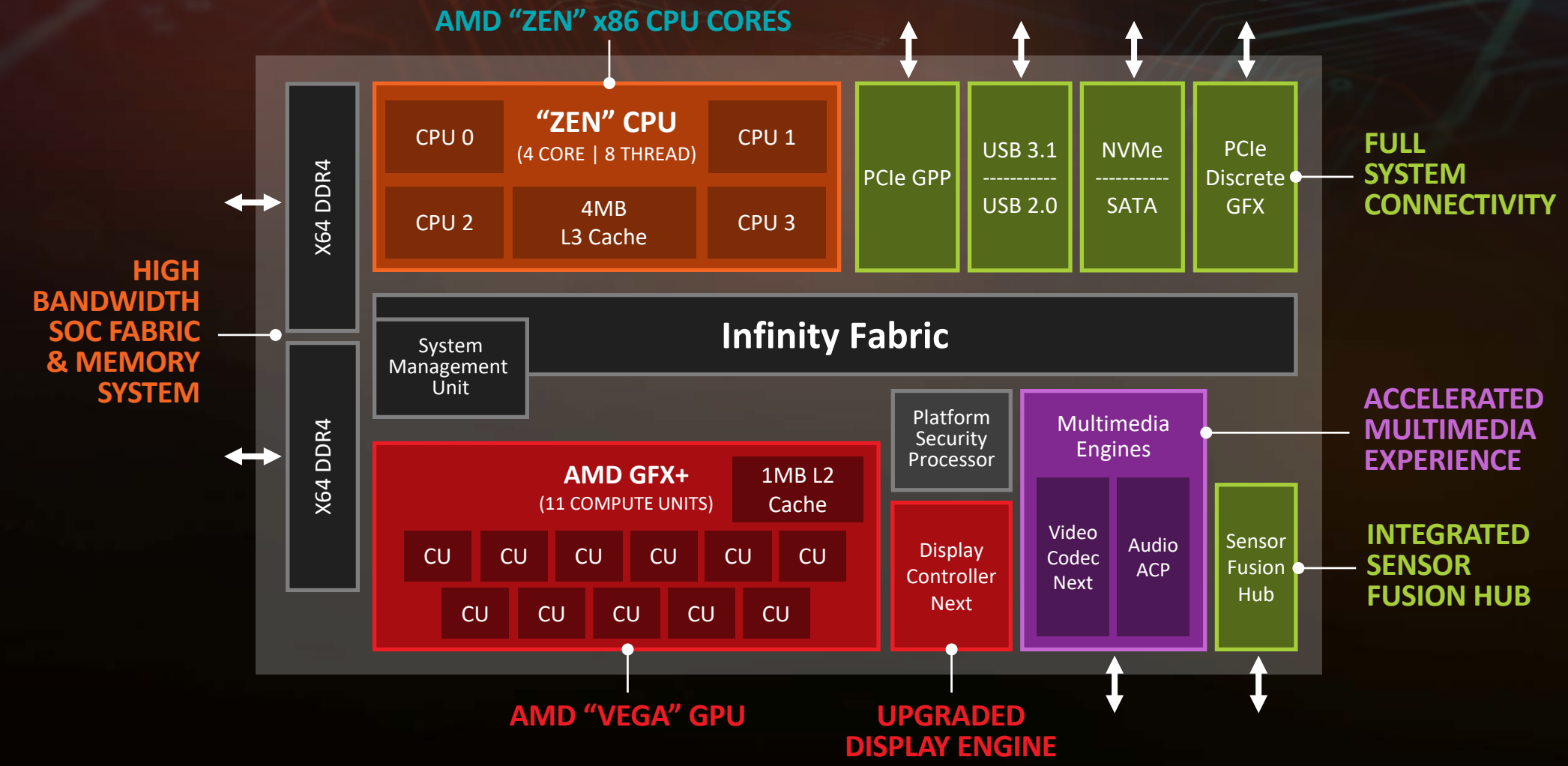
MOBILE APU GENERATIONAL PERFORMANCE GAINS



Scaled GPU and CPU up to reach target frame rate	Managed power delivery and thermal dissipation	Improved memory bandwidth efficiency	Upgraded display experience	Increased package performance density

* See footnotes for details.

“RAVEN RIDGE” APU



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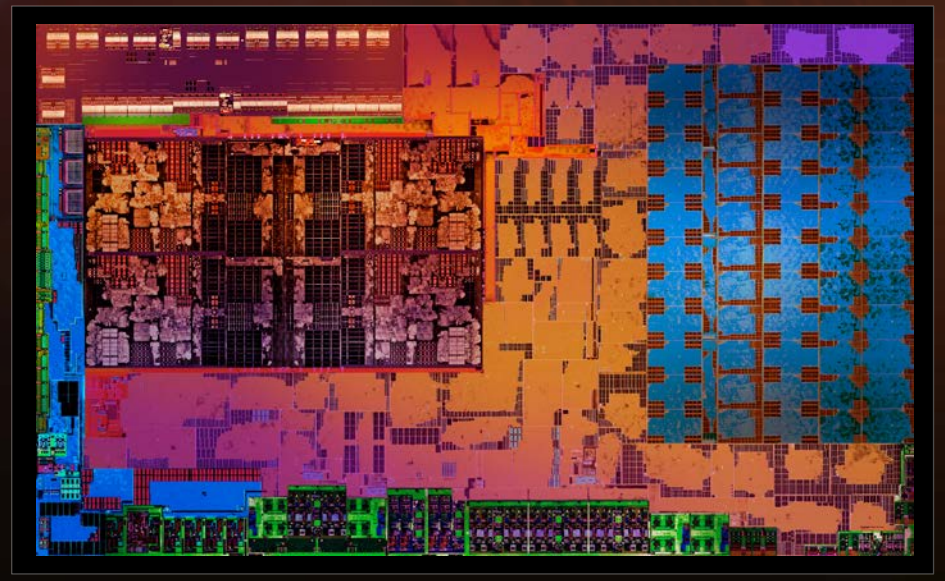
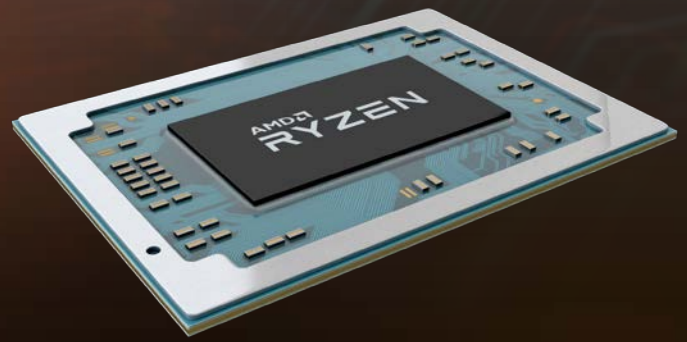
SIGNIFICANT DENSITY INCREASE

RYZEN
With Radeon™ Vega Graphics

"Raven Ridge" die





BGA Package: 25 x 35 x 1.38mm

Technology: GLOBALFOUNDRIES 14nm – 11 layer metal
Transistor count: 4.94B
Die Size: 209.78mm^2

59% more transistors

16% smaller die

than prior generation "Bristol Ridge" APU

* See footnotes for details.

AMD

INTEGRATED “VEGA” GRAPHICS

Graphics Engine

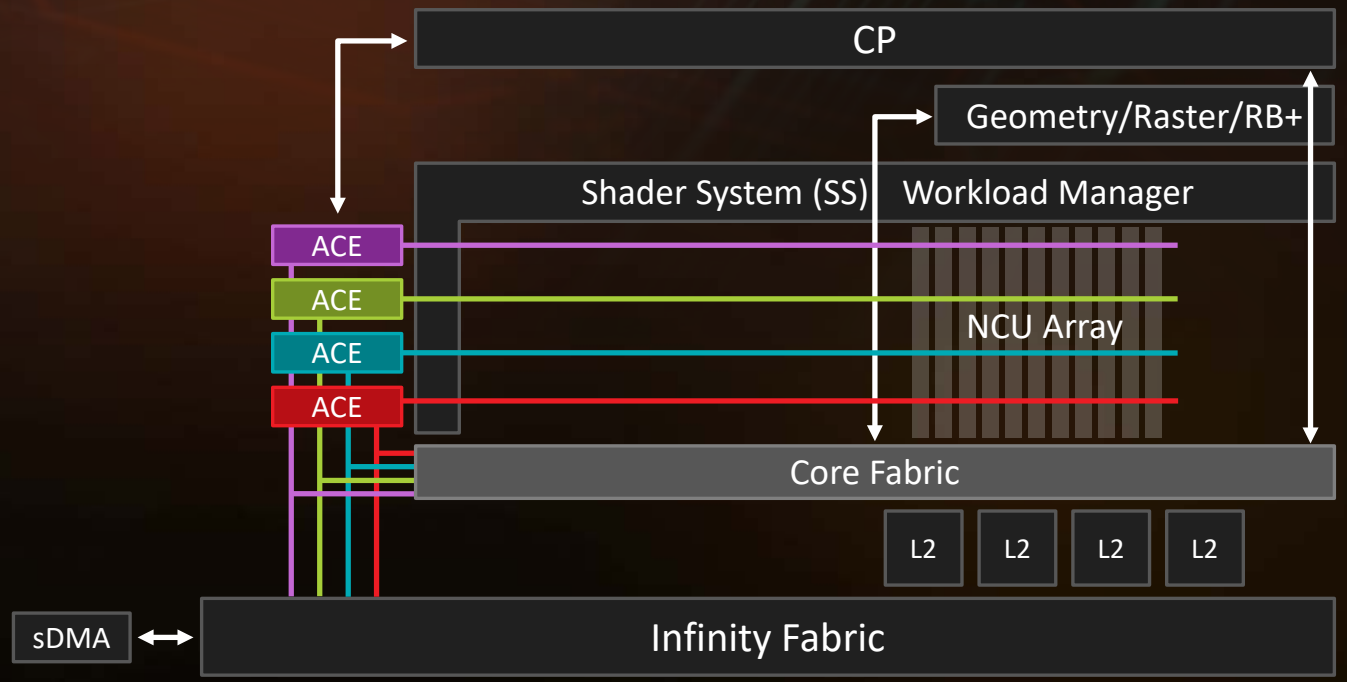
- Up to 11 Next Gen Compute Unit (NCU)
- 1 MB L2
- Flexible Geometry Engine
- 1 Draw Stream Binning Rasterizer
- 16 Pixels Units (32bpp)
- 44 Texture Units

DirectX® 12.1 Features

- Conservative Rasterization
- Raster Ordered Views
- Standard Swizzle
- Axis Aligned Rectangular Primitives

Throughput at 11 NCU

- 1200 MTri/sec @ 1200 Mhz
- Rendering 19.2 GPix/sec @1200 MHz
- 1690 FP32GFLOPS /
  3379 FP16GFLOPS @ 1200 MHz
- 52.8 MTex per second @ 1200MHz



