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ENERGY SCIENCES NETWORK

BERKELEY LAB

U.S. DEPARTMENT OF ENERGY

Networking for the American Science Cloud

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What is Genesis Mission | American Science Cloud?

H.R.1 - An Act to provide for reconciliation pursuant to title II of H. Con. Res. 14

Sec. 50404 Transformational Artificial Intelligence Models

(a) Definitions.--In this section:

(1) **American science cloud**.--The term "American science cloud" means a system of United States government, academic, and private sector programs and infrastructures utilizing cloud computing technologies to facilitate and support scientific research, data sharing, and computational analysis across various disciplines while ensuring compliance with applicable legal, regulatory, and privacy standards.

(2) Artificial intelligence.--The term "artificial intelligence" has the meaning given the term in section 5002 of the National Artificial Intelligence Initiative Act of 2020 (15 U.S.C. 9401).

(b) **Transformational Models**.--The Secretary of Energy shall–

(1) mobilize National Laboratories to partner with industry sectors within the United States to curate the scientific data of the Department of Energy across the National Laboratory complex so that the data is structured, cleaned, and preprocessed in a way that makes it suitable for use in artificial intelligence and machine learning models; and

(2) initiate seed efforts for self-improving artificial intelligence models for science and engineering powered by the data described in paragraph (1).

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Source: https://www.congress.gov/bill/119th-congress/house-bill/1/text

AmSC is a First-of-a-Kind Integrated Platform for Transformative Science

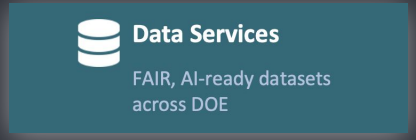
- Deliver a **common fabric** for scientists to build on
- Provide **modular services and abstractions** used to accelerate discovery cycles
- Leverage **science and industry innovations** rapidly as they are integrated into the platform
- Build a science-focused platform through **co-design**

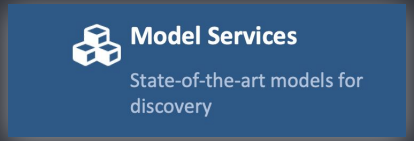
AI-driven scientific discovery in the Genesis Mission

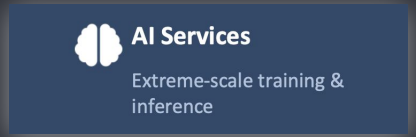
AmSC enables DOE scientists and collaborating teams to

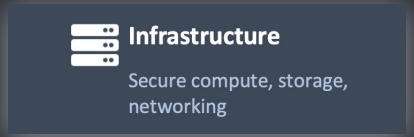
- Create, access, and integrate world-class AI-ready datasets
- Run scalable model training on contributed compute infrastructure
- Perform large-scale modeling-simulation and AI
- Control instruments
- Move data efficiently across sites

AmSC enables custom science workflows to run across secure compute, storage, and data providers connected via high-speed networks









AmSC works closely with ModCon Transformational AI Models Consortium

ModCon Mission

- Establish a consortium to accelerate the technical development and scientific discovery of the Model Teams
- Develop and deliver domain cross-cutting services as an engine for transformational AI model development
- Convene partners from industry, academia, and internationally to accelerate AI development and adoption

Four Core Teams

deliver support to Genesis Teams

IPPF
Partnerships and IP Management

DBS
Data Brokers & Standards

BPSW
Best Practices for Scientific Workflows

BASE
Cross-Cutting AI Capabilities

ModCon to Deliver

AI-Ready Data Pipelines
Transform raw scientific data into training-ready datasets

Scientific Workflows
Leaderboards, workflows, and upskilling for continuous discovery

Transformational Capabilities

- Core Agentic Framework
- Self-Improving Models Harness
- Multimodal Reasoning Frontends
- Safety, Security, Assurance
- Evaluation

Genesis Mission - A National Mission to Accelerate Science Through Artificial Intelligence

What is the Genesis Mission?

