



GENESIS

Technical Brief

CONTACT

ASCEND Center: Dr. Anthony Skjellum | askjellum@tntech.edu

Procurement & Systems Integration: Michael Todd, MJM Systems | mtodd@mjmssystems.com

EXECUTIVE SUMMARY

GENESIS is Tennessee Technological University’s ASCEND Center (Advanced Scalable Computing, Extreme Networks & Data) flagship high-performance computing (HPC) cluster for AI and scientific computing.

Designed to support advanced artificial intelligence, scientific computing and data-intensive research, GENESIS provides Tennessee Tech researchers, students and collaborators with access to nationally competitive computing infrastructure capable of supporting modern AI and large-scale simulation workloads.

GENESIS is housed at the Crossville Research Center, which is envisioned as Tennessee’s next high-technology Research Park — a hub for industry collaboration, startup activity, and federal partnerships.

ABOUT THE ASCEND CENTER

The ASCEND Center (Advanced Scalable Computing, Extreme Networks & Data) is Tennessee Tech’s flagship research center in high-performance computing, AI infrastructure, and extreme-scale networking. Directed by Dr. Anthony Skjellum, a pioneering figure in HPC standards including the MPI (Message Passing Interface) standard, ASCEND drives workforce development, builds national-laboratory partnerships, and positions Tennessee Tech as a key contributor to the nation’s computational science enterprise.

ASCEND’s research mission spans HPC systems and algorithms, AI and machine learning, quantum computing readiness, cybersecurity, and scientific data management. ASCEND students have presented research at SC (Supercomputing) conferences, interned at Lawrence Livermore National Laboratory and Sandia National Laboratories, and contributed to high-impact publications and standards efforts.

GENESIS SYSTEM OVERVIEW

GENESIS is built on 27 Supermicro AS-4145GH-TNMR server nodes powered by AMD Instinct™ MI300A Accelerated Processing Units (APUs), delivering 13.2 PFLOPS of peak FP64 compute and 211.7 PFLOPS of AI tensor performance.

System Highlights

- 27 advanced server nodes
- 108 AMD Instinct MI300A accelerated processing units
- More than 13 quadrillion calculations per second
- 13.5 TB unified HBM3 memory
- Approximately 3.5 PB storage capacity



THE AMD INSTINCT™ MI300A: PERFORMANCE SPECIFICATIONS

Each GENESIS server node is powered by four AMD Instinct™ MI300A APUs — the world’s first accelerated processing units to combine a high-performance CPU, CDNA3 GPU, and high-bandwidth memory in a single package at HPC scale. The MI300A’s unified memory architecture eliminates the PCIe data-transfer bottleneck that constrains traditional GPU computing systems.

Performance Specifications — Per AMD MI300A APU

Specification	Value
Architecture	CDNA3 GPU + Zen 4 CPU (same package)
CPU Cores	24-core AMD EPYC (Zen 4), 3.7 GHz
GPU Compute Units	228 CDNA3 Compute Units
Unified HBM3 Memory	128 GB (CPU + GPU share — zero PCIe copy)
Memory Bandwidth	5.2 TB/s
FP64 Matrix Performance	122.6 TFLOPS
BF16 Tensor (AI Training)	1,307.4 TFLOPS
FP16 Tensor (Inference)	1,307.4 TFLOPS
INT8 Tensor (AI Inference)	2,614.9 TOPS
TDP	550 W

GENESIS — AGGREGATE CLUSTER PERFORMANCE

Cluster Metric	Value	Basis
Total Compute Nodes	27	Supermicro AS-4145GH-TNMR
Total AMD MI300A APUs	108	4 APUs × 27 nodes
Peak FP64 Performance	13.2 PFLOPS	108 × 122.6 TFLOPS
Peak BF16 AI Performance	137.8 PFLOPS	108 × 1,307 TFLOPS
Total INT8 AI Throughput	275.7 POPS	108 × 2,614 TOPS
Total Unified HBM3 Memory	13.5 TB	108 × 128 GB
Aggregate Memory Bandwidth	567 TB/s	108 × 5.2 TB/s
Total Zen 4 CPU Cores	2,592	108 × 24 cores
Total GPU Compute Units	24,624	108 × 228 CUs

