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ENERGY SCIENCES NETWORK

BERKELEY LAB

U.S. DEPARTMENT OF ENERGY

# AI (Artificial Intelligence), AmSC (American Science Cloud), and the Genesis Mission

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ESnet

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Helsinki, Finland
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# Some thoughts on AI

*“AI will reinvent virtually every customer experience we know, and enable altogether new ones about which we’ve only fantasized.” - Andy Jassy, Amazon CEO (circa 2025)*

*“AI is the defining technology of our times. It’s augmenting human ingenuity and helping us solve some of society’s most pressing challenges.” - Satya Nadella, CEO of Microsoft (circa 2018)*

*“AI is probably the most important thing humanity has ever worked on. I think of it as something more profound than electricity or fire,” - Sundar Pichai, CEO of Google (circa 2018)*

*“Just like every business has an email address and a website and a social media account, I think, in the future, every business is going to have an AI.” - Mark Zuckerberg, CEO of Meta (circa 2024)*

*“A computer would deserve to be called intelligent if it could deceive a human into believing that it was human.” - Alan Turing, Computing Pioneer (circa 1950)*

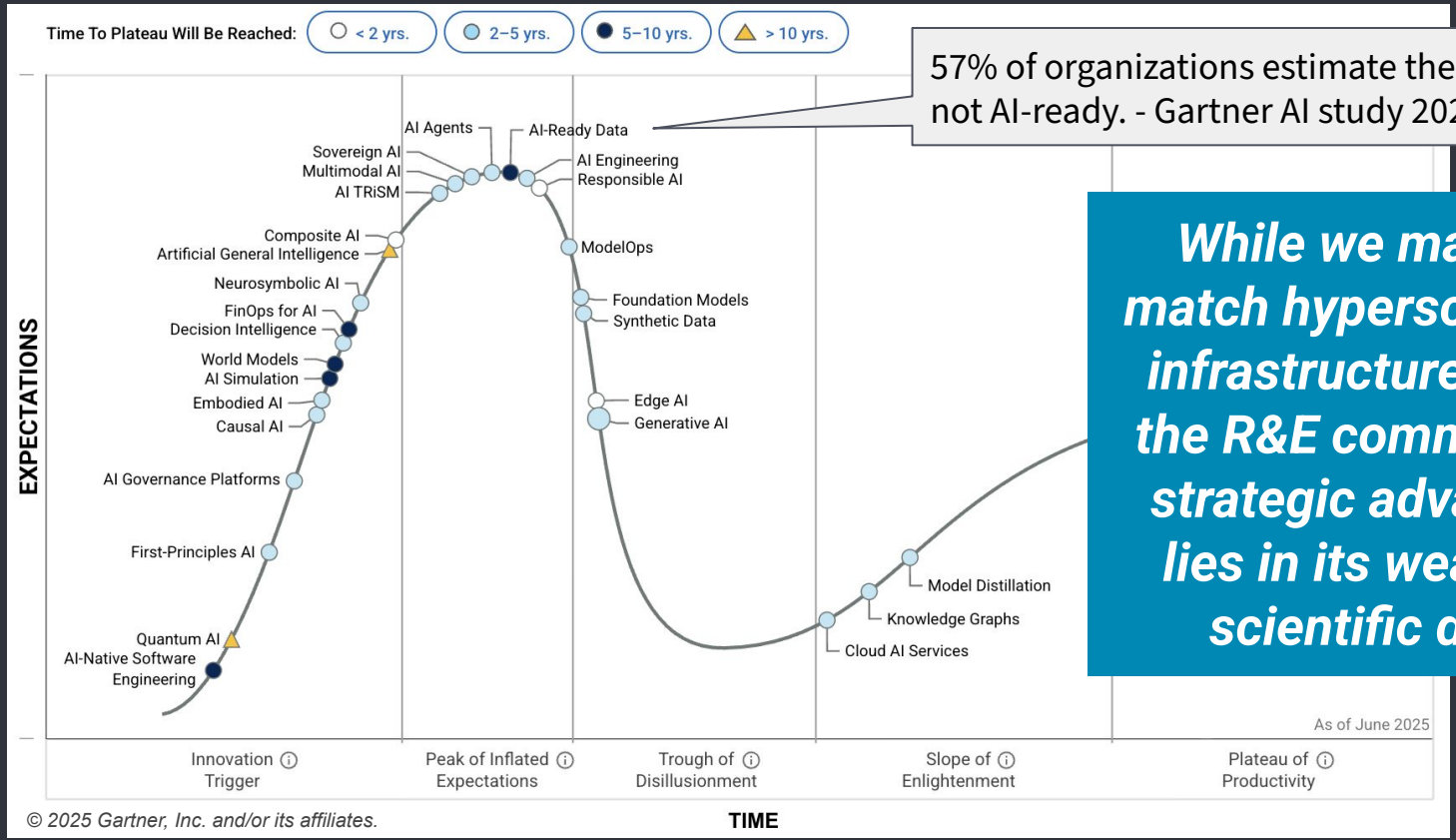
# Top 4 Hyperscalers control 71% of AI infrastructure capacity

