AMD MI355X and Instinct Platform

Complete Technical Documentation Pack for AI/HPC Supercluster Implementation

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1. AMD MI355X Technical Specifications

Architecture Overview

- **GPU Architecture:** CDNA 4 (4th Generation)
- **Process Node**: 3nm TSMC
- **Compute Units**: 256 CUs
- **Stream Processors**: 16,384
- **Target Availability:** H2 2025
- **Design Focus**: Disaggregated modular architecture

Memory Specifications

- **Memory Type:** HBM3E
- **Memory Capacity**: 288 GB
- **Memory Bandwidth:** 8 TB/s
- **Memory Interfaces**: 12× HBM3E stacks

Performance Metrics

- **FP64 Performance**: 165 TFLOPS
- **FP32 Performance:** 330 TFLOPS
- **FP16 Performance:** 1.32 PFLOPS
- **BF16 Performance**: 1.32 PFLOPS
- **FP8 Performance:** 2.64 PFLOPS
- **FP4 Performance:** 5.05 PFLOPS (10.1 PFLOPS with sparsity)
- **INT8 Performance:** 2.64 POPS

Power and Cooling

- **TDP (Liquid-cooled)**: 1400W
- **TDP (Air-cooled variant)**: 1000W
- **Form Factor**: OAM (OCP Accelerator Module)
- **Cooling Requirements:** Direct liquid cooling mandatory for 1400W variant

- **Operating Temperature**: 0°C to 45°C (liquid), 0°C to 35°C (air)

Interconnect Technology

- **Infinity Fabric Links**: 7× bidirectional
- **Per-Link Bandwidth**: 153.6 GB/s
- **Total IF Bandwidth**: 1.075 TB/s
- **Future UALink Support**: MI400 series (2026)

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2. Official AMD Documentation Downloads

Primary Documentation

1. AMD MI355X GPU Datasheet (PDF)
   - Complete specifications
   - Architecture details
   - Performance metrics
2. AMD MI355X Platform Datasheet (PDF)
   - Server integration guidelines
   - Platform requirements
   - Cooling specifications
3. AMD Instinct MI300 Series Cluster Reference Guide (PDF)
   - Cluster design patterns
   - Networking architecture
   - Scaling guidelines
   - Storage integration

Product Pages

- MI355X Product Page
- MI350 Series Overview
- AMD Instinct Accelerators

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3. AMD GPU Roadmap and Evolution

Current Generation (Available Now)

MI300X (Production)

- 192 GB HBM3
- 5.3 TB/s memory bandwidth
- 750W TDP
- 8× Infinity Fabric links

MI300A (APU - CPU+GPU)

- 128 GB HBM3
- 24 Zen 4 CPU cores + GPU
- Unified memory architecture
- 760W TDP

Next Generation (2025-2026)

MI355X (H2 2025)

- 288 GB HBM3E
- 8 TB/s bandwidth
- Disaggregated architecture
- 1400W TDP

MI400 Series (2026)

- UALink 1.0 support (rack-scale)
- Enhanced Infinity Fabric
- Next-gen packaging

Future (2027+)

MI500 Series

- UALink 2.0 (256 accelerators)
- Advanced chiplet design
- Sub-2nm process technology

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4. Server Platform Support for AMD GPUs

AMD Reference Platforms

AMD Instinct MI300X Platform

- **Form Factor**: 8× OAM modules

- **Interconnect**: Full mesh Infinity Fabric
- **Power**: Up to 12kW per server
- **Cooling**: Direct liquid cooling required

Dell EMC Solutions

PowerEdge XE9680L

- **GPU Support**: 8× MI300X/MI355X OAM
- **Form Factor**: 6U liquid-cooled
- **Memory**: Up to 8TB DDR5
- **Networking**: 8× 400GbE ports
- **Power**: 10kW+ capability

PowerEdge XE8640

- **GPU Support**: 4× MI300X (PCIe variant)
- **Alternative configuration for lower density**

SuperMicro AMD Platforms

AS-8125GS-TNHR

- **GPU Support**: 8× MI300X OAM
- **Processors**: Dual AMD EPYC 9004
- **Memory**: 24× DDR5 slots
- **Cooling**: Liquid cooling required
- **Power**: 12kW total system power