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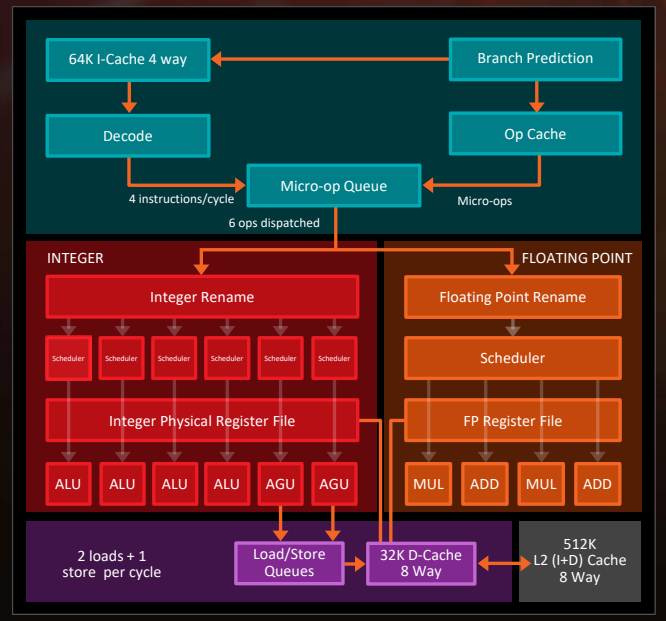
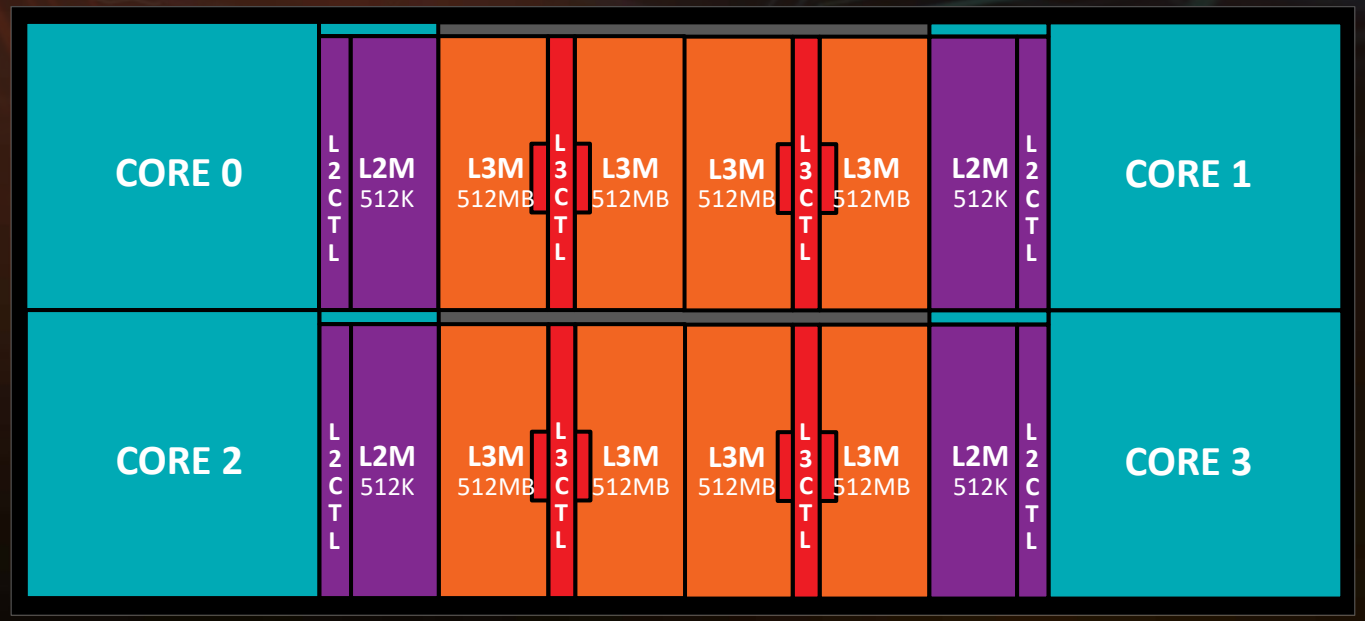
“ZEN” CPU IMPROVES VISUAL FRAME RATE





High performance “Zen” core

- Free up more power for GPU

Up to **4**
“ZEN” CPU cores

512KB
L2 Cache per core

4MB
Shared L3 Cache

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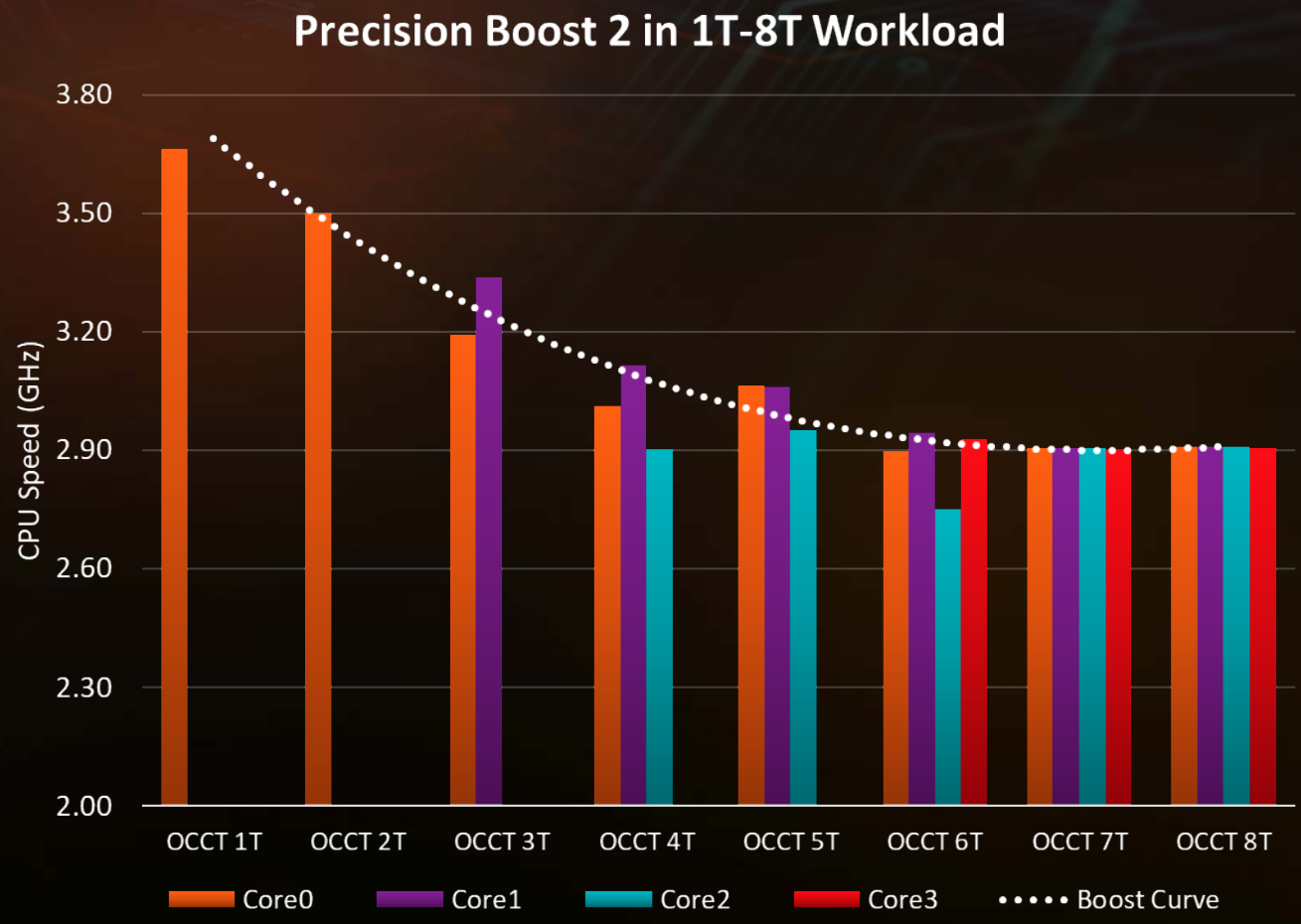
“ZEN” WITH PRECISION BOOST 2

- Governed by CPU temperature, current, load
- Seeks highest possible frequency from environmental inputs, graceful roll-off
- Opens new boost opportunities for real-world nT workloads (e.g., games)
- 25MHz granularity

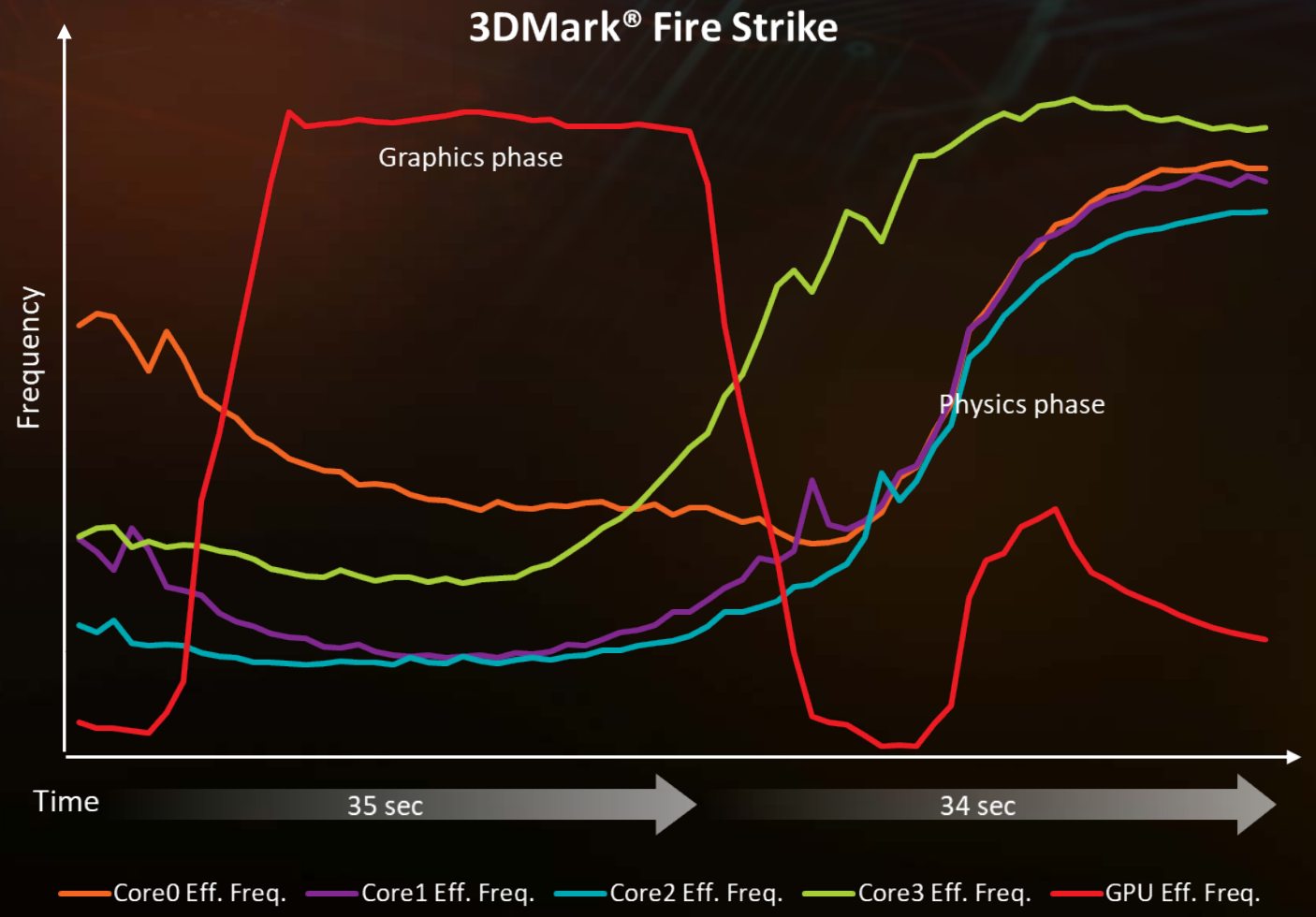


* See footnotes for details.

