

The Simulation Century



Richard Boyd. AI. Digital Twins. The century that changes everything.

Special Event: “The Simulation Century”

Digital Twins and AI in Space

August 18, 2026

Alexandria, VA

Moderator: Mr. Richard Boyd This is our **fifteenth** annual session to address the growing issue of managing the human/ machine interface as we hurtle towards the Singularity. We will continue our discussion of how to achieve fluency with smarter balance between humans and machines to optimize outcomes. The Simulation Century Panel presentations this year will focus on technologies that build towards the proper balance between machines and automation to optimize outcomes in Space. We will discuss digital twins for operations and maintenance of ground stations and satellites and managing the contested logistics supply chain of custody.

“The Simulation Century” - Digital Twins and AI in Space (or AI and the New Scientific Method)

Presentations and Speakers:

- ***“Whats Does AI want in Space?”***; Richard Boyd, CEO, Ultisim Inc
- ***“Digital Threads and Twins for Earth Observation”*** ; Dr. Jeff Arnold, Entarian
- ***“The Fifth Paradigm in Hydrologic Science”*** Dr. Christa D Peters-Lidard, Schmidt Sciences

The Simulation Century

Richard Boyd. AI. Digital Twins. The century that changes everything.

Simulation Century Core Concepts

- This is the Simulation Century. The last century was the first where humans used video images to record and analyze the human condition. This century is about AI-enriched simulation and prediction
- The central problem in an accelerating information age is how to achieve the right balance between humans and automation to optimize outcomes
- Those who attain fluency with automation and digital tools will outperform those who do not; and will begin to appear Super Human.
- How do we teach digital fluency by allowing humans and machines to play together?
- How do we build an empowered Metaverse? A Digital Twin of Earth?

Boyd, Richard. "SuperHuman Education", *Getting Smart*, (March, 2013)

<http://gettingsmart.com/2013/03/superhuman-education/>

Boyd, Richard and Rob Szczerba. "SuperHuman Healthcare", *Intelligent Hospital Today*, (September, 2012) <http://intelligenthospitaltoday.com/?p=721#comment-299>

Boyd, Richard. "Nearer the Holodeck", *Armed Forces Journal*, (May, 2010)

<http://www.armedforcesjournal.com/2010/05/4578938/>

Richard Boyd, CEO, UltiSim

Richard Boyd is the CEO of UltiSim, An AI infrastructure and digital twin company designed to help businesses achieve the right balance between humans and machines. Over the last thirty years Richard has led or helped create some of the most innovative game, simulation and AI technology companies in the industry. At Aerospace giant Lockheed Martin he created and led a group of innovative engineers and designers across all mission areas called Virtual World Labs. Richard joined Lockheed Martin in 2007 with the acquisition of 3Dsolve, a North Carolina based computer game technology firm where he was founder and CEO.

Richard served for a decade on the executive management team of Virtus Corporation where he helped create several pioneering computer gaming companies including Red Storm Entertainment, with author Tom Clancy; iRock Entertainment with Ozzy Osbourne; and Timeline Computer Entertainment, with author Michael Crichton.



Dr. Christa D. Peters-Lidard



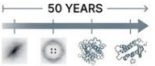
Dr. Christa Peters-Lidard former Director, Sciences and Exploration Directorate, NASA Goddard. Hydrologist and leader in land surface modeling and data assimilation, integrating remotely sensed precipitation and soil moisture into Earth system models. Led development of NASA's Land Information System (LIS), co-winner of NASA's 2005 Software of the Year. In 20+ years at Goddard she rose from Chief of the Hydrological Sciences Lab to Director of the Sciences and Exploration Directorate (2023–2025), leading the world's largest collection of Earth and space scientists (490+ civil servants). NASA lead for the USAID Famine Early Warning Systems Network; originated the Earth Information System as Acting Goddard Chief Scientist. Fellow, AMS and AGU; 2026 Distinguished Visiting Scientist, Schmidt Sciences. B.S. Geophysics, Virginia Tech; Ph.D., Princeton.