| Company | Market Share | Capacity (GW) | 2024 Investment |
|---|---|---|---|
| aws | 30% | 15-20 GW | $100B+ planned |
| Microsoft Azure | 20% | 12-15 GW | $80B committed |
| Google Cloud | 13% | 8-10 GW | $75B global |
| Meta | 8% | 5-7 GW | $65-72B capex |
| Others | 29% | 25-30 GW | Various |

*Source: Tilawat, M. (Sep 25, 2025). AI Data Center Statistics 2025: The $200 Billion Revolution in Global Infrastructure. allaboutai.com*

# “Data is the new oil” *(But it needs to be mined and refined before it is valuable)*

## Hype Cycle for Artificial Intelligence, 2025




57% of organizations estimate their data is not AI-ready. - Gartner AI study 2025

***While we may not match hyperscalers in infrastructure scale, the R&E community’s strategic advantage lies in its wealth of scientific data!***





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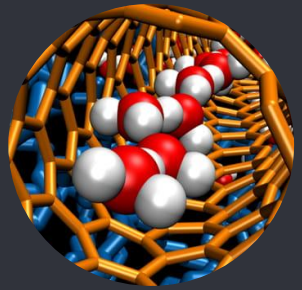
# DOE SC has vast amounts of scientific data!


Advanced Scientific Computing Research (ASCR)

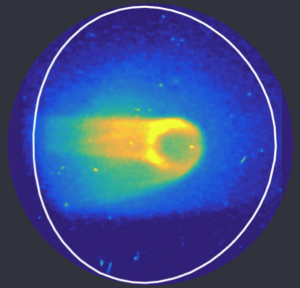


Basic Energy Science (BES)

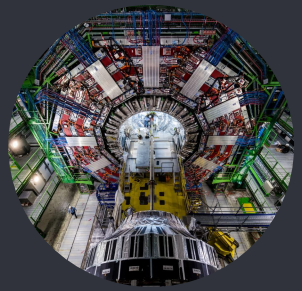
Biological and Environmental Science (BER)

**DOE Office of Science is the largest supporter of basic research in the physical sciences in the US**

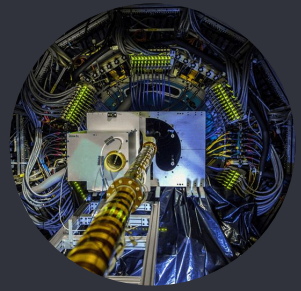

"OSTI.GOV makes discoverable over 75 years of research results from DOE and its predecessor agencies."



Fusion Energy Sciences (FES)



High Energy Physics (HEP)



Nuclear Physics (NP)

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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

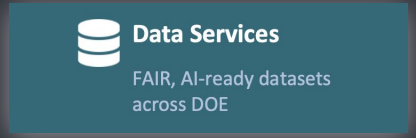
- Deliver a **common fabric** for scientists to build on
- Provide **modular services and abstractions** used to accelerate discovery cycles
- Leverage **science and industry innovations** rapidly as they are integrated into the platform
- Build a science-focused platform through **co-design**

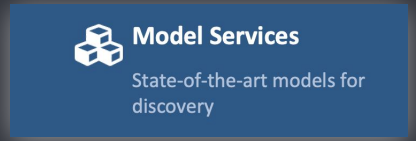
# AI-driven scientific discovery in the Genesis Mission

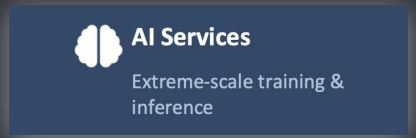
AmSC enables DOE scientists and collaborating teams to

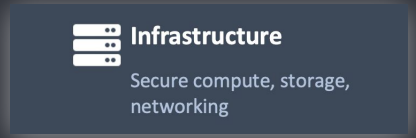
- Create, access, and integrate world-class AI-ready datasets
- Run scalable model training on contributed compute infrastructure
- Perform large-scale modeling-simulation and AI
- Control instruments
- Move data efficiently across sites

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

# AmSC Unique Infrastructure Enables Transformational AI Models

WHAT WE WILL ACCOMPLISH

HOW WE WILL EXERCISE

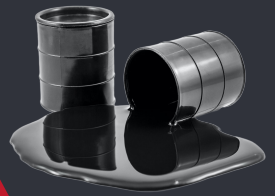
**DOMAIN AI MODELS**
with leading partners

**TRAIN**

**Consortium for Transformational AI Models (ModCon)**

Assemble fully
**AI-ready data**

**DATA**



"Data is the new oil", but it needs to be mined and refined before it is valuable.

