Building on Data Center Leadership

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MEGATRENDS DRIVING COMPUTE IN DATA CENTERS

Cloud

AI

HPC

Data Analytics

Video Streaming
EXPANDING DATA CENTER TAM

$125B LONG-TERM TAM

Server CPU $42B
FPGA and Adaptive SoC $13B
GPU & AI $64B
DPU & Infrastructure Acceleration $6B

Based on AMD internal data
OUR JOURNEY IN GPU ACCELERATION

- **2020**
  - **Ecosystem Growth**
    - First purpose-built GPU architecture for the data center
  - **AMD Instinct™ MI100**
    - AMD CDNA™
  - **Driving HPC and AI to a New Frontier**
    - First multi-die data center GPU expands scientific discovery and brings choice to AI training
  - **AMD Instinct™ MI200**
    - AMD CDNA™ 2
  - **Data Center APU**
    - Breakthrough architecture designed for leadership efficiency and performance for HPC and AI
  - **AMD Instinct™ MI300**
    - AMD CDNA™ 3

**Roadmaps Subject to Change**
# AMD INSTINCT™ MI200

**DEFINING LEADERSHIP IN HPC**

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>MI250X Advantage vs A100</th>
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<td>FP64 Vector</td>
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<td>FP64 Matrix</td>
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<tr>
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**3RD GEN AMD INFINITY ARCHITECTURE**

- CPU & GPU Memory Coherence
- Exceptional System Bandwidth & Performance

See Endnotes MI200-01, MI200-07, MI200-24A, MI200-26B
LEADING THE EXASCALE ERA

- **Powering World’s #1 Supercomputer**
  First to break Exascale barrier

- **Powering World’s #1 Green Supercomputer**
  8 of top 10 most efficient systems rely on AMD

- **Powering World’s #1 AI Supercomputer**
  More than 3X the previous record holder

- 95% growth in TOP500 systems Year-over-Year
  Powering more than half of all new systems

TOP500, Green500, and HPL-AI lists, as of May 30, 2022
“As part of our long-term partnership with AMD, I’m excited to share that **Azure will be the first public cloud to deploy clusters of AMD’s flagship MI200 GPUs for large scale AI training**. We’ve already started testing these clusters using some of our own AI workloads with great performance.”

**Kevin Scott**
Executive Vice President and Chief Technology Officer, Microsoft
AMD INSTINCT™ MI300
THE WORLD’S FIRST DATA CENTER APU

- 4th Gen AMD Infinity Architecture: AMD CDNA™ 3 and EPYC™ CPU “Zen 4” Together
  CPU and GPU cores share a unified on-package pool of memory

- Groundbreaking 3D Packaging
  CPU | GPU | Cache | HBM

- Designed for Leadership Memory Bandwidth and Application Latency

- APU Architecture Designed for Power Savings Compared to Discrete Implementation

Available 2023

>8X
Expected AI Training Performance vs. MI250X

See Endnote MI300-03: Preliminary data and projections, subject to change.
SCALING THE SOFTWARE DEFINED DATA CENTER
INFRASTRUCTURE ACCELERATION AND NETWORKING ARE ESSENTIAL

Cloud and Virtualization
Cloud services overhead can consume up to 30% of CPU cores

Shift of Compute to Edge
Extend visibility and management beyond the data center boundary

Security of Data Traffic
Secure data at rest and in flight at all endpoints
AMD NETWORKING TECHNOLOGY

**Solarflare™**
- Ultra Low Latency NICs
- Ubiquitous in Financial Exchanges
- Crucial for High Frequency Trading

**Alveo™**
- FPGA-Based Adaptive Acceleration
- Programmable Hardware for Custom Network Functions
- Extreme Packet Processing Rates

**Pensando™**
- P4 Packet Processing Engines
- Tens of Millions of Network Flows
- Multiple Concurrent Services at Line Rate
ALVEO™
ADAPTIVE NETWORK ACCELERATION

- Shipping to Hyperscale Customers
- Accelerates Custom and Evolving Network Functions
- Extends Confidential Computing to Network Interface
- 2 x 200G | 400M Packets per Second

Next Generation in 2024
PENSANDO™
WORLD’S MOST INTELLIGENT DPU

- 144 P4 Packet Processors
- Fully Programmable Control, Data, and Management Planes
- Supports Tens of Millions of Network Flows
- Concurrent Services at Line Rate Performance
  Network | Security | Storage | Telemetry