TUNE FOR THE PHASES OF VISUAL WORKLOADS

STEER POWER WHERE IT'S BEST USED

- Trade power/current based on dynamic utilization:
  - Core ↔ Core
  - CPU ↔ GPU
- On-die regulation and fine-grained frequency control enables fast, accurate frequency and voltage changes
- Fine-grained p-states (FGPS) across the IPs - continuous frequency control

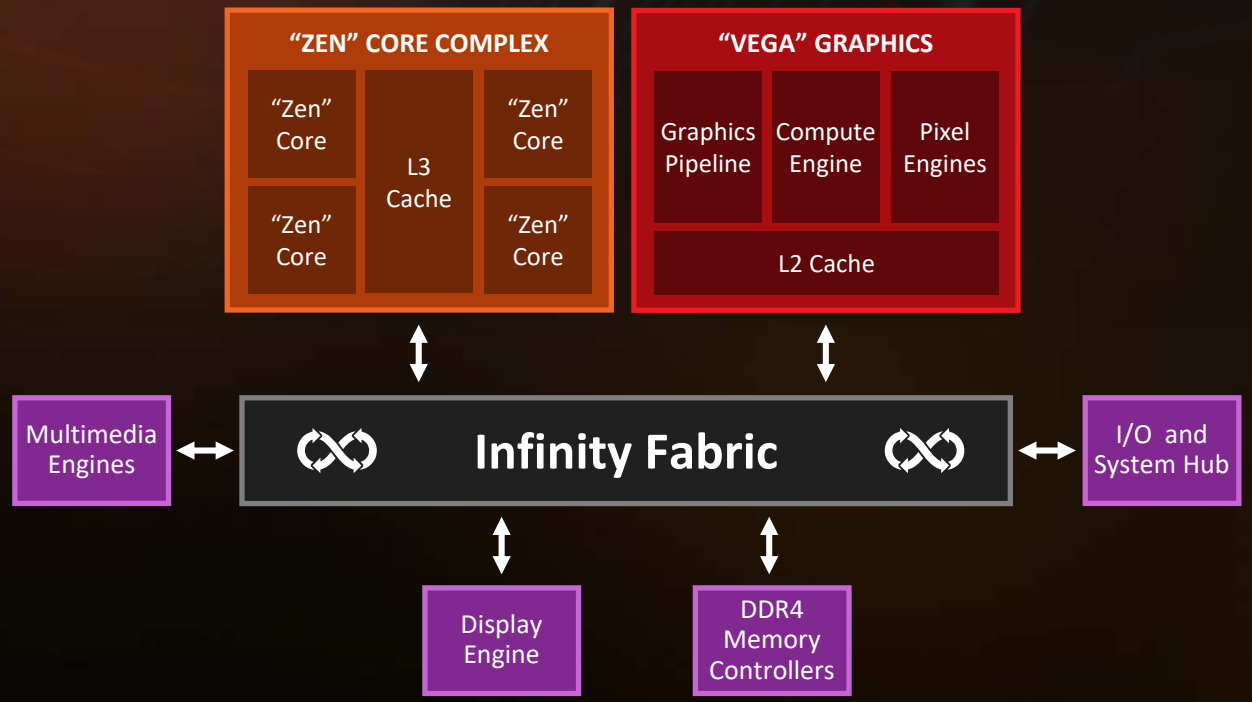


* See footnotes for details.

“ZEN” CPU AND “VEGA” GFX CO-MANAGEMENT

WITH INFINITY FABRIC

- CPU threads feed major GPU resources: 3D engine, compute engine, and DMA engine (data fetch and writeback)
- CPU “submits” tasks, GFX “renders” or “computes”
- One coherent control and data interface to integrate and manage the full SoC
- Power budgeting based on activity and efficiency
- Enhanced flow for quiescing/powering-off CPU-GFX component



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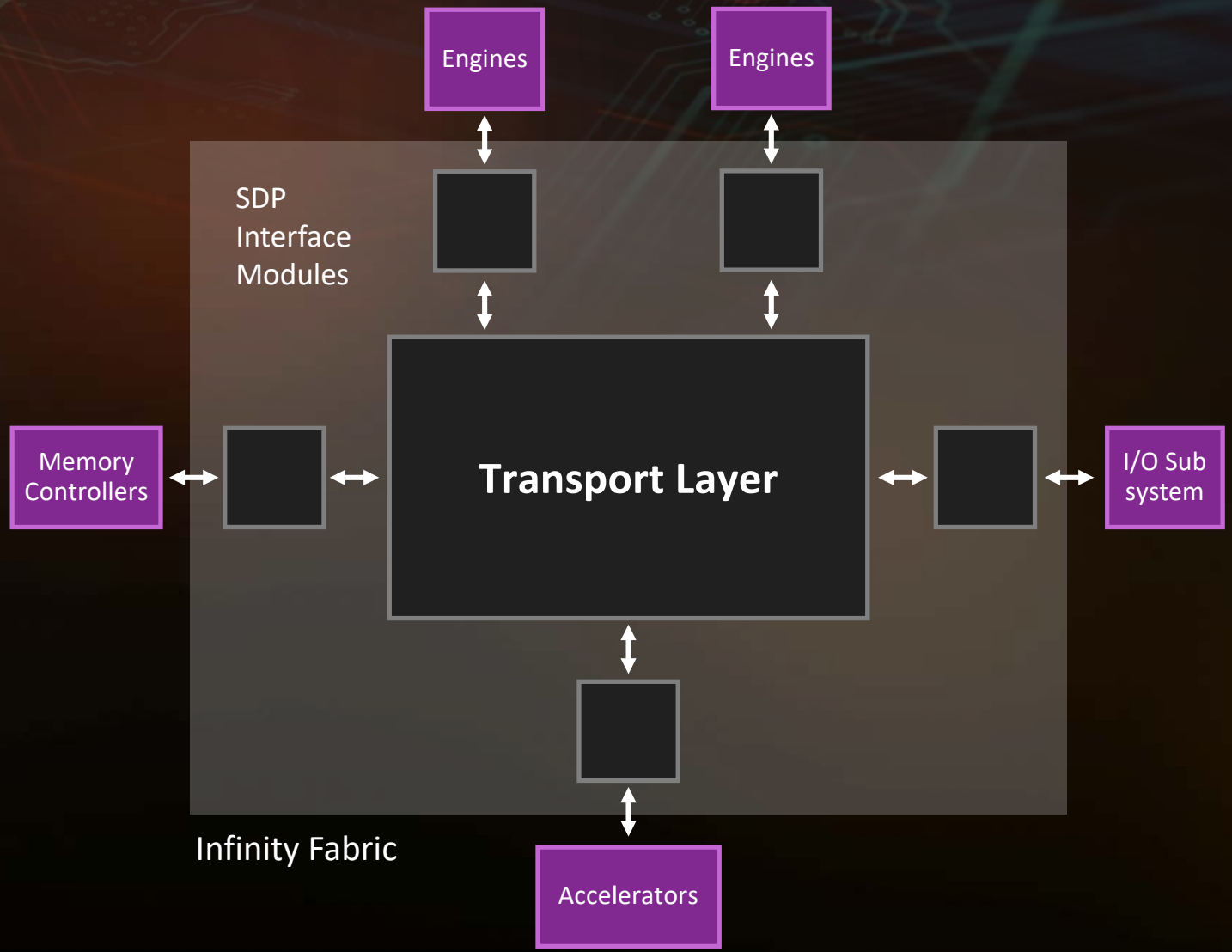
FAST DEPLOYMENT OF NEW ARCHITECTURE

MODULAR AMD INFINITY FABRIC

- Standard port definition for IP connections (SDP = Scalable Data Port)
  - Common interface definition used for CPU, GPU, I/O, multi-media hubs, display, memory controller
- Coherent HyperTransport™ transport layer
  - Builds upon generations of coherent fabric development
  - Flexible topology to adapt to diverse SoC configurations
- SDP hides complexities of coherence protocol from connected IP



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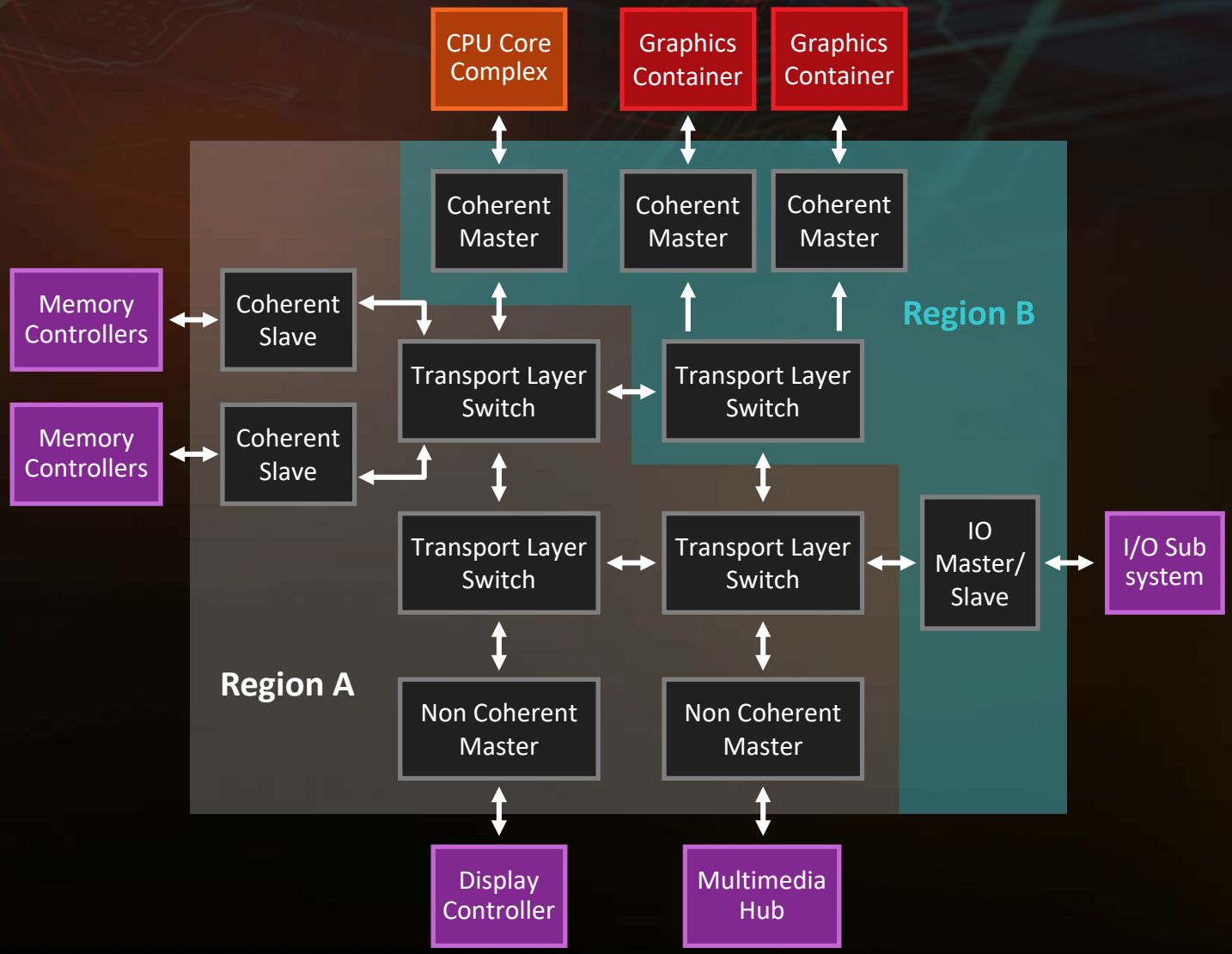
“RAVEN RIDGE” INFINITY FABRIC