AS-4125GS-TNRT

- **GPU Support**: 8× PCIe accelerators
- **Compatible with MI300X PCIe variant**
- **Air or liquid cooling options**

Lenovo ThinkSystem

SR780a V3 (Liquid-cooled)

- **Potential MI355X support pending validation**
- **Neptune 6th Gen liquid cooling**
- **8× OAM capable platform**

HPE Cray Systems

HPE Cray EX4000

- **Designed for MI300X/MI355X**
- **Blade architecture**
- **Advanced liquid cooling**
- **Slingshot interconnect option**

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5. ROCm Software Stack

ROCm 7.0 (Latest Release - 2025)

Key Features:

- Full PyTorch 2.5 support
- TensorFlow 2.15 compatibility
- JAX acceleration
- Unified memory management
- Enhanced profiling tools

Download and Documentation:

- [ROCm Installation Guide]
- [ROCm GitHub Repository]
- [AMD Developer Resources]

Framework Support

```bash
# ROCm-optimized containers
docker pull rocm/pytorch:rocm6.2_ubuntu22.04_py3.10_pytorch_2.3.0
docker pull rocm/tensorflow:rocm6.2_ubuntu22.04_py3.10_tf_2.15
```

Development Tools

- **rocprof**: Performance profiling
- **rocgdb**: GPU debugging
- **hipcc**: HIP compiler
- **MIGraphX**: Graph optimization
- **rocBLAS/rocFFT**: Optimized libraries

6. Networking for AMD MI355X Clusters

Current Networking (RoCEv2)

AMD currently relies on third-party NICs for cluster networking:

Recommended NICs:

- NVIDIA ConnectX-7 (400 Gb/s)
- Intel E810-2CQDA2 (200 Gb/s)
- Broadcom BCM957508 (200 Gb/s)

Configuration for AMD Clusters:

```yaml
RoCEv2 Settings:
  MTU: 9000
  DSCP: 48
  ECN: enabled
  PFC: priority 3
  Congestion: DCQCN
  RDMA: enabled
  GPUDirect: requires ROCm 5.4+
```

Infinity Fabric Interconnect

Intra-node Communication:

- 7× bidirectional links per GPU
- 153.6 GB/s per link
- 1.075 TB/s aggregate bandwidth
- Full mesh topology within server

Topology Options:

- Fully connected (8 GPUs)
- Ring topology (>8 GPUs)
- Hypercube (large configurations)

Future: UALink Consortium

UALink 1.0 (2026 with MI400):

- Industry standard for accelerator interconnect
- 200 GB/s per link
- Scale to 1024 accelerators
- Members: AMD, Intel, Google, Meta, Microsoft

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7. Cluster Architecture for MI355X

Reference Architectures

Small Cluster (256-1024 GPUs)

```
Configuration:
- 32-128 servers (8 GPUs each)
- 8-32 racks
- 2-tier leaf-spine network
- 400 GbE per GPU
- Single pod design
```

Medium Cluster (1024-10,000 GPUs)

```
Configuration:
- 128-1250 servers
- 32-312 racks
- 3-tier fat-tree network
- 800 GbE per GPU recommended
- Multi-pod with optical switching
```

Large Cluster (10,000-100,000 GPUs)

```
Configuration:
- 1250-12,500 servers
- Multiple datacenter halls
- Dragonfly+ or 3-tier Clos
- Multiple network planes
- Campus-scale deployment
```

Pod Design for MI355X

Recommended Pod Configuration:

- **Pod Size**: 512 GPUs (64 servers)
- **Racks**: 16 (4 servers per rack)

- **Power per Rack**: 56 kW (liquid-cooled)
- **Network**: 2× 800 GbE spine switches
- **Cooling**: 100% liquid cooling required

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8. Power and Cooling Infrastructure

Power Requirements at Scale

1,000 MI355X GPUs (1400W variant)

- GPU Power: 1.4 MW
- Server Overhead: 200 kW
- Networking: 50 kW
- **Total IT Load**: 1.65 MW
- **With PUE 1.2**: 1.98 MW

10,000 MI355X GPUs

- GPU Power: 14 MW
- Server Overhead: 2 MW
- Networking: 500 kW
- **Total IT Load**: 16.5 MW
- **With PUE 1.2**: 19.8 MW