2nd Generation | 2 x 200G | 7nm
In Production Today

“ELBA” DPU
PENSANDO™ SOFTWARE
TURNKEY INFRASTRUCTURE SOLUTION FOR
THE SOFTWARE DEFINED DATA CENTER

- Based on Open Standards and APIs
- Easily Incorporate and Accelerate New Services
- “Zero Trust Security” Throughout
- Works with Existing Management Tools
- Solutions Deployed Today
DPU ACCELERATION ACROSS THE DATA CENTER

P4 SmartNIC

Smart Switch

Storage

Dell Technologies, Hewlett Packard Enterprise, IBM, Microsoft, Oracle, VMware
AMD SECURING THE DATA CENTER
COMPREHENSIVE SECURITY FEATURES FROM CORE TO EDGE

**Distributed Security Services**
Extend the perimeter

**Edge and Beyond**

**Smart Switch & Appliance**
Help secure east-west traffic and legacy endpoints

**Infrastructure**

**Advanced SmartNIC**
Help secure every endpoint

**Confidential Compute**
Help secure application environment

**Root of Trust**
Help secure CPU at boot

**Compute Node**

**Modern Server**

**Smart Switch**

**Appliance**

**Legacy Server**

**Advanced Telemetry**
Monitor and detect threats in real time

**Network Security**
Elastic
Fortinet
Guardicore
Splunk
OUR PATH FORWARD

UNMATCHED DATA CENTER TECHNOLOGY

- Leadership Performance
- World-Class Efficiency
- Comprehensive Security Features

AMD EPYC
AMD INSTINCT
AMD PENSANDO
XILINX ALVEO
XILINX VERSAL
Endnotes

- MI200-01 - World's fastest data center GPU is the AMD Instinct™ MI250X. Calculations conducted by AMD Performance Labs as of Sep 15, 2021, for the AMD Instinct™ MI250X (128GB HBM2e OAM module) accelerator at 1,700 MHz peak boost engine clock resulted in 95.7 TFLOPS peak theoretical double precision (FP64 Matrix). 47.9 TFLOPS peak theoretical double precision (FP64), 95.7 TFLOPS peak theoretical single precision matrix (FP32 Matrix). 47.9 TFLOPS peak theoretical single precision (FP32), 383.0 TFLOPS peak theoretical half precision (FP16), and 383.0 TFLOPS peak theoretical Bfloat16 format performance (BF16) floating-point performance. Calculations conducted by AMD Performance Labs as of Sep 18, 2020, for the AMD Instinct™ MI100 (12GB HBM2 PCIe® card) accelerator at 1,502 MHz peak boost engine clock resulted in 1.54 TFLOPS peak theoretical double precision (FP64), 1.61 TFLOPS peak theoretical single precision (FP32), 10.6 TFLOPS peak theoretical half precision (FP16) floating-point performance. Published results on the NVIDIA A100 (80GB) GPU accelerator, boost engine clock of 1410 MHz, resulted in 19.5 TFLOPS peak theoretical precision cores. (FP64 Tensor Core), 9.7 TFLOPS peak theoretical double precision (FP16), 19.5 TFLOPS peak theoretical single precision (FP32), 78 TFLOPS peak half precision (FP16). 312 TFLOPS peak full precision (FP64 Tensor Flow), 39 TFLOPS peak Bfloat16 (BF16), 312 TFLOPS peak Bfloat16 format precision (BF16 Tensor Flow), theoretical floating-point performance. The TF32 data format is not IEEE compliant and not included in this comparison. https://www.nvidia.com/content/dam/en-za/Solutions/Data-Center/nvidia-ampere-architecture-whitepaper.pdf, page 15, Table, MI200-01