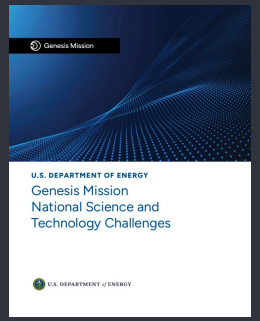
A national initiative led by the Department of Energy and its 17 National Laboratories to build the world's most powerful scientific platform to accelerate **discovery**, strengthen **national security**, and drive **energy innovation**.

https://genesis.energy.gov

Goal:

Genesis Mission will develop an **integrated platform** that connects the world's best **supercomputers, experimental facilities, AI systems, and unique datasets** across every major scientific domain to **double the productivity and impact** of American research and innovation within a decade.

Genesis Mission 26 Sciences and Technology Challenges



https://www.energy.gov/documents/genesis-mission-science-and-technology-challenges

- Reenvisioning Advanced Manufacturing and Industrial Productivity
- Reimagining Construction and Operation of Buildings
- Scaling the Biotechnology Revolution
- Securing America's Critical Minerals Supply
- Delivering Nuclear Energy that is Faster, Safer, Cheaper
- Accelerating Delivery of Fusion Energy
- Transforming Nuclear Cleanup and Restoration
- Discovering Quantum Algorithms with AI
- Realizing Quantum Systems for Discovery
- Recentering Microelectronics in America
- Securing U.S. Leadership in Data Centers
- Accelerating Materials Discovery, Production, and Qualification for Strategic Deterrence
- Achieving AI-Driven Autonomous Laboratories
- Designing Materials with Predictable Functionality
- Enhancing Particle Accelerators for Discovery
- Unifying Physics from Quarks to the Cosmos
- Predicting U.S. Water for Energy
- Scaling the Grid to Power the American Economy
- Unleashing Subsurface Strategic Energy Assets
- Accelerating Nuclear Threat Assessment, Preparedness, and Response
- Harnessing America's Historic Nuclear Data and Research
- Increasing Experimental Capacity at Nuclear Research Facilities
- Integrating Design and Production Operations for Nuclear Deterrence
- Safeguarding Nuclear Materials from Proliferation Threats
- Streamlining Production, Removing Red Tape, and Ensuring Safety in the Nuclear Enterprise
- Strengthening Deterrence Through Attribution of Nuclear and Radiological Signatures

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AmSC is a cornerstone of the Genesis Mission platform

- **National Science and Technology Challenges -** High-impact scientific efforts to address Genesis Mission priorities, selected in response to the current RFA. These projects may be users of the Genesis Mission platform and therefore AmSC.
- **The Model Consortium (ModCon) -** developing tools and frameworks that will be hosted by AmSC infrastructure
- **AmSC is a coalition of Infrastructure Partners (IPs):** DOE labs that contribute and integrate core capabilities into AmSC

National S&T Challenges:
Leverage ModCon and AmSC services to accelerate scientific discovery

Model Consortium:
Develop AI models & workflows that are supported by AmSC

AmSC Infrastructure Partners:
Integrate core capabilities into AmSC

What are the networking challenges facing AmSC?

AI Traffic is Rising - Agentic workflows will drive demand

1448%	75%+	10x	36x	63%
Increase in tokens processed by AI models in the last 12 months	Of inference-driven data creation and processing at the edge by 2030	Bandwidth required upstream compared to downstream	Increase in AI traffic as early as 2023-2024	Of predicted traffic growth in 2035 is expected to be AI related

Antich, J (2026). The Impact of AI in the WAN. A data-drive analysis. CTO Office, Provider Connectivity, Cisco. NetNod 2026. https://www.netnod.se/sites/default/files/2026-03/2.%20Javier%20Antich%20AI%20impact%20Cisco.pptx_.pdf

ESnet7 is expected to deploy an addition 50-70% above the current historical growth trend to accommodate for AI workflows.