She's a Fellow of both the American Meteorological Society and the American Geophysical Union, and was the NASA lead for the USAID-funded Famine Early Warning Systems Network and originated the Earth Information System concept while Acting NASA Goddard Chief Scientist.

Dr. Jeffrey Arnold, Senior Vice President Engineering Entarian



Dr. Jeff Arnold is Chief Innovation Officer at Entarian , where he arrived in October 2024 to lead the company's new Innovation Foundry, coming from MITRE Corporation, where he had been Chief Scientist leading geoscience R&D in the Emerging Technologies Innovation Center since 2022. His 25-year federal research career began in computational and experimental atmospheric chemistry at NOAA and USEPA national labs, and he then created and led for over a decade the U.S. Army Engineer national research program that transformed field observations and continental-scale hydro-climatology models into engineering inputs for national water and energy security. His current work centers on machine-learning emulators and other AI components that simplify use of massive Earth science and space weather datasets, identifying the most useful digital analytic approaches for decisions that enhance U.S. public safety and prosperity. He holds a Ph.D. in tropospheric chemistry and physics from UNC Chapel Hill and has co-authored more than 150 peer-reviewed publications

	The Baconian Method	The Simulation Century
Hypothesis Generation	 Human intuition (10s of possibilities).	 Machine pattern-matching (Millions of possibilities).
Experimental Scale	 Physical labs (Slow, linear, resource-intensive).	 Monte Carlo in-silico simulations (10^8 scale).
The Human Role	Sole creator and generator.	Curator, evaluator, and context-provider.
Historical Milestone (Protein Structure)	 50 YEARS → Crystallography (170,000 structures in 50 years).	 FEW MONTHS → AlphaFold (200,000,000 structures in months).

The New Scientific Method

AI Contagion and Epistemic Airlocks



Richard Boyd

Richard.Boyd@UltiSim.com

40TH ANNIVERSARY

A STEVEN SPIELBERG FILM
CLOSE ENCOUNTERS
OF THE THIRD KIND

DIGITALLY REMASTERED IN 4K

A COLUMBIA TRISTAR PRODUCTION
"CLOSE ENCOUNTERS OF THE THIRD KIND" is a PHILLIPS production a STEVEN SPIELBERG Film
Starring RICHARD DREYFUS Also Starring FRED CLAUSS AND SANDRA BLOK AND FRANCIS TRUPHET AND LACOMBE
Music by JOHN WILLIAMS Visual Effects by DOUGLAS TRUMBULL Director of Photography WILLIAM ZWISLOCKY, A.S.C.
Produced by JARVIS PHILLIPS and MICHAEL PHILLIPS Screenplay and Directed by STEVEN SPIELBERG

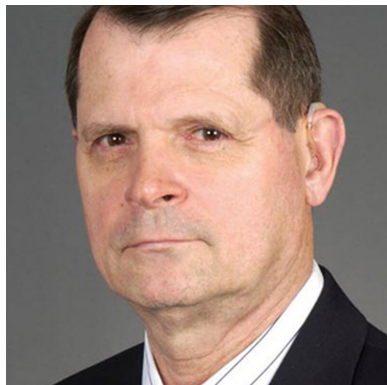
PG PARENTS STRONGLY CAUTIONED Some Material May Be Inappropriate for Children Under 13

IN THEATERS EVERYWHERE SEPTEMBER 15TH

ON BLU-RAY™ AND 4K ULTRA HD™ SEPTEMBER 19TH



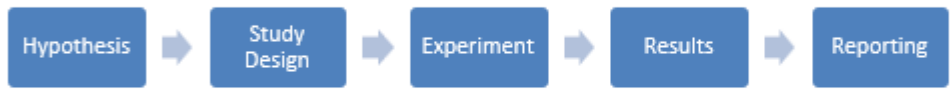
2009



Dr. Richard Satava of the University of Washington has written extensively on the use of simulation for experimentation and discovery in medicine. He describes what he calls a “new scientific method”:

Build the computer model, add the data from a real world experiment, see if the results match real-world expectations, change the input data to more closely approximate the model, and run the next iteration. This is continued until there is concurrence with the evidence of real-world results... The result is that the world of science has (unknowingly) changed the scientific method to include an additional step between designing the experiment... and conducting the experiment. The step is... model and simulate, by repeated iteration to optimize the design of the experiment, and then proceed to conduct the experiment (Satava, 2005).