Devise **cloud-like services** spanning computing, networking, storage, code

**INFRASTRUCTURE PLATFORM**

**American Science Cloud (AmSC)**

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

What is the Genesis Mission?

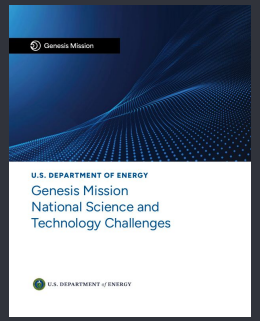
A national initiative led by the Department of Energy and its 17 National Laboratories to build the world's most powerful scientific platform to accelerate **discovery**, strengthen **national security**, and drive **energy innovation**.

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

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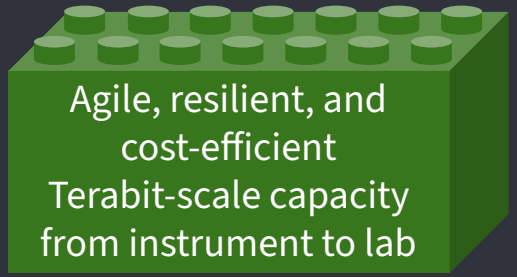



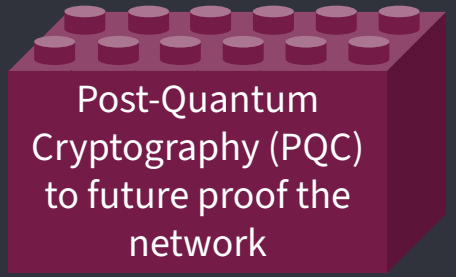




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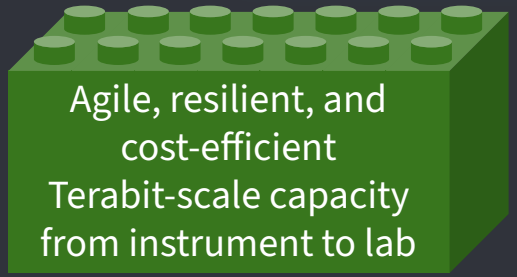
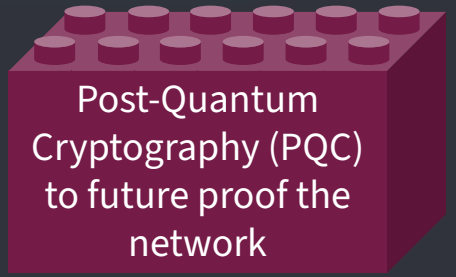
***ESnet7 is expected to deploy an additional 50-70% above the current historical growth trend to accommodate for AI workflows.***







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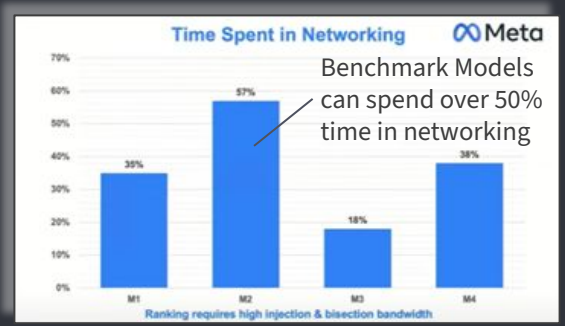
# Predictable Networking is Critical for AI Workflows — Networks Must Provide Negotiable Service Guarantees

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.

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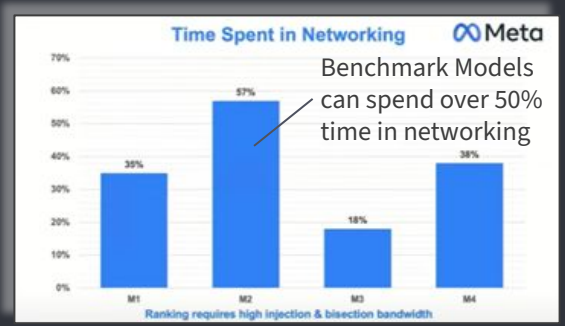


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Traffic-engineer (prioritize) critical AI training and inference workflows

Secure, application driven programming of multi-domain resources using tools like SENSE

Event centric forecasting of bursty, intermittent time series data using NetBurst (with UCSB)