50,000 MI355X GPUs

- GPU Power: 70 MW
- Server Overhead: 10 MW
- Networking: 2.5 MW
- **Total IT Load**: 82.5 MW
- **With PUE 1.2**: 99 MW

Liquid Cooling Requirements

Direct-to-Chip Liquid Cooling:

- **Flow Rate**: 1.5-2.0 LPM per GPU
- **Temperature Delta**: 10-15°C
- **Inlet Temperature**: 20-30°C
- **Pressure Drop**: <1.5 bar

- **Coolant**: Deionized water or glycol mix

Infrastructure Needs:

- **CDU Capacity**: 500-1000 kW per unit
- **Redundancy**: N+1 CDU configuration
- **Piping**: Stainless steel or approved polymers
- **Leak Detection**: Mandatory at all connections

Cooling Vendors for MI355X

- **Vertiv XDU**: Up to 1.3 MW per unit
- **CoolIT Systems**: Direct-to-chip solutions
- **Asetek**: OAM-specific cooling
- **Motivair**: ChilledDoor and CDU systems

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9. Storage Solutions for AMD Clusters

Recommended Storage Platforms

VAST Data

- AMD MI300X validated
- 20 GB/s per node
- RDMA support
- QLC flash optimized

WekaFS

- ROCm integration
- GPUDirect Storage compatible
- 100+ GB/s per cluster
- S3 API support

DDN AI400X2

- 90 GB/s per appliance
- Parallel filesystem
- AMD reference architecture
- 360 TB capacity per 2U

Ceph (Budget Option)

- Open source
- Object/block/file
- Scale-out architecture
- Lower performance tier

Performance Guidelines

```
Per GPU Requirements:
- Bandwidth: 2-5 GB/s
- IOPS: 10,000-50,000
- Latency: <500 microseconds
- Capacity: 200-500 GB active dataset
```

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10. TCO Analysis for MI355X Deployment

Component Pricing (Estimated)

Hardware Costs:

- MI355X GPU: $15,000-25,000 (estimated)
- 8-GPU OAM Server: $150,000-250,000
- 800GbE Switch: $150,000-300,000
- Liquid Cooling Infrastructure: $1,000 per kW

10,000 GPU Deployment TCO

Capital Expenses:

```
GPUs:                    $200M
Servers (1,250):         $250M
Networking:              $75M
Storage:                 $50M
Cooling Infrastructure:  $50M
Facilities Upgrade:      $25M
Total CapEx:             $650M
```

Operating Expenses (Annual):

```
Power (19.8 MW):        $15M
Cooling Maintenance:     $2M
Staff (20 FTEs):         $4M
Hardware Maintenance:    $32M
Software Licenses:       $5M
Total OpEx:              $58M/year
```

3-Year TCO: $824M

Cost Comparison

Metric	MI355X	H100 SXM	RTX 6000 Ada
GPU Cost	$20,000	$30,000	$7,000
Power/GPU	1400W	700W	300W
Memory	288 GB	80 GB	48 GB
$/GB Memory	$69	$375	$146
3-Year Power	$3,700	$1,850	$790

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11. Deployment Timeline and Planning

Pre-Deployment Phase (6-12 months before)

- [ ] Finalize GPU allocation from AMD
- [ ] Design liquid cooling infrastructure
- [ ] Order electrical infrastructure upgrades
- [ ] Plan datacenter modifications
- [ ] Establish vendor partnerships

Infrastructure Phase (3-6 months before)

- [ ] Install liquid cooling systems
- [ ] Deploy power distribution
- [ ] Build network fabric
- [ ] Set up storage systems
- [ ] Implement monitoring infrastructure

Deployment Phase

- [ ] Rack and stack servers
- [ ] Connect liquid cooling loops
- [ ] Cable network fabric
- [ ] Install ROCm stack
- [ ] Configure orchestration

- [ ] Run validation tests

Production Readiness

- [ ] Benchmark performance
- [ ] Stress test cooling
- [ ] Validate redundancy
- [ ] Train operations team
- [ ] Document procedures

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12. Mixed Workload Support

Service Tier Implementation

Tier 1: Bare Metal as a Service

```yaml
Platform: OpenStack Ironic / MAAS
Allocation: Per-GPU or per-node
Network: SR-IOV for isolation
Storage: Direct-attached NVMe
```