He describes this change graphically, first in terms of the accepted scientific method:

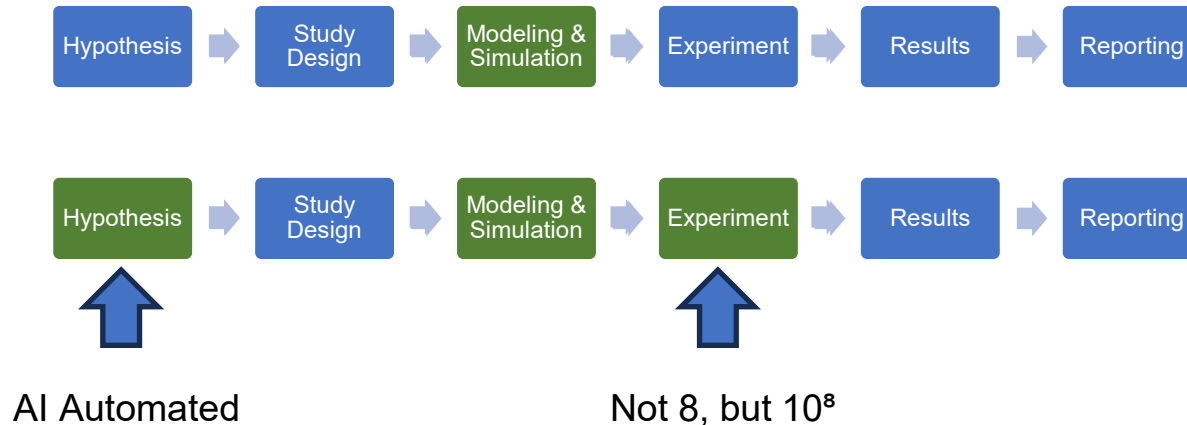


He then describes what he calls “the simulation method or the (new) scientific method:”



*“The Universe is full of magical things, patiently waiting
for our wits to grow sharper”* - **Eden Phillpotts**

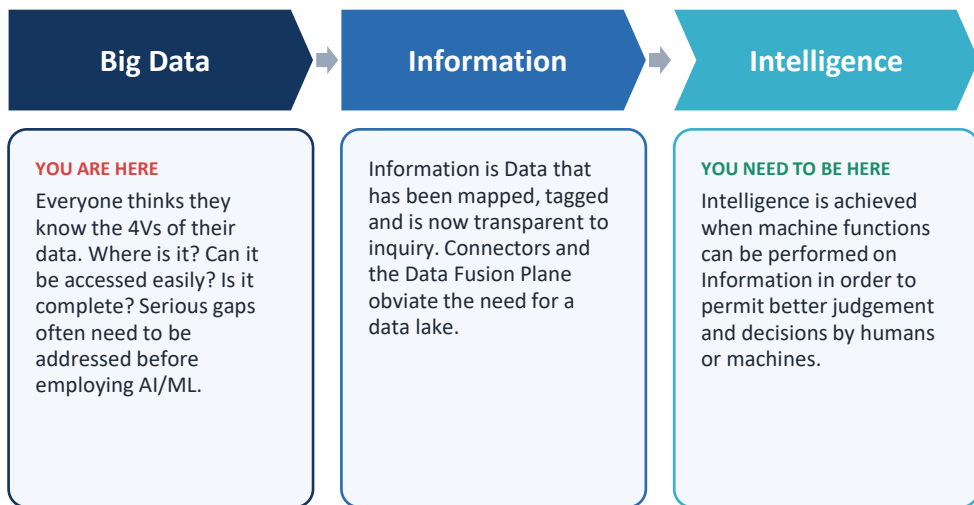
“Civilization advances by extending the number of important
operations which we can perform without thinking of them. ”
— **Alfred North Whitehead**