“Raven Ridge” Optimizations

- 32 Byte internal datapath width
- Up to 1.6GHz for bandwidth exceeding 50GB/s
- Up to 5 transfers/clock per switch
- Improved CPU latency under load, while maintaining DRAM efficiency
- Structured for multi-region power gating
- Floorplan-aware, optimized display to memory routing



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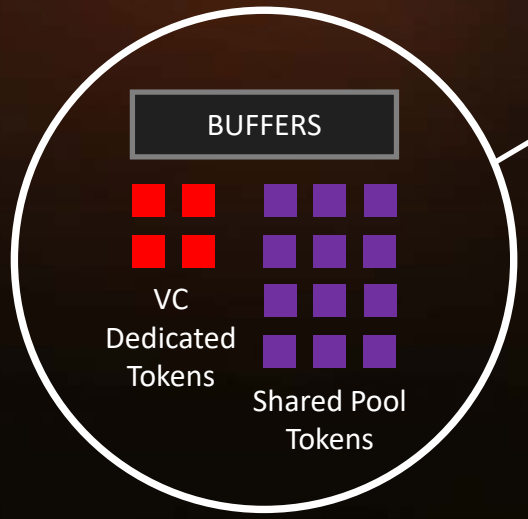
QUALITY OF SERVICE FOR SMOOTH VISUAL EXPERIENCE

Three Request Classes

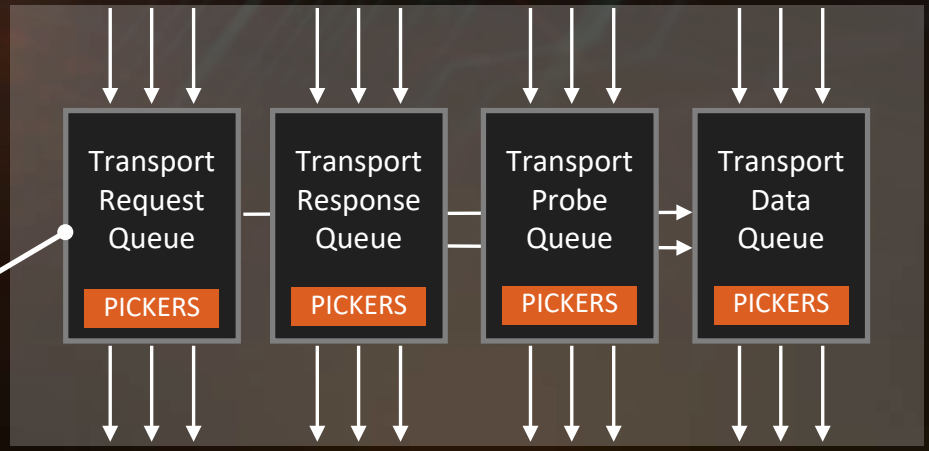
- Hard real time:
  - High BW (e.g., display surface refresh)
  - Low BW (e.g., audio)
- Soft real time (e.g., video playback)
- Non real time
  (e.g., typical CPU/GPU/IO requests)

Architectural Mechanisms

- Multiple virtual channels
- Priority classes (Low/Medium/High/Urgent)
- End-to-end priority escalation by VC for out of bounds conditions



Switch-level View of QoS Architecture



Picker arbitration generally age ordered, except when younger passes older due to:

1) priority
2) VC resource availability
3) other resource such as output port busy

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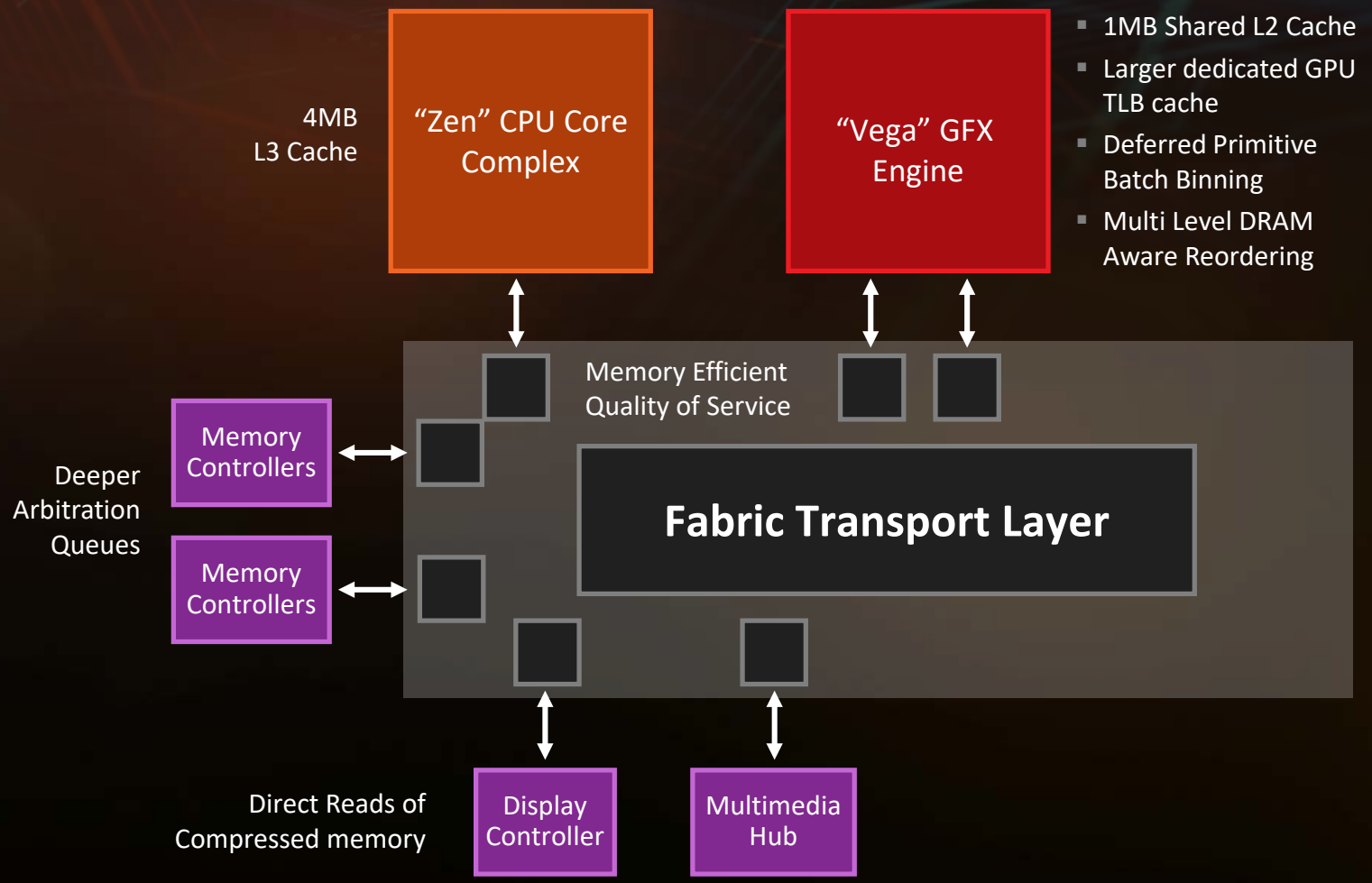
MEMORY BOUND PERFORMANCE OPTIMIZATION

New features and optimized SoC configuration contribute to improved memory-limited performance:

- Caching and algorithms to reduce memory requests
- Improved lossless compression usage (DCC)
- Better request ordering to reduce DRAM page conflicts and read/write turnarounds



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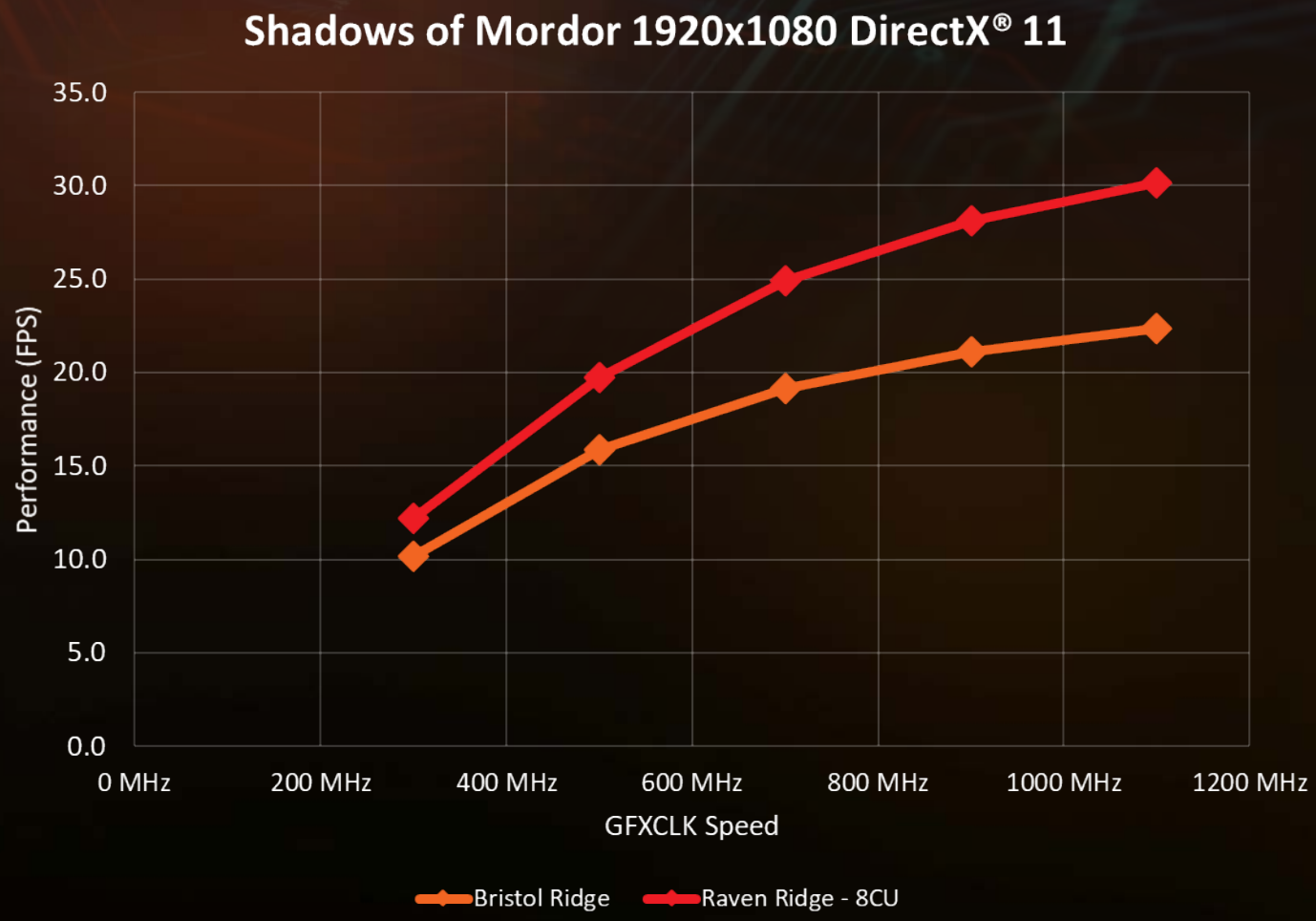
“RAVEN RIDGE” GRAPHICS SCALING