Extend ESnet to the wireless edge to bring field science into the AI Era



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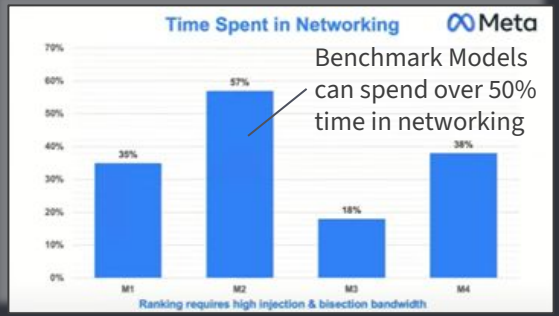
***ESnet is exploring AI driven traffic classification and AI (network foundation) models to predict short term traffic congestion to selectively reroute critical traffic.***

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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.

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.

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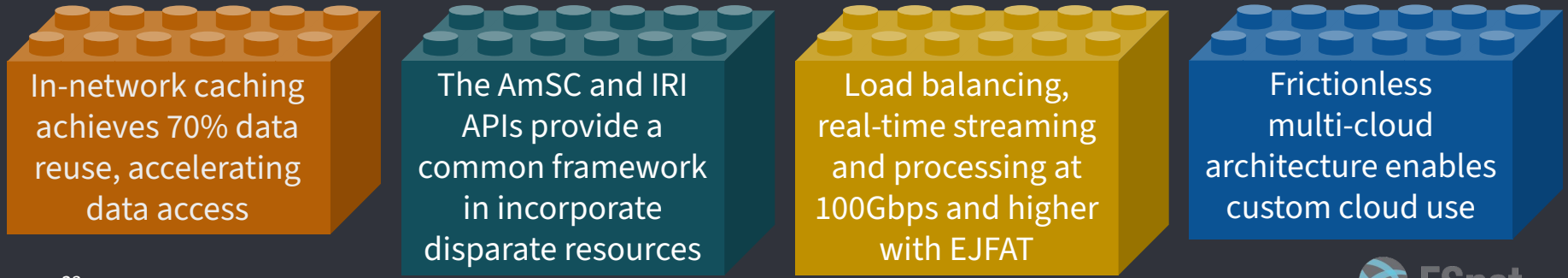




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***ESnet7 design requirements are intimately tied to its role as the American Science Cloud WAN data fabric.***

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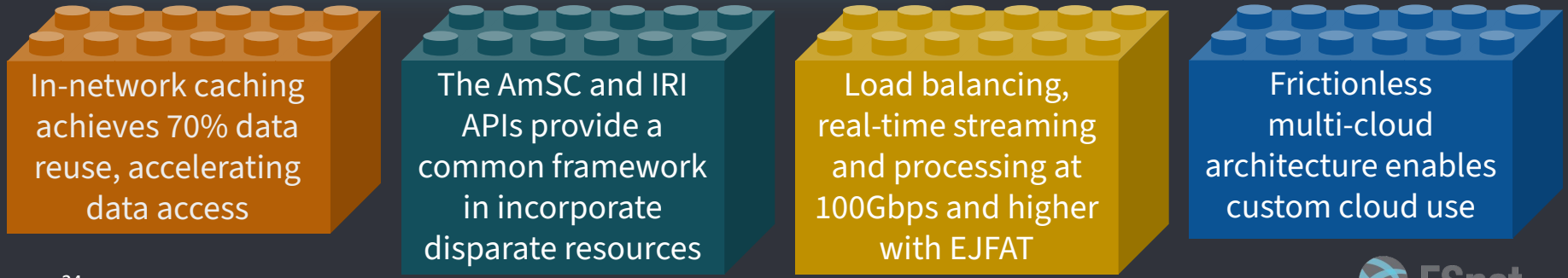




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# AI Attacks Are Increasing in Scale, Frequency, and Complexity — Networks Need Automated and Autonomous Management

*"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

**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

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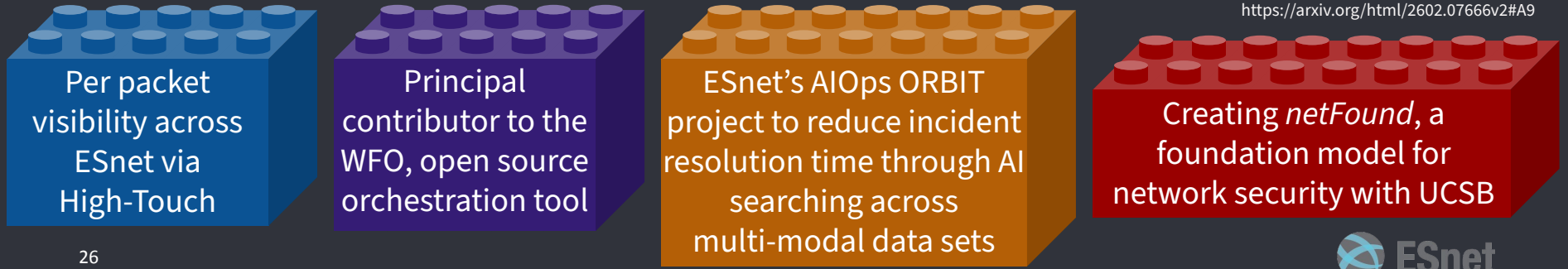