Information Age Angst

“Our thesis is that this is The Simulation Century. The last century was about television: the first time in human history when we could reflect on past or current events by reviewing film footage. This century is about modeling and simulating the past, the present as well as the future - and predicting or influencing future outcomes. A Digital Twin Operating System will help cities, companies and organizations model, plan, predict and design for increasingly complex technological futures.” - Boyd

It is a big leap (or 2) from Data to Intelligence



Hangar 51: The Problem



- **Warehoused content is not curated knowledge.**
- Like Hangar 51 in Raiders Of The Lost Ark, most data and experts in large organizations are undiscoverable or underutilized.

The Unusable Warehouse of people and data

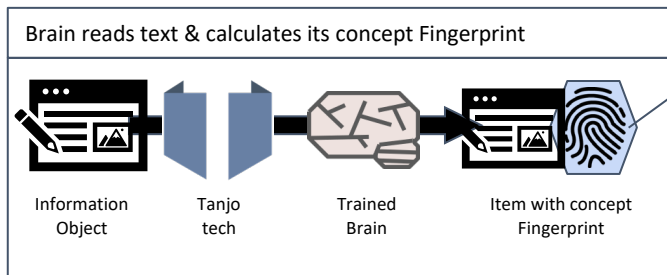


Now where was that write-up where we already figured this out...?

Hyperdimensional Text Fingerprint Comparison

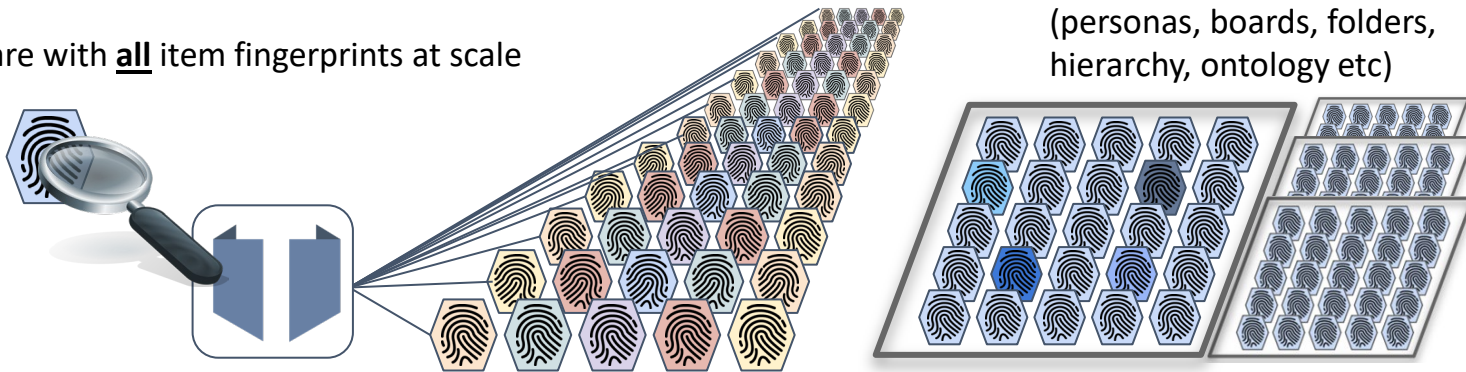


1) Scan all text items



Hyperdimensional fingerprint
of the ideas / concepts / topics in
the text from machine learning
analysis (up to 4,000!)

2) Compare with all item fingerprints at scale



3) Deliver matches into a taxonomy you choose (personas, boards, folders, hierarchy, ontology etc)

The Scientific Method Just Got an Upgrade

Unsupervised Machine Learning

Discover hidden structure & classification in unlabeled data.