- MI200-07 - Calculations conducted by AMD Performance Labs as of Sep 21, 2021, for the AMD Instinct™ MI250X and MI250 (128GB HBM2e) OAM accelerators designed with AMD CDNA™ 2 6nm FinFet process technology at 1,600 MHz peak memory clock resulted in 128GB HBM2e memory capacity and 3.276 TFLOPS peak theoretical maximum throughput. MI250X and MI250X OAM memory bus interface is 4.096 bits 2.0 and memory data rate is 3.2 Gbps for total memory bandwidth of 3.276 TFLOPS. MI250X has the highest published results for the NVIDIA A100 GPU accelerated system throughput obtained in 8GB HBM2e memory capacity and 2.393 TB/s GPU memory bandwidth performance. https://www.nvidia.com/content/dam/en-za/Solutions/Data-Center/a100/pdf/nvidia-a100-datasheet-us-nvidia-1758950-4-w.pdf MI200-07

- MI200-24A - Testing Conducted by AMD performance lab as of 10/12/2021, on a single socket Optimized 3rd Gen AMD EPYC™ CPU server with 1x AMD Instinct™ MI250X OAM (128 GB HBM2e) 560W GPU with AMD Infinity Fabric™ technology using benchmark OpenMM_amoebagk v7.6.0, (converted to HIP) and run at double precision (8 simulations*10,000 steps) plus AMD optimizations to OpenMM_amoebagk that are not yet upstream resulted in a median score of 387.0 seconds or 223.2558 NS/Day. Tested with NVIDIA DGX A100 80GB (400W) and using benchmark OpenMM_amoebagk v7.6.0, run at double precision (8 simulations*10,000 steps) with CUDA code version 11.4 resulted in a median score of 921.0 seconds or 93.8111 NS/Day. Information on OpenMM: https://openmm.org/ Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-24A

- MI200-26B - Testing Conducted by AMD performance lab as of 10/14/2021, on a single socket Optimized 3rd Gen AMD EPYC™ CPU (64 core) server with 1x AMD Instinct™ MI250X OAM (128 GB HBM2e, 560W) GPU with AMD Infinity Fabric™ technology using benchmark SuperBench v 0.4.0 benchmark, CPT2-Large. EPYC/Instinct system: Dual socket, 64 core, 2nd Gen AMD EPYC™ 7002 Series CPU powered server with 8x AMD Instinct™ MI250X OAM (128 GB HBM2e) 500W GPUs with AMD Infinity Fabric™ technology. Benchmark: CPT2-Large with AMD | Microsoft optimized batch sizes tuned for GPT2 powered server with 1x NVIDIA A100 SXM 80GB (400W), CUDA Base results for system configurations that are not yet available upstream. Benchmark Results: GPT2 resulted in a median throughput of 8x A100: DenseNet169 = 4712.705, DenseNet201 = 3877.668 Samples (Throughput)/ sec. Details on SuperBench here. Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-26B

- MI200-57 - Testing Conducted by AMD performance lab as of 25/5/2022 using SuperBench v 0.4.0 benchmark, CPT2-Large. EPYC/Instinct system: Dual socket, 64 core, 2nd Gen AMD EPYC™ 7002 Series CPU powered server with 8x AMD Instinct™ MI250X OAM (128 GB HBM2e) 500W GPUs with AMD Infinity Fabric™ technology. Benchmark: CPT2-Large with AMD | Microsoft optimized batch sizes tuned for GPT2-Large technology for system configurations that are not yet available upstream. Benchmark: CPT2-Large resulted in a median throughput of 8x MI250X = 767.08 Samples (Throughput)/ sec. Training model separates copies of model on each GPU: total system throughput obtained by calculating the sum of the throughput obtained on each GPU. Vs. EPYC/NVIDIA system: NVIDIA DGXA100, Dual AMD EPYC 7002 Series CPUs with 8x NVIDIA A100 80GB (400W), Benchmark: CPT2-Large Commit(Containe): superbench/superbench:v0.4.0-cuda11.11 from here. Testing conducted in a median throughput of 8x A100: 589.435 Samples (Throughput)/ sec. Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-57