GENERATIONAL IMPROVEMENTS FOR MEMORY BOUND GAMING PERFORMANCE

Gaming performance scaling uplift due to new AMD Vega GPU features:

- 4x larger GFX L2 cache, unified across all graphics clients
- DSBR (Draw Stream Binning Rasterizer) feature reduces bandwidth
- Improved lossless DCC memory compression



* See footnotes for details.

AMD

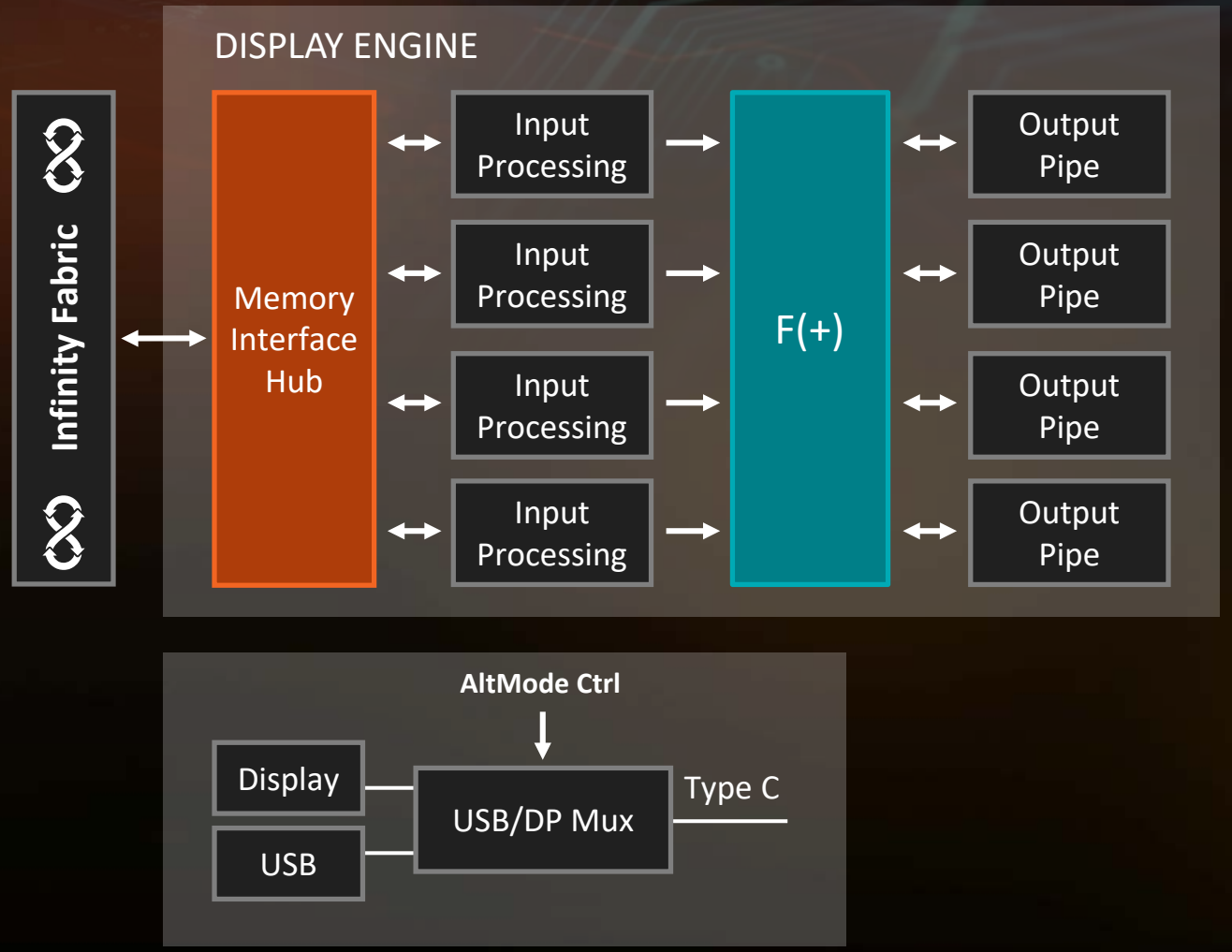
NEW GENERATION DISPLAY AND VIDEO CODEC ENGINE

Display Engine (DCN)

- Flexible display pipe architecture
  - Up to four 4kp60 displays
- Low power display engine with DCC, 4K2K@60hz @Vmin
- HDR support
  - From 32bpp to 64bpp surfaces
  - From sRGB to BT2020
- Higher bandwidth interfaces - HDMI 2.1, DP 1.4, HBR3
- USB-Type C with display alt-mode

Video Codec (VCN)

- Unified encode and decode engine
  - Up to 4kp60 HEVC 10b decode
  - Up to 4kp30 HEVC 8b encode
- Low power video playback – 4kp30 @Vmin
- HEVC 10b decode
- HEVC encode for superior quality skype
- VP9 decode for efficient YouTube playback



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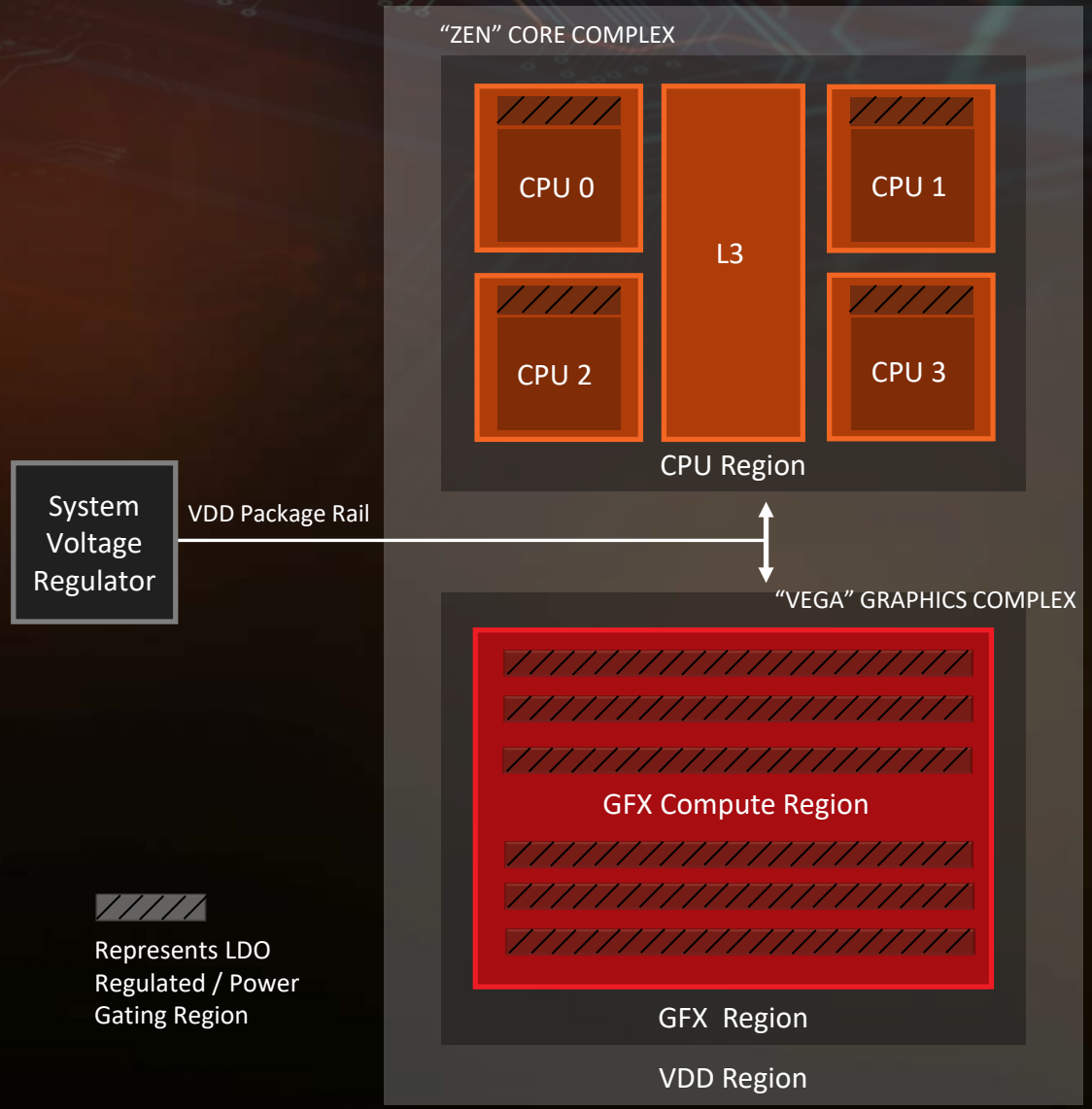
EFFICIENT POWER DELIVERY

WITH DIGITAL LOW-DROPOUT REGULATORS

- Current delivery overprovisioned for worst-case overlap between CPU and GPU
- Fine-grain LDO control allows for efficient tracking of the CPU and GFX phases, powered by a unified VDD power rail
- 1st stage: off-chip motherboard vreg
  2nd stage: on-chip vreg with digital LDO
- Multiple digital LDO regions for CPU cores, graphics core, and sub-regions
  - Idle engine is powered off
- Allows more peak CPU/GPU current to improve boost performance