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***ESnet7 will incorporate AI intelligent decision making to bridge high-fidelity network monitoring with full stack network automation.***

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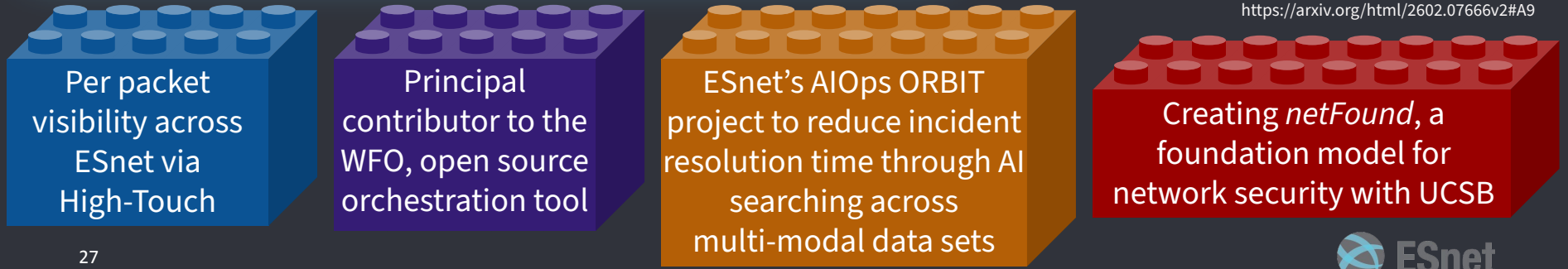




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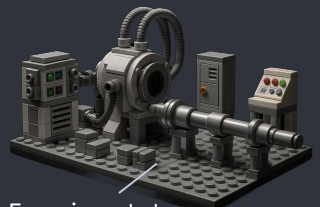
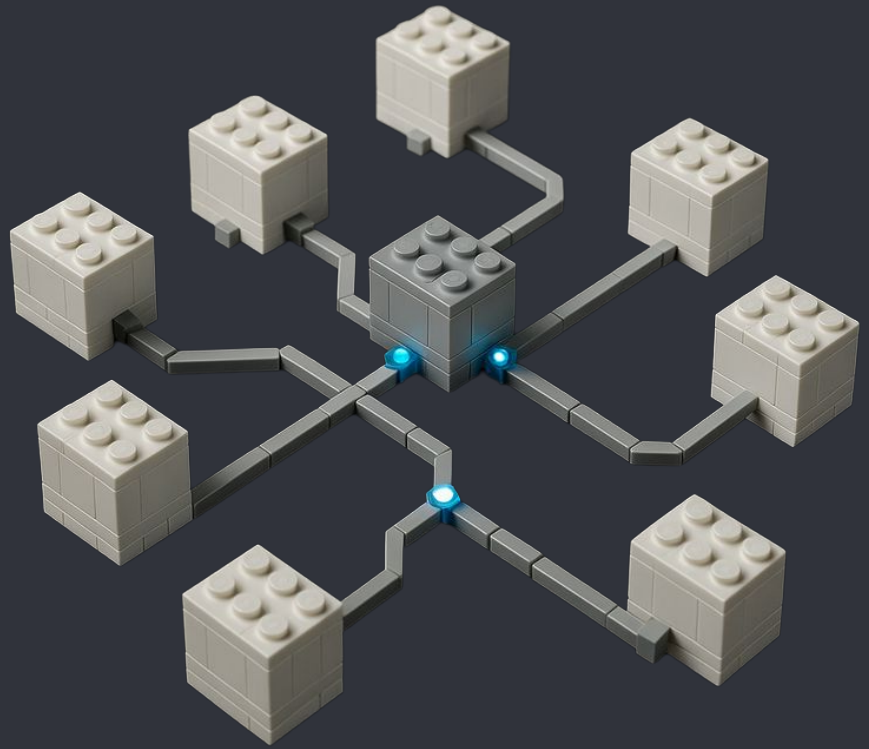
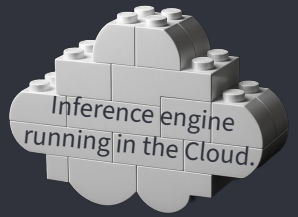
# A Remote Inferencing Example