Multi-year fiber Indefeasible Right of Use (IRU) for national (and trans-Atlantic) links provides the agility, flexibility, and velocity to deploy “raw” bandwidth as needed

Open Line System (OLS) prevents vendor lock-in and allows for latest transponder technology to be deployed regardless of vendor

Post Quantum Encryption (PQC) will be needed to protect sensitive AI related communications and support data privacy.

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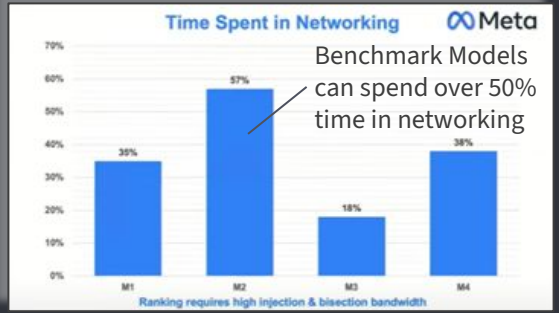
Predictable Networking is Critical for AI Workflows - Networks must provide negotiable Service Guarantees

Emerging AI applications, such as autonomous laboratories, experiment fast-feedback, and real-time interactive agents, rely on instantaneous data processing to function safely and effectively. Network QoS, reliability and stability are critical to workflow performance integrity.

ESnet is exploring AI (network foundation) models to predict short term traffic congestion to selectively reroute critical traffic.



Bjorlin, A (2022). Infrastructure for Large-Scale AI. VP of Engineering, Infrastructure, Meta. OPC Global summit 2022. https://drive.google.com/file/d/1qqjo-5JtYAcRlK_LWYuQFH-b9MoFOP02/view

ESnet WAN Traffic Engineering (TE) and Quality of Service (QoS) controls provide fine grain service differentiation for selected traffic.

Tools like SENSE provides a way for workflows to programmatically interact with the network to request multi-domain end-to-end guaranteed bandwidth.

ESnet is collaborating with UCSB on NetBurst, focusing on event-centric forecasting of bursty, intermittent time series data in network environments.

Wireless edge deployments extends ESnet's networking capabilities into remote areas to support field science.

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AI Workflows need Data-Aware Infrastructure - Networking must be woven into the very fabric of data services

Hyperscalers (AWS, Google Cloud, and Microsoft Azure) have moved away from treating the network as a "pipe" that simply connects servers. Instead, they treat networking as an integrated fabric that is co-designed with compute, storage, and AI accelerators.

ESnet7 design requirements are intimately tied to its role as the American Science Cloud WAN data fabric.

Genesis Mission | AMERICAN SCIENCE CLOUD

The American Science Cloud (AmSC) is a cornerstone of the Genesis Mission's platform—an integrated, federated platform that connects AI models, curated scientific data, workflows, and computing resources across DOE laboratories to accelerate discovery, enable autonomous science, and scale impact to the broader research ecosystem.

In-network caching within ESnet has shown up to 70% of data reuse for LHC CMS, reducing network congestion in the WAN.

The Integrated Research Infrastructure (IRI) initiative provides a framework to integrate compute, storage, network, and instrument resources.

EJFAT integrates compute load balancing with networking to facilitate real-time streaming and processing at 100Gbps and higher.

Frictionless cloud access is needed to overcome "data gravity", enable cloud bursting, and support job placement agility.

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AI attacks are increasing in scale, frequency and complexity - Networks need automated and autonomous management

*"The rise of AI-generated threats dramatically increases the volume and variety of malware you face. This means relying less on static signatures and more on **behavioral analytics and AI-driven detection** to automatically identify and stop the flood of novel threats at scale." - 2026 Global Threat Research Report, elastic security labs*

ESnet7 will incorporate AI intelligent decision making to bridge high-fidelity network monitoring with full stack network automation.