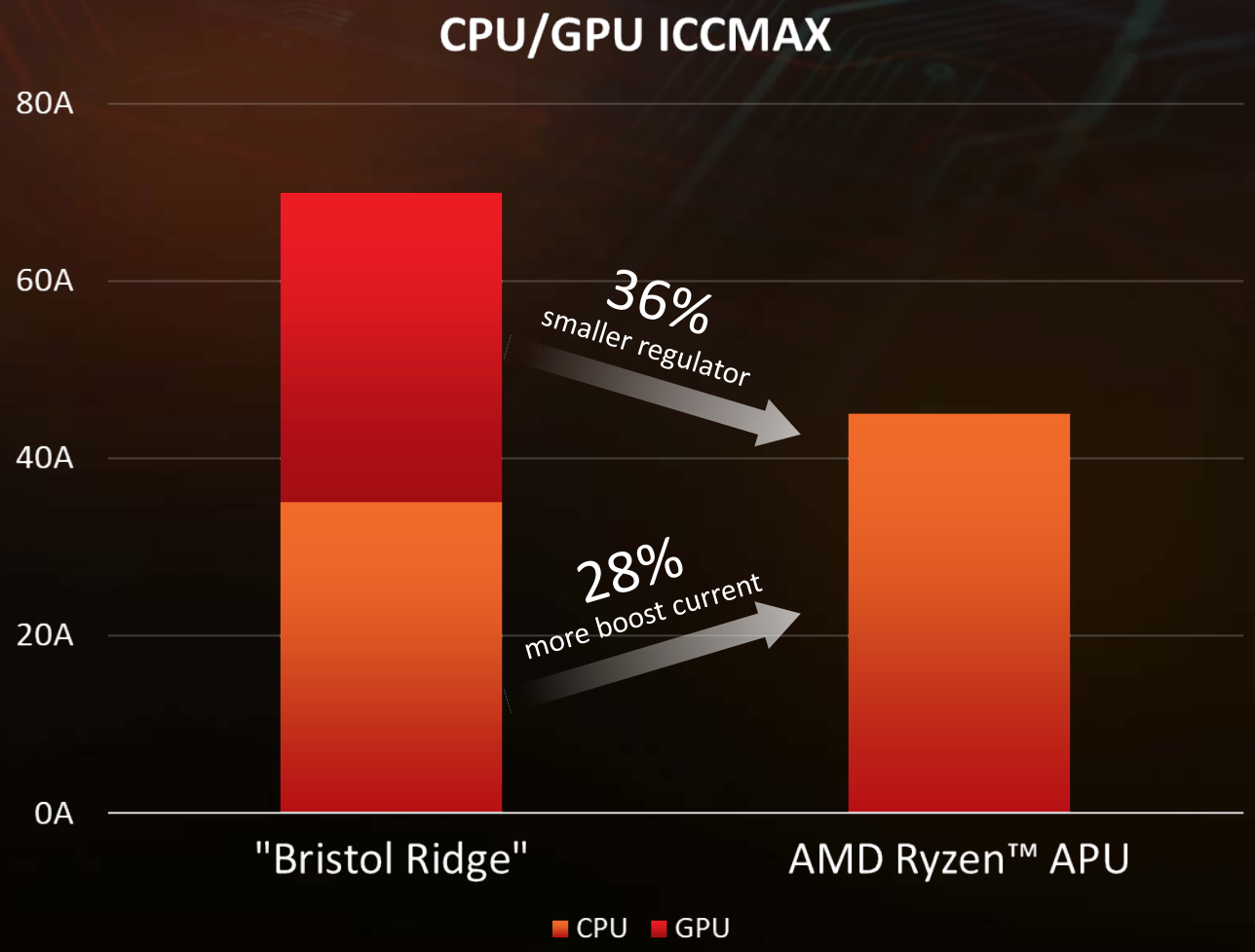


* See footnotes for details.

SYNERGISTIC POWER RAIL SHARING

WITH DIGITAL LDO REGULATORS

- Shared regulator reduces total regulator current requirements
- Less motherboard power supply footprint
- More peak CPU/GPU current to improve boost performance



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ENHANCED POWER OFF STATE

CPU AND GPU

For CPU Cores

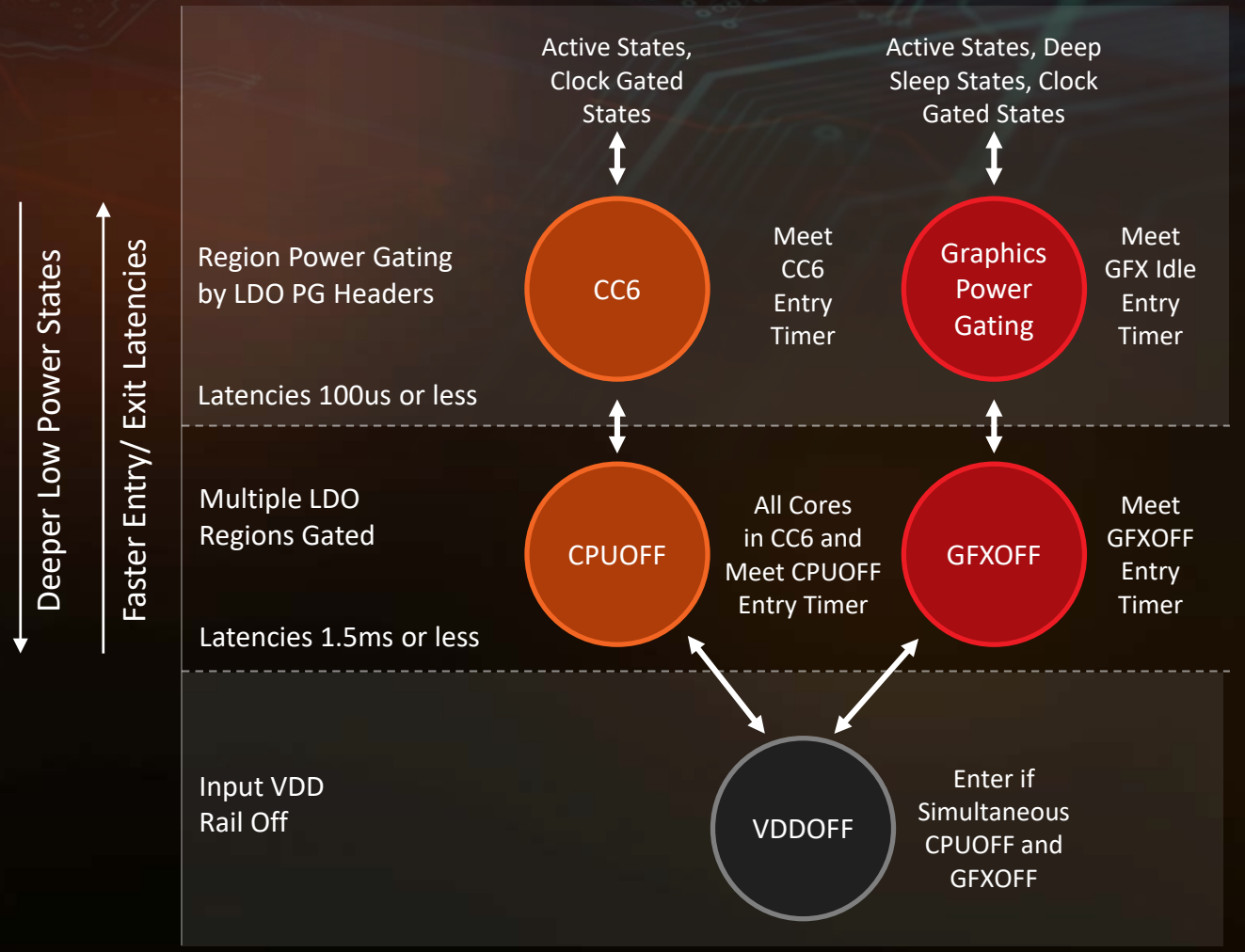
- Each core can enter CC6 power gating
- CPUOFF can lower L3 cache power when all cores in CC6

For Graphics

- Gating can power down up to 95% of the GPU
- GFXOFF can further power down GPU un-core (aka GPU monitor logic)

GFXOFF+CPUOFF=VDDOFF; Halts System VDD Regulator

- Up to 99% residency in Windows static screen idle*



* See footnotes for details.

MORE THERMAL COMPUTE HEADROOM IN NOTEBOOKS

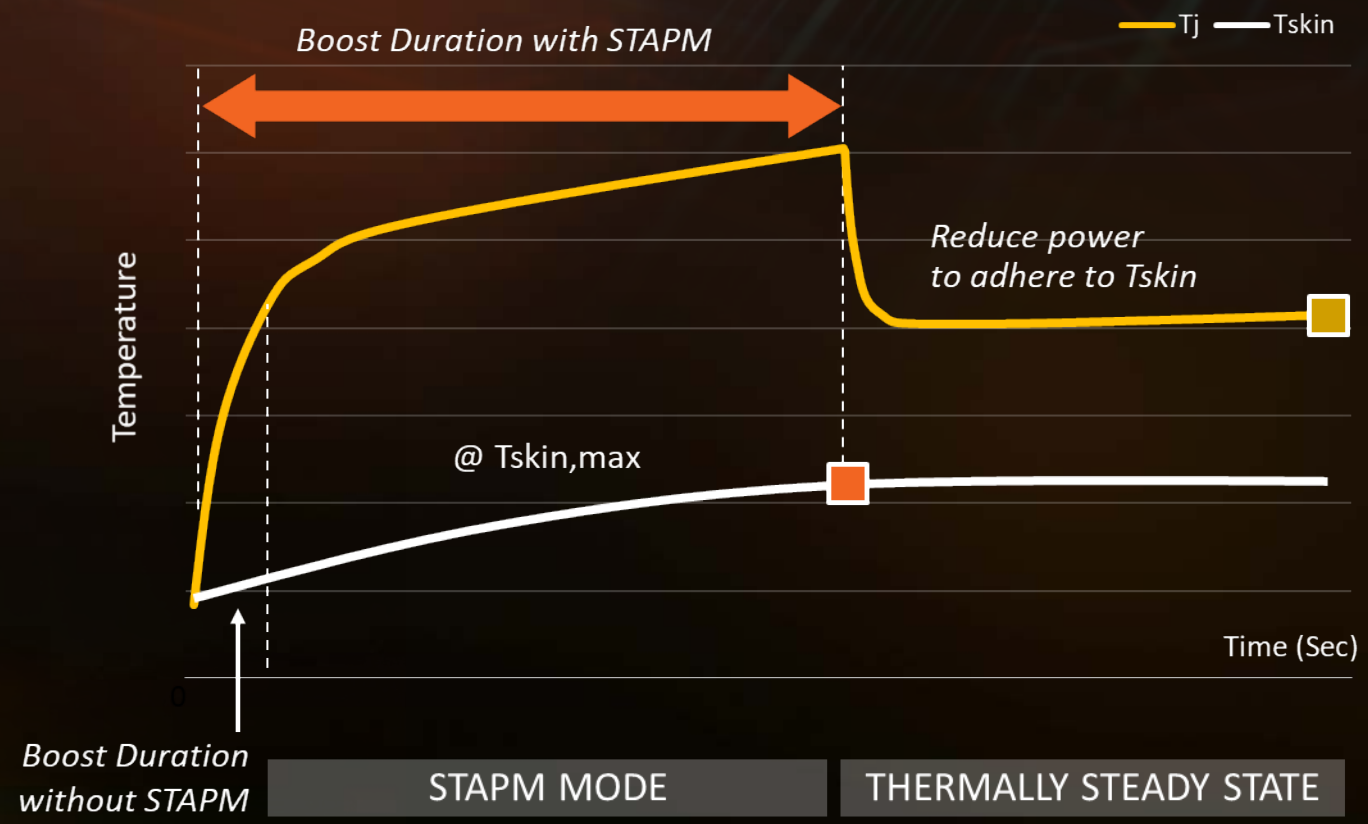
SKIN TEMPERATURE AWARE POWER MANAGEMENT (STAPM)