Discover the best correlations:

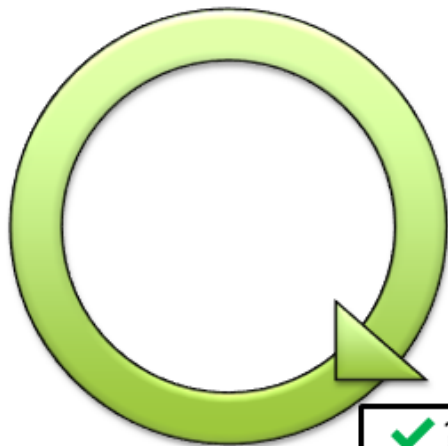
AB CD EF GH IJ KL MN OP
QR ST UV WX YZ

Pick useful ones: EF MN ST WX

TANJO.ai

Scientific Method

Invent a Hypothesis,
Design an Experiment, Test It, Repeat



✓? X?

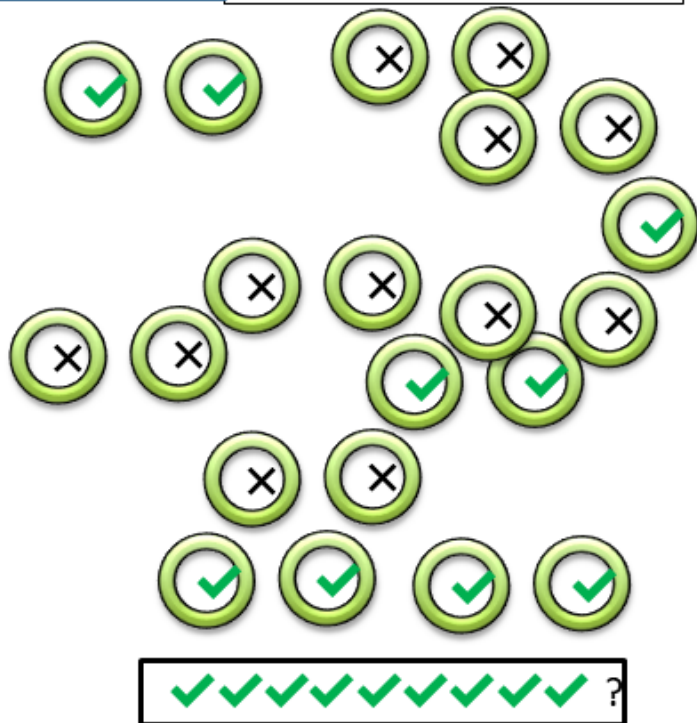
✓? X?

✓? X?

✓? X?

Unsupervised
Machine Learning

Find Every Valid Hypothesis,
Then Pick The Useful Ones



The End of the Hypothesis Bottleneck

The Bottleneck:
Human Cognition

400 Years of Constraint

Since Francis Bacon, science has been constrained by the aperture of human imagination. We explore the universe of knowledge one conceived hypothesis at a time.

30% 70%

The Simulation Century

Machine learning shatters this constraint. Operating in thousands of dimensions, it explores the entirety of possibility space—proposing correlations too subtle, high-dimensional, or counterintuitive for human minds to grasp.

The New Scientific Method with the Data Fusion Plane and Veritage

The Engine of Discovery: Autonomous Hypothesis Generation



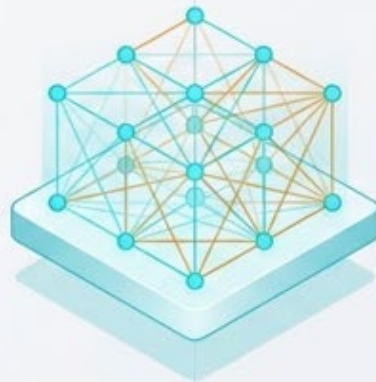
Step 1: Raw Silos

Unstructured and structured federated data (satellite, in-situ, models) remain in custody.



Step 2: Semantic Indexing

Disparate environmental data types are embedded and mapped into a unified ontology.



Step 3: Cross-Domain Reasoning

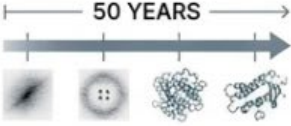
The DFP traverses the knowledge graph, identifying non-obvious relationships across previously isolated disciplines.