Tier 2: BM + Kubernetes

```yaml
Platform: K8s with AMD GPU Operator
Scheduling: GPU-aware schedulers
Isolation: MIG equivalent (future)
Monitoring: DCGM-like metrics
```

Tier 3: Full MLOps Platform

```yaml
Stack:
  - Kubeflow/MLflow
  - JupyterHub
  - Model Registry
  - Experiment Tracking
  - Data Versioning (DVC)
```

Tier 4: Inference as a Service

```yaml
Framework: Triton Inference Server
Optimization: TensorRT equivalent
Auto-scaling: Based on queue depth
Load Balancing: Round-robin/least-loaded
```

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13. Competitive Analysis

MI355X vs Competition

Feature	MI355X	NVIDIA H200	Intel Gaudi 3
Memory	288 GB	141 GB	128 GB
Memory BW	8 TB/s	4.8 TB/s	3.6 TB/s
FP8 TFLOPS	2,640	1,979	1,835
TDP	1400W	700W	600W
Interconnect	IF + RoCEv2	NVLink + IB	RoCEv2
Software	ROCm	CUDA	OneAPI
Availability	H2 2025	Now	Now

Strengths

- Highest memory capacity (288 GB)
- Exceptional memory bandwidth (8 TB/s)
- Open software ecosystem (ROCm)
- Competitive pricing expected
- Strong hyperscaler adoption

Limitations

- Extreme power consumption (1400W)
- Requires liquid cooling
- Limited server ecosystem currently
- No equivalent to NVLink (until UALink)
- Software maturity behind CUDA

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14. Best Practices and Recommendations

When to Choose MI355X

✅ **Ideal Use Cases:**

- Memory-bound workloads
- Large language models (>100B parameters)
- Scientific computing (FP64)
- Cost-sensitive deployments
- Open-source software stack preference

❌ **Avoid For:**

- Power-constrained facilities
- Air-cooled only datacenters
- Applications requiring NVLink
- CUDA-dependent workflows
- Small-scale deployments (<100 GPUs)

Implementation Strategy

1. **Start with MI300X** for immediate deployment
2. **Plan liquid cooling** infrastructure now
3. **Develop on ROCm** to ensure compatibility
4. **Design for UALink** future upgrade path
5. **Partner with AMD** for early access and support

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15. Support and Resources

AMD Support Channels

- **Enterprise Support**: Direct AMD engagement
- **ROCm Forums**: community.amd.com
- **GitHub**: github.com/RadeonOpenCompute
- **Documentation**: rocm.docs.amd.com

Training Resources

- **AMD Instinct University**: Online training
- **Partner Training**: Dell, HPE, SuperMicro

- **ROCm Learning Center**: Developer tutorials

Ecosystem Partners

- **PyTorch**: Native ROCm support
- **Hugging Face**: ROCm-optimized models
- **MLPerf**: Performance benchmarks
- **OpenAI Triton**: Kernel development

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16. Future Roadmap Implications

2026: MI400 Series + UALink

- Rack-scale coherent fabric
- 72 accelerators per rack
- Enhanced chiplet architecture
- PCIe Gen6 support

2027: MI500 Series

- UALink 2.0 (256 accelerators)
- Advanced packaging (3D)
- Sub-2nm process
- Integrated networking

Long-term Strategy

- **Adopt MI355X** for memory-intensive workloads
- **Prepare for UALink** ecosystem
- **Invest in liquid cooling** infrastructure
- **Develop ROCm expertise** internally
- **Plan for heterogeneous** GPU clusters

Key Takeaways

1. **MI355X offers 288 GB memory** - industry-leading capacity
2. **1400W TDP requires liquid cooling** - no air-cooled option
3. **H2 2025 availability** - plan infrastructure now
4. **ROCm ecosystem maturing** - PyTorch/TensorFlow ready

5. **UALink future** promises better scaling (2026+)
6. **Cost-competitive** with NVIDIA expected
7. **Hyperscaler adoption** driving ecosystem

For organizations with liquid cooling infrastructure and memory-intensive workloads, MI355X represents a compelling alternative to NVIDIA's dominance, especially considering the 3.6× memory capacity advantage over H100/H200.