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





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# A Remote Inferencing Example

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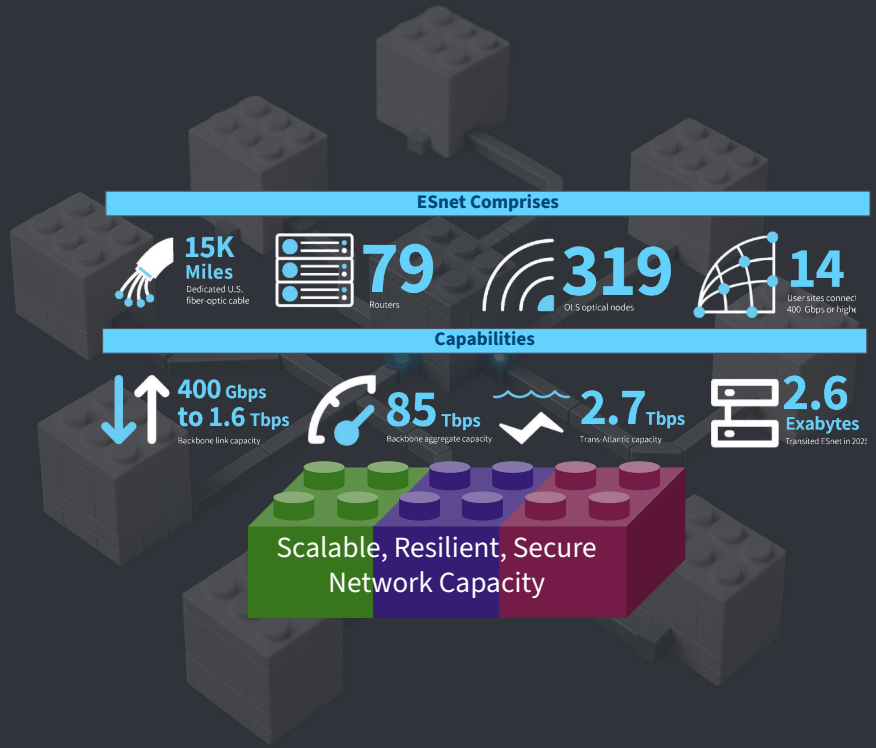


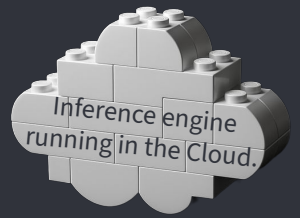




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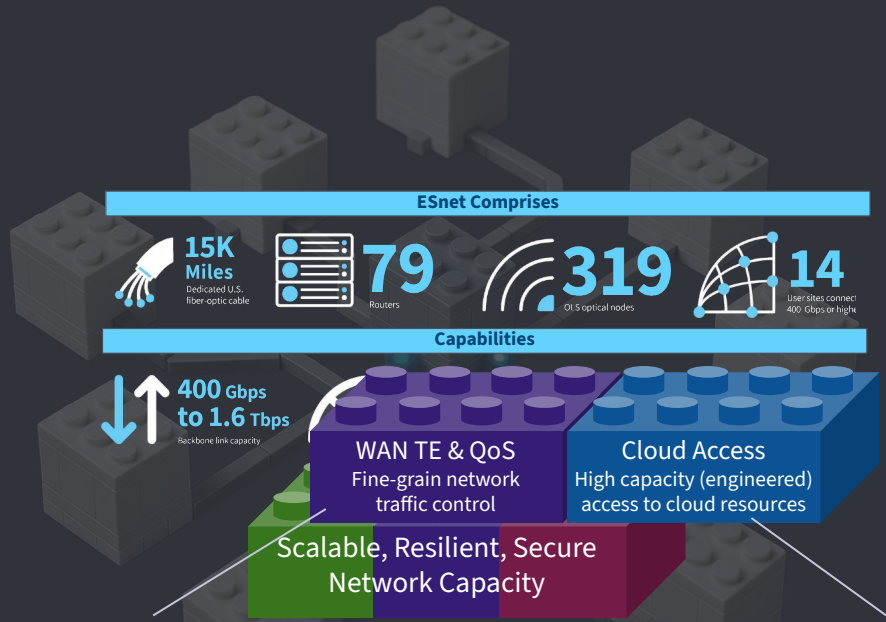


WAN TE & QoS ensures the data stream is routed over uncongested paths and receives the right service guarantees.