Before STAPM:

APU guard-banded to Tj~60C to meet Tskin requirements

After STAPM:

Delta between ambient and Tskin calculated based on the power/activity system components



Conceptual example of behavior

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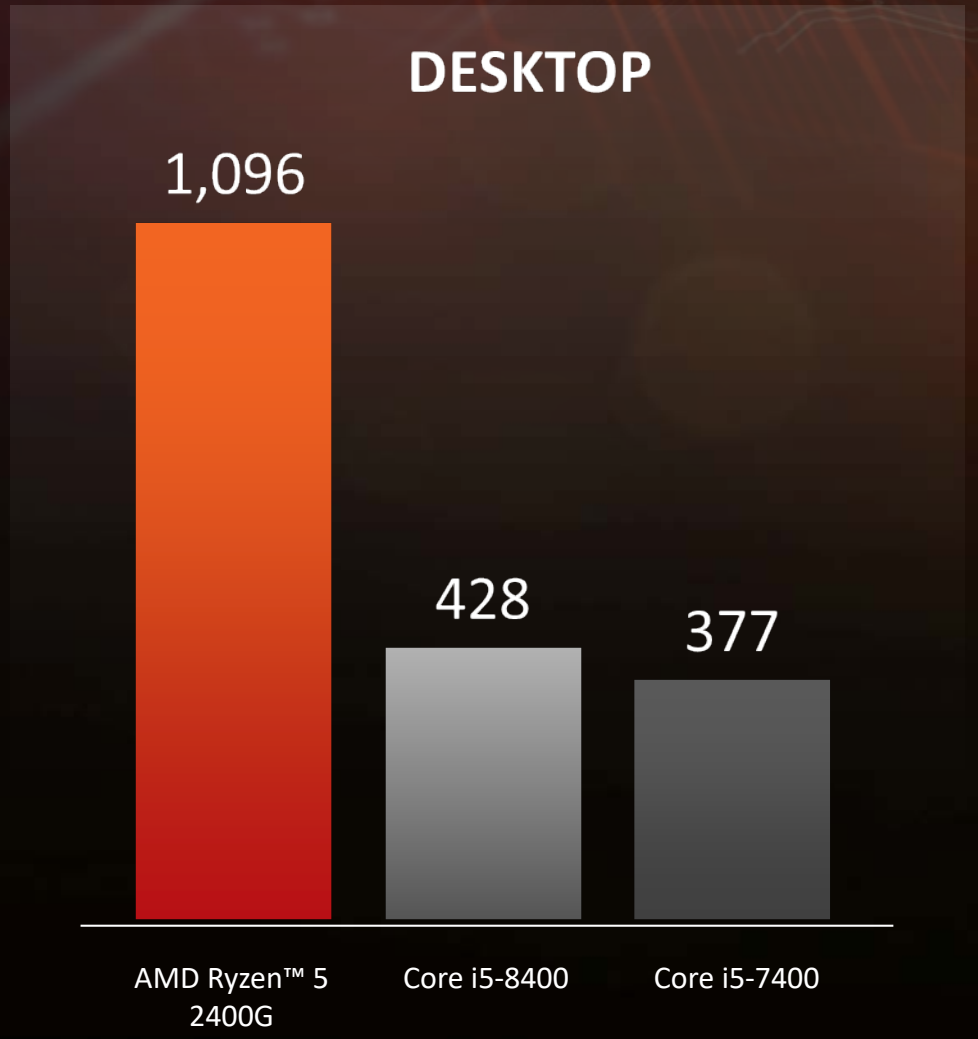
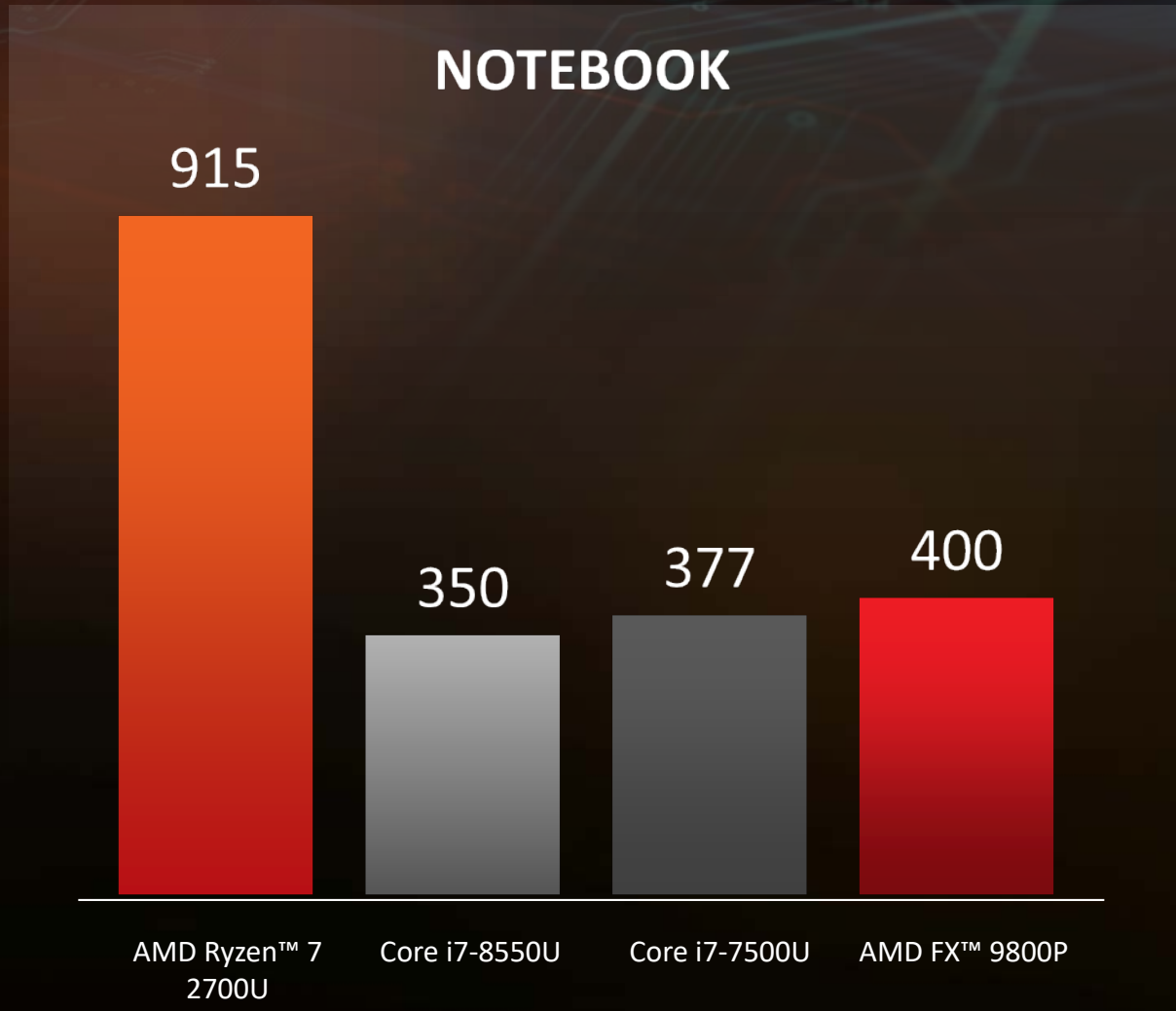
3DMARK® TIME SPY





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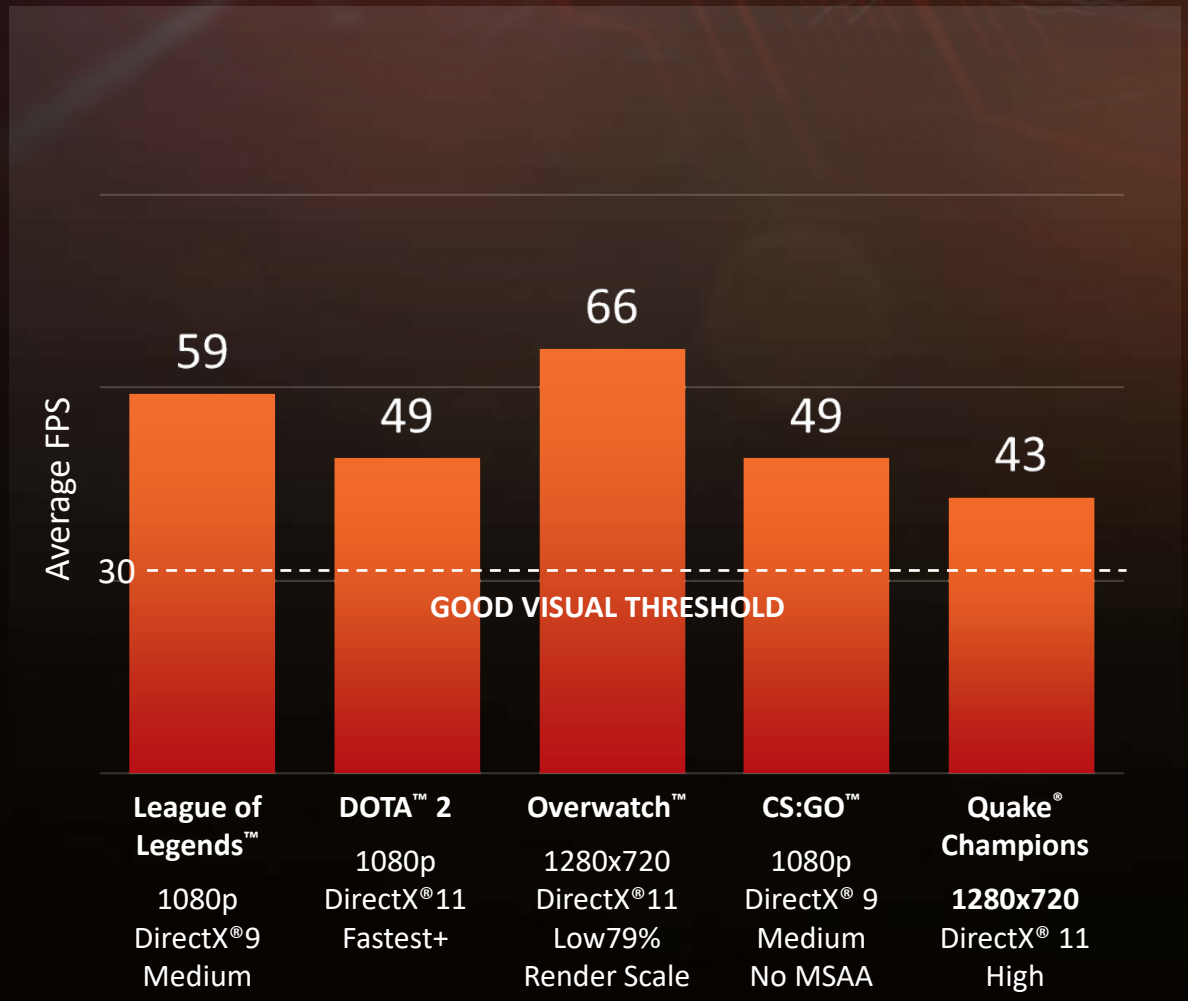
GAMING ON THE GO
IN AN ULTRATHIN



AMD RYZEN™ 5 2400G
DESKTOP PROCESSOR

* See footnotes for details.