- MI200-59 - Testing Conducted by AMD performance lab as of 25/5/2022 using SuperBench v 0.4.0 benchmark. DenseNet169/201, Framework PyTorch 1.9. EPYC/Instinct system: Dual socket, 64 core, 2nd Gen AMD EPYC™ 7002 Series CPU powered server with 8x AMD Instinct™ MI250X OAM (128 GB HBM2e) 500W GPUs with AMD Infinity Fabric™ technology. ROCM * 5.1.0 Benchmark: DenseNet model (Median scores of DenseNet169, DenseNet201 datasets) with AMD | Microsoft optimized batch sizes tuned for DenseNet results for system configurations that are not yet available upstream. Commit(Containe): compute/cpuperformanceยอดเยี่ยม57.3.15_superbench04 from here Benchmark Results: DenseNet testing resulted in median throughput scores of 8x MI250X: DenseNet169 = 6578.759, DenseNet201 = 5254.561 Samples (Throughput)/ sec. Training model separates copies of model on each GPU: total system throughput obtained by calculating the sum of the throughput obtained on each GPU. Vs. EPYC/NVIDIA system: NVIDIA DGXA100, Dual AMD EPYC 7002 Series CPUs with 8x NVIDIA A100 80GB (400W), CUDA 11.6 and Driver Version 510.47.03. Commit(Containe): superbench/superbench:v0.4.0-cuda11.11 from here. Testing conducted in a median throughput of 8x A100: DenseNet169 = 4712.705, DenseNet201 = 3877.668 Samples (Throughput)/ sec. Details on SuperBench here. Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-59

- MI200-61 - Testing Conducted by AMD performance lab as of 25/5/2022 using SuperBench v 0.4.0 benchmark, Bertracne. EPYC/Instinct system: Dual socket, 64 core, 2nd Gen AMD EPYC™ 7002 Series CPU powered server with 8x AMD Instinct™ MI250X OAM (128 GB HBM2e) 500W GPUs with AMD Infinity Fabric™ technology. ROCM * 5.1.0. PyTorch 1.9 Benchmark: Bert-Base with AMD | Microsoft optimized batch sizes tuned for Bert-Base results for system configurations that are not yet available upstream. Commit(Containe): compute/cpuperformance53.1.5_superbench04 from here Benchmark Results: Bert-Base resulted in a median throughput of 8x MI250X = 8320.032 Samples (Throughput)/ sec. Training model separates copies of model on each GPU: total system throughput obtained by calculating the sum of the throughput obtained on each GPU. Vs. EPYC/NVIDIA system: NVIDIA DGXA100, Dual AMD EPYC 7002 Series CPUs, CUDA 11.6 and Driver Version 510.47.03. Commit(Containe): superbench/superbench:v0.4.0-cuda11.11 from here. Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-61
Endnotes (Cont.)

- MI200-63 - Testing Conducted by AMD performance lab as of 25/5/2022 using SuperBench v 0.4.0 benchmark. Resnet 50/101/152 datasets. All configurations used Framework: PyTorch 1.9 EPYC/Instinct system: Dual socket, 64 core, 2nd Gen AMD EPYC™ 7002 Series CPU powered server with 8x AMD Instinct™ MI250X OAM (128 GB HBM2e) 500W GPUs with AMD Infinity Fabric™ technology, ROCm™ 5.1.0 Benchmark: Resnet model (Median scores of Resnet50, Resnet 101, Resnet152 datasets) with AMD | Microsoft optimized batch sizes tuned for Resnet results for system configurations that are not yet available upstream. Commit(Container): computecqe/superbench:rocml5.13_superbench04 from here Benchmark Results: Resnet testing resulted in median throughput scores of 8x MI250X: resnet50 = 9708.873, resnet101 = 6705.041, resnet152 = 5250.635 Samples (Throughput)/ sec. Training model separates copies of model on each GPU: total system throughput obtained by calculating the sum of the throughput obtained on each GPU. Vs. EPYC/Nvidia system: NVIDIA DGXA100, Dual socket 64-core AMD EPYC 7742 Series CPUs, with 8x NVIDIA A100 SXM 80GB (400W), CUDA 11.6 and Driver Version 510.47.03. OS: Benchmark model (Median scores of Resnet50, Resnet 101, Resnet152 datasets) Commit(Container): superbench/superbench:v0.4.0-cuda11.1 from here Benchmark Results: Resnet testing resulted in median throughput of 8x A100: resnet50 = 7057.052, resnet101 = 4968.324, resnet152 = 3806.318 Samples (Throughput)/ sec. Details on SuperBench found here Server manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and optimizations MI200-63

- MI300-03 - Measurements by AMD Performance Labs June 4, 2022. MI250X FP16 (306.4 estimated delivered TFLOPS based on 80% of peak theoretical floating-point performance). MI300 FP8 performance based on preliminary estimates and expectations. Actual results based on production silicon may vary. MI300-03