DARPA AI Cyber Challenge (AIxCC) (2023-2025)
Cyber Reasoning Systems (CRS) to discover and remediate vulnerabilities in real-world open-source software

42	7	143	53	$85K	$50K
Teams	Finalist	Hours	Challenge Problems	Cloud	LLM API Credits

All 7 teams found 0-day vulnerabilities, yielding 25 distinct vulnerabilities across 10 projects, of which 12 (48%) were patched.

SoK: DARPA's AI Cyber Challenge (AIxCC): Competition Design, Architectures, and Lessons Learned, 2026, https://arxiv.org/html/2602.07666v2#A9

ESnet's High-Touch system provides packet level visibility at scale across the ESnet WAN perimeter.

ESnet is a principal contributor to the WorkFlow Orchestrator (WFO), an R&E co-developed network orchestration tool.

ESnet's AIOps ORBIT project aims to reduce incident resolution time by implementing a semantic search across ESnet's multimodal operations data sets.

ESnet is collaborating with UCSB on *netFound*, a domain-specific foundation model for network security.

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A Remote Inferencing Example

In-network caching acts a temporal data lake, storing the data stream in case of processing failure. The data can be subsequently streamed to a different compute resource.

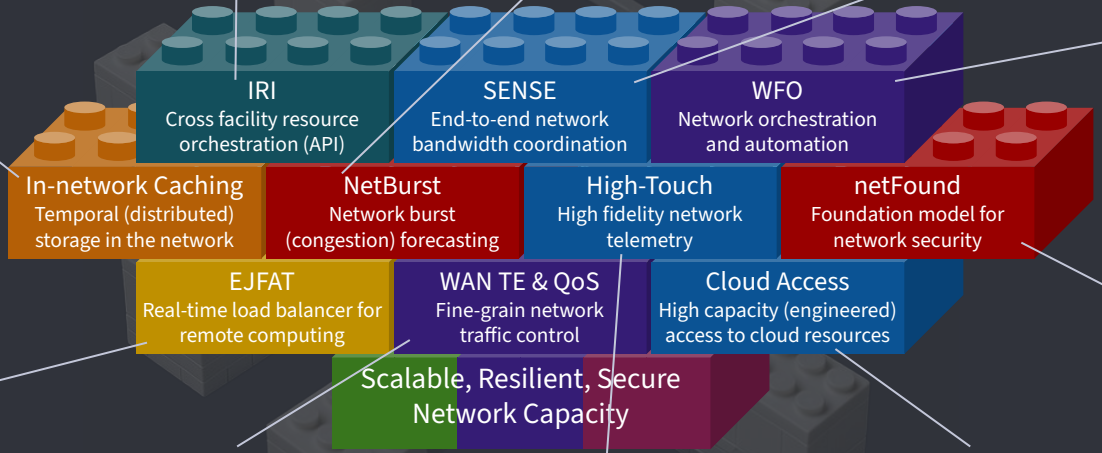
IRI provides the API to acquire CSP resources for inferencing.

NetBurst forecasts congestion in the network to proactively reroute time-sensitive traffic.

SENSE understands the end-to-end connection topology and orchestrates network bandwidth resources.

WFO gets requests from SENSE, consults NetBurst, and dynamically provisions guaranteed bandwidth virtual circuits in ESnet.

Experiment streams data to the Cloud for real-time inferencing.



EJFAT takes the data stream and load balances it on Cloud resources (and shunts a duplicate stream into the in-network temporal data lake.

WAN TE & QoS ensures the data stream is routed over uncongested paths and receives the right service guarantees.

High-Touch monitors traffic packet level activity in the network. This information is fed to NetBurst and netFound.

Cloud access ensures optimal connectivity to CSP resources.

netFound monitors the network for unusual activity.

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"The data center is the new unit of compute."

— Jensen Huang *(circa 2020)*

Co-founder, President, CEO of NVIDIA

“In the AI era, the WAN is the new LAN and the continent is the data center."

— Bikash Koley *(circa 2025)*

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