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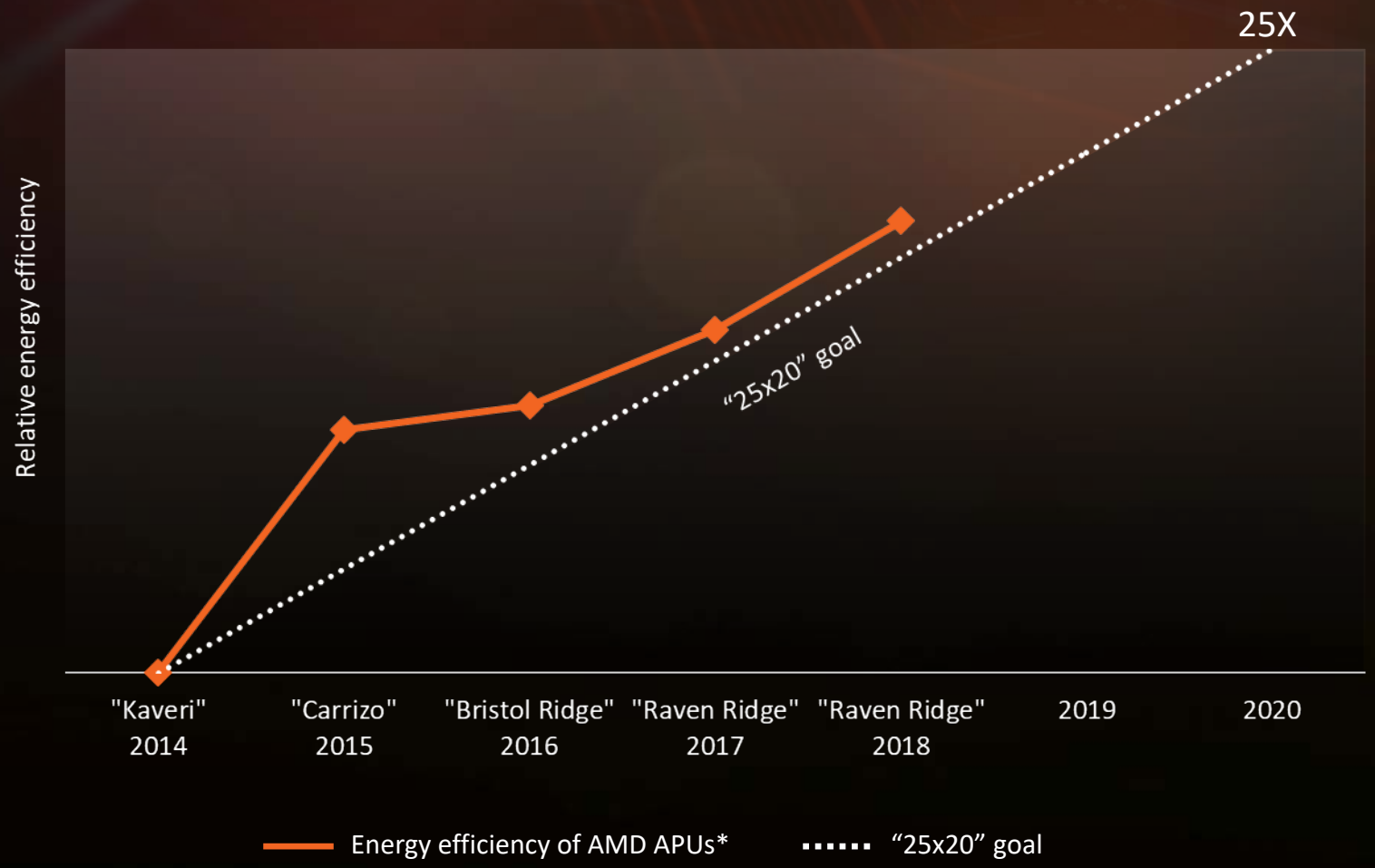
AMD ACCELERATING ENERGY EFFICIENCY

ON TRACK TO ACHIEVE OUR GOAL



25X ADDITIONAL ENERGY EFFICIENCY BY 2020 (2014–2020)

Developing energy efficient processors has long been a design focus at AMD. In 2014, AMD set a bold "25x20" goal to deliver at least 25X more energy efficiency in our mobile processors by 2020. Visit AMD.com/25x20.

GREEN ELECTRONICS COUNCIL CATALYST AWARD 2016

AREA RESPONSIBLE 2017

* See footnotes for details.

AMD

RYZEN

With Radeon™ Vega Graphics

The true potential of the APU realized by combining “Zen” CPU with “Vega” Graphics

Data movement improvements at all levels to reduce bandwidth bottlenecks

Advances in power and thermal management provide more headroom for visual throughput

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FOOTNOTES

Slide 2: Based on AMD testing as of 9/28/2017. System configuration(s): AMD Reference Motherboard (2700U), HP ENVY X360 (FX-9800P/"7th Gen APU"), Samsung 850 Pro SSD, Windows 10 x64 1703, 1920x1080. AMD Ryzen™ 7 2700U Graphics Driver: 23.20.768.9. AMD FX-9800P Graphics Driver: 22.19.662.4. 1x8GB DDR4-2133 (AMD FX-9800P). 2x4GB DDR4-2400 (AMD Ryzen™ 7 2700U). Power Consumption defined as joules of power consumed during a complete run of Cinebench R15 nT: AMD FX™ 9800P = 3782 joules (100%) vs. AMD Ryzen™ 7 2700U =1594J (58% less). Different configurations may yield different results

Slide 4: Based on "Bristol Ridge" die size of 250.04mm2 and transistor count of 3.1 billion.

Slide 7: Based on AMD testing of as of 9/25/2017. System configuration(s): AMD Reference Platform, AMD Ryzen™ 7 2700U APU, 2x4GB DDR4-2400, graphics driver 17.30.2015. AMD SenseMI technology is built into all Ryzen processors, but specific features and their enablement may vary by product and platform. Learn more at http://www.amd.com/en/technologies/sense-mi.

Slide 8: Based on AMD testing as of 10/11/2017. Clock speed plot is a snapshot of 8 seconds of 3DMark Fire Strike. "Effective frequency" is the product of the reported clock speed and %time in active workload C0 C-state.

Slide 14: Based on AMD testing as of 6/11/2018. System configuration(s): AMD "Bristol Ridge" Mobile APU reference platform, AMD FX-9800P, 2x8GB DDR4-2400, Crucial BX100 SSD, Windows 10 x64 Build 16299, Graphics Driver: 21.19.384.20, BIOS: TMY130BA; AMD Ryzen™ Mobile APU reference platform, AMD Ryzen™ 7 2700U, 2x8GB DDR4-2400, WD7500BPKX, Windows 10 x64 Build 16299, Graphics Driver: 24.20.154.6220, BIOS: WGV8215N

Slide 17: Based on AMD infrastructure requirements for "Bristol Ridge" 15W TDP (VDDCR_CPU supply EDC limit is 35A, VDDCR_GFX supply EDC limit is 35A), and AMD infrastructure requirements for "Raven Ridge" 15W TDP (VDDCR_VDD supply EDC limit is 45A).

Slide 18: Based on AMD internal data of an optimized AMD Ryzen™ Mobile APU reference platform as of 9/25/2017. PC manufacturers may vary configuration yielding different results.

Slide 20: Notebook: Based on AMD testing as of 9/25/2017. Common system configurations: Samsung 850 Pro SSD, Windows 10 x64 1703, 1920x1080; Intel Graphics Driver: 22.20.16.4691; AMD Ryzen™ mobile APU Graphics Driver: 23.20.768.9; AMD FX-9800P Graphics Driver: 22.19.662.4; AMD FX-9800P configured in HP ENVY X360 (1x8GB DDR4-2133). AMD Ryzen™ 7 2700U configured in AMD reference platform (2x4GB DDR4-2400). Core i7-8550U configured in Acer Swift 3 (2x4GB DDR4-2400). Core i7-7500U configured in HP ENVY X360 (2x4GB DDR4-2400). Graphics results measured with 3DMark® TimeSpy. Core i7-8550U score (350) is baseline 100%. Core i7-7500U score (377) is 107% of baseline. AMD FX-9800P score (400) is 114% of baseline. AMD Ryzen™ 7 2700U score (915) is 261% of baseline. Different configurations may yield different results.

Desktop: Common system configurations: Samsung 850 Pro SSD, Windows 10 x64 Pro RS3, 1920x1080; Intel i5 8400 Graphics Driver: 15.47.02.4815; Intel I5-7400 Graphics Driver: 15.46.05.4771; AMD Ryzen™ mobile APU Graphics Driver: CL1491290-171206a-321461E 2.1.1 RC5 17.40 RC19; AMD Ryzen™ 5 2400G configured in AMD reference platform (2x8GB DDR4-2667). Core i5-8400 configured in Z370 Aorus Gaming 5 (2x8GB DDR4-2667). Core i5-7400 configured in B250 Gaming M3 (2x8GB DDR4-2400).

Slide 21: Based on AMD testing as of 9/25/2017. System configuration(s): HP ENVY X360, AMD Ryzen™ 7 2700U, 2x4GB DDR4-2400, Samsung 850 Pro SSD, Windows 10 x64 1703, Graphics Driver: 17.30.1025, BIOS F11.
Desktop Testing by AMD Performance labs as of 01/02/2018 on the following systems. PC manufacturers may vary configurations yielding different results. Results may vary based on driver versions used. System Configs: All systems equipped with 16GB dual-channel DDR4 @ 2666 MHz, Samsung 850 PRO 512GB SSD, Windows 10 RS2 operating system. Socket AM4 System: AMD Ryzen 5 2400G, AMD Ryzen 3 2200G, Myrtle RV motherboard. Graphics driver 23.20.768.0 (17.40).

Slide 22: Data source: AMD confidential based on internal test results of upcoming "Raven Ridge" APU.

ATTRIBUTION

DISCLAIMER