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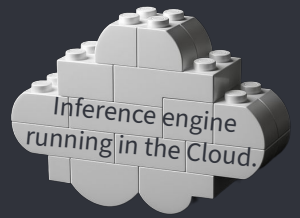




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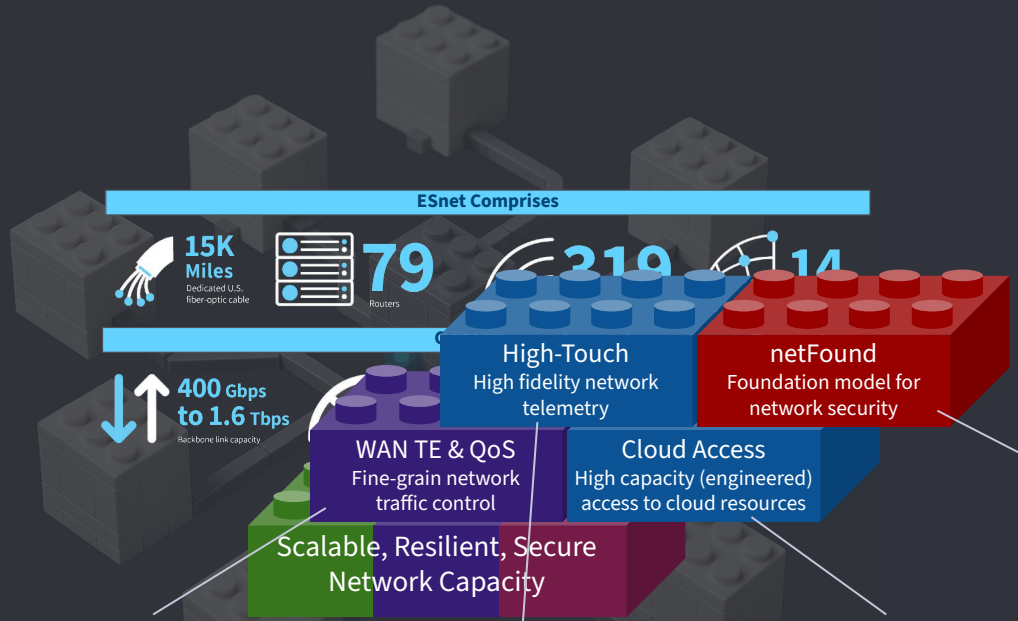


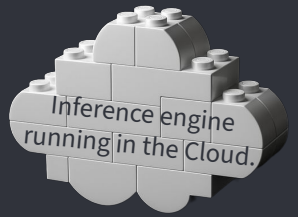


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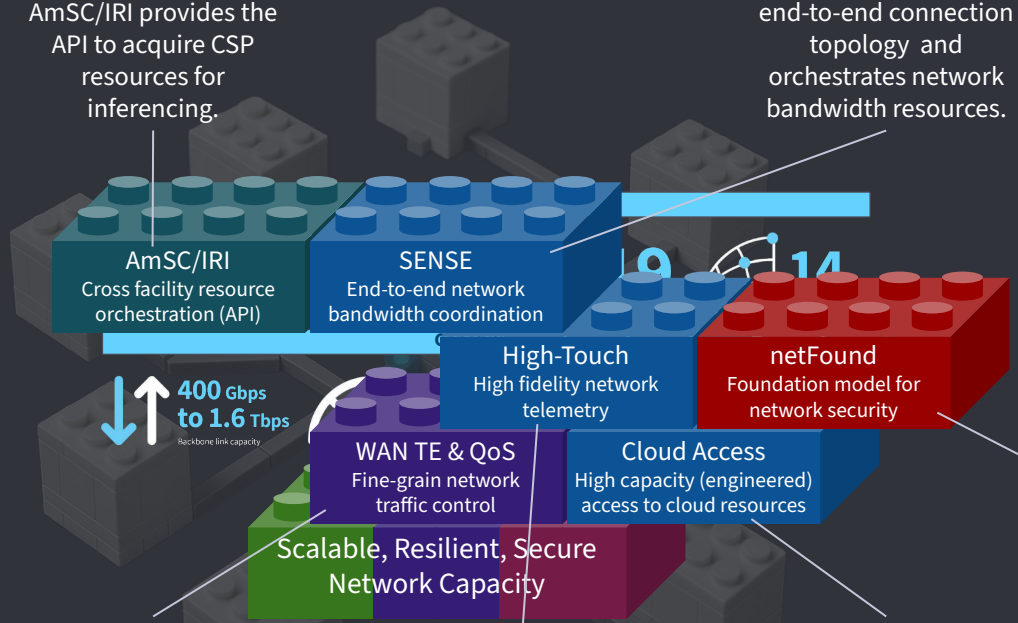
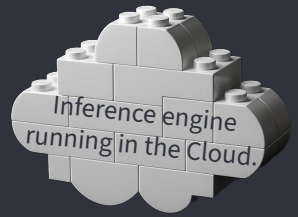
# A Remote Inferencing Example

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

AmSC/IRI provides the API to acquire CSP resources for inferencing.