SUPERMICRO AS-4145GH-TNMR SERVER NODES

Each GENESIS compute node is a Supermicro AS-4145GH-TNMR 4U rackmount server purpose-built for AMD MI300A APU deployments. Each node includes:

- 4× AMD MI300A APUs delivering 490 TFLOPS FP64 and 512 GB unified HBM3 per node
- 4× 960 GB Micron 7450 PRO NVMe SSDs (PCIe 4.0, M.2, 110 mm) for fast local scratch storage
- 2× 200G NVIDIA ConnectX-7 InfiniBand/Ethernet adapters (PCIe Gen 5 × 16) for compute fabric
- 2× 25GbE NVIDIA CX-6 LX adapters (SFP28, OCP 3.0) for management and data networking
- TPM 2.0 hardware security module; SMC DCMS node management software license
- 3-year warranty: 3 years labor, 3 years parts, 1-year critical response support

NETWORKING & STORAGE

The GENESIS compute fabric is powered by three NVIDIA QM9700 NDR InfiniBand switches with 64 non-blocking 400G ports that enable scalability and sub-microsecond latency for tightly coupled MPI workloads. A 16-port NVIDIA Skyway will enable the primary GENESIS compute fabric to communicate with Ethernet networks without compromising on performance within the compute zone.

Storage for GENESIS is provided by a DDN EXAScaler 400NVX2 Appliance. In addition, 2 SS9024 HDD enclosures populated with 180 26TB HDDs support the system, totaling approximately 3.5 PB of usable storage totaling approximately 3.5 PB of usable storage.

POWER, COOLING & PHYSICAL INFRASTRUCTURE

GENESIS will be housed in Crossville, TN at Tennessee Tech's Crossville Research Center. Designed and installed by Joe Powell & Associates, a custom power/cooling solution provides up to 140 kW (480 kBTU/hr) of cooling capacity and up to 120kVA of power conditioning. This solution comprises four Vertiv Liebert CR035RA in-row cooling units, four Liebert MCL055 Microchannel Condensers, and 1 120kVA Vertiv APM2 UPS. A VS3750 Vertiv SmartCabinet will enable ASCEND staff and researchers to house supporting systems and begin qualifying research software in parallel with the deployment of primary power and cooling systems.

Plans exist to double the current power and cooling capacity for GENESIS as supplements and enhancements are funded.

RESEARCH CAPABILITIES ENABLED BY GENESIS

GENESIS is designed to serve the full breadth of Tennessee Tech's research mission, with particular strength in:

- AI and large-scale machine learning — training frontier models directly on unified HBM3 memory, eliminating GPU memory walls
- Computational fluid dynamics, finite element analysis, and large-scale engineering simulations
- Molecular dynamics and quantum chemistry for materials science and pharmaceutical research
- Climate, weather, and environmental modeling with high-resolution regional simulations
- Multi-physics simulations running seamlessly across CPU and GPU
- Cybersecurity research including AI-driven threat analysis at scale
- Data analytics and visualization of petabyte-scale datasets from experiments and sensors
- Quantum computer simulation

ABOUT TENNESSEE TECHNOLOGICAL UNIVERSITY

Tennessee Technological University (Tennessee Tech) is a public research university in Cookeville, Tennessee, founded in 1915. Ranked among the top national universities by U.S. News & World Report for nine consecutive years, Tennessee Tech boasts the highest freshman retention rate, highest four-year graduation rate, and highest early post-college salary levels among all Locally Governed Institutions in Tennessee. The university recently recorded its highest total enrollment since 2015 and set an all-time enrollment record in the College of Engineering.

Tennessee Tech holds a Carnegie classification of R2: Doctoral Universities – High Research Activity with an additional recognition as an “Opportunity” university for higher access and higher earnings. Learn more about Tennessee Tech: tntech.edu.