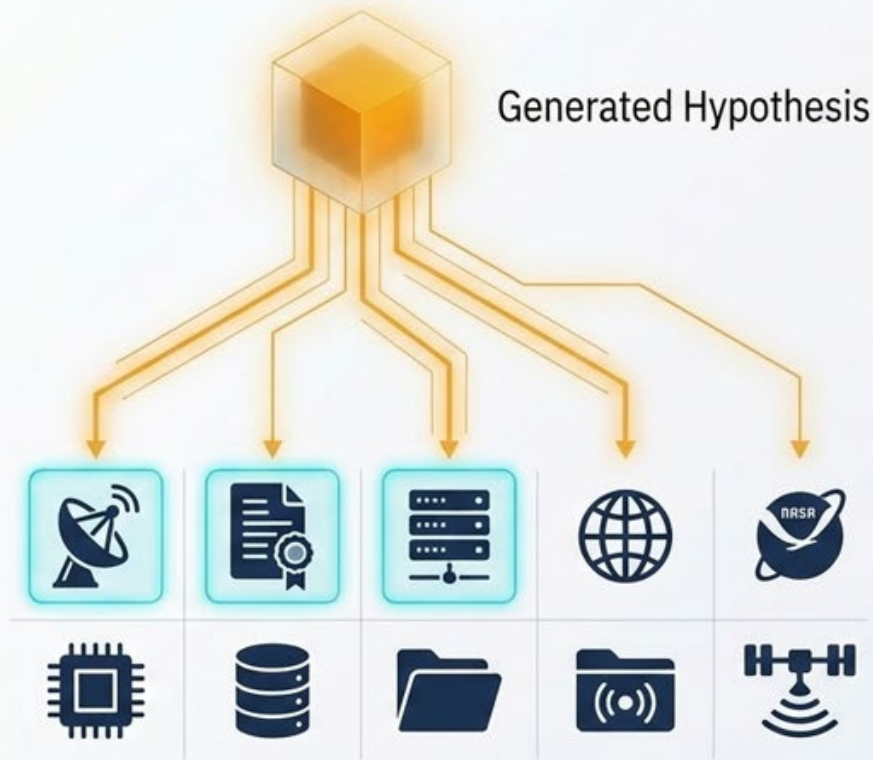
Step 4: Confidence-Scored Output

Surfacing falsifiable, highly specific scientific hypotheses with full provenance chains for human validation.

Defining the New Scientific Method

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Veritage™: Absolute Provenance and Scientific Integrity



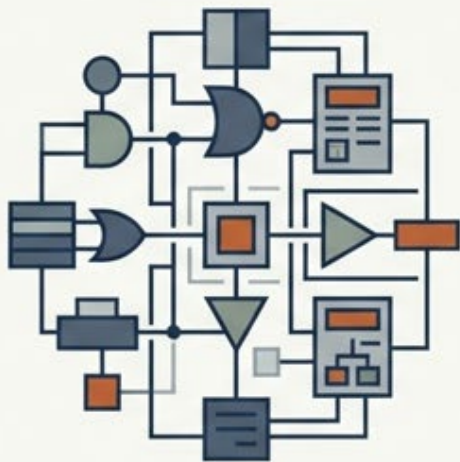
Cryptographic Audit Trails.
Every inference is permanently linked to its exact lineage.

Object-Level Policy.
Access rights and source origin are preserved from the original DAAC/NOAA asset.

Open-Science Ready. Fully aligned with SPD-41a, OGC, and ISO 19115 to meet FAIR data obligations for the global research community.



Compound AI for High-Stakes Operations



Symbolic AI

Rule-based, logical reasoning. Encodes explicit military doctrine, mission constraints, and rules of engagement. Highly explainable.



The Hybrid Advantage

AI that discovers hidden patterns but remains strictly bounded by mission rules. Provides full provenance chains for every recommendation. All processing stays in customer-controlled infrastructure.