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

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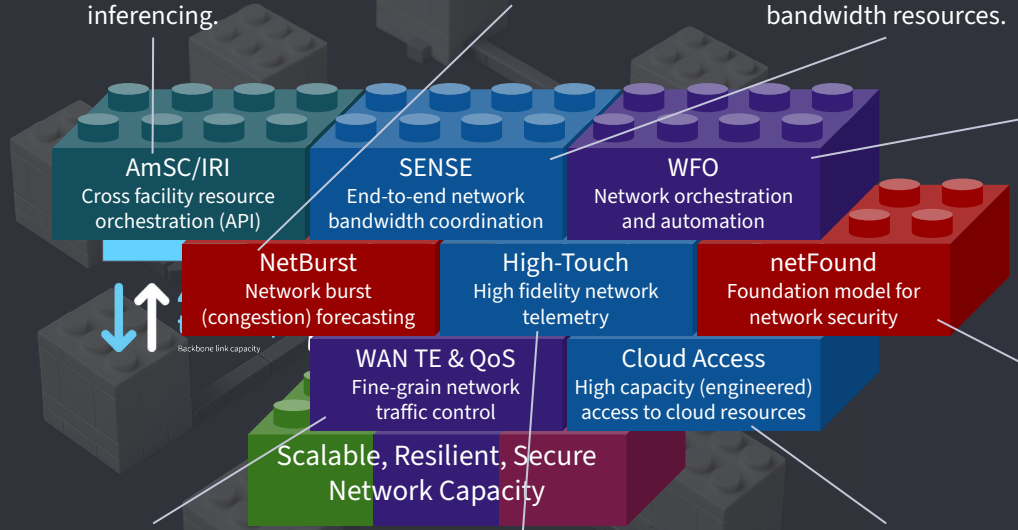


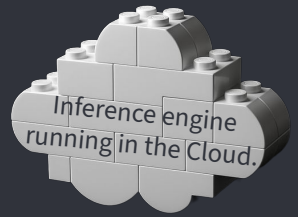


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ESnet

# 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.

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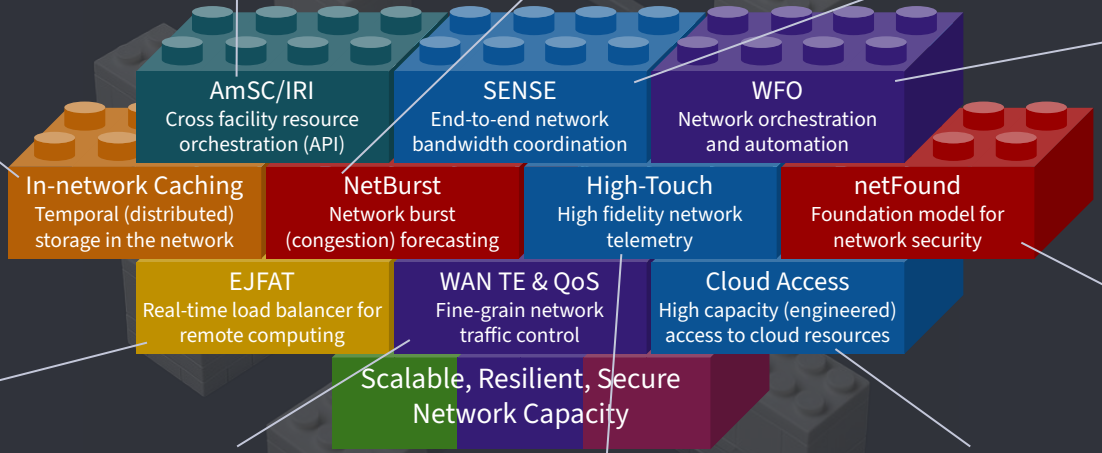


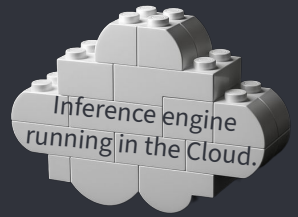


EJFAT takes the data stream and load balances it on Cloud resources (and shunts a duplicate stream into the in-network temporal data lake.

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ESnet

*"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)*

VP, Google Global Infrastructure, Google Cloud

*Building a network in the AI era requires a* ***rethink of how we design the network***

Chin Guok
<chin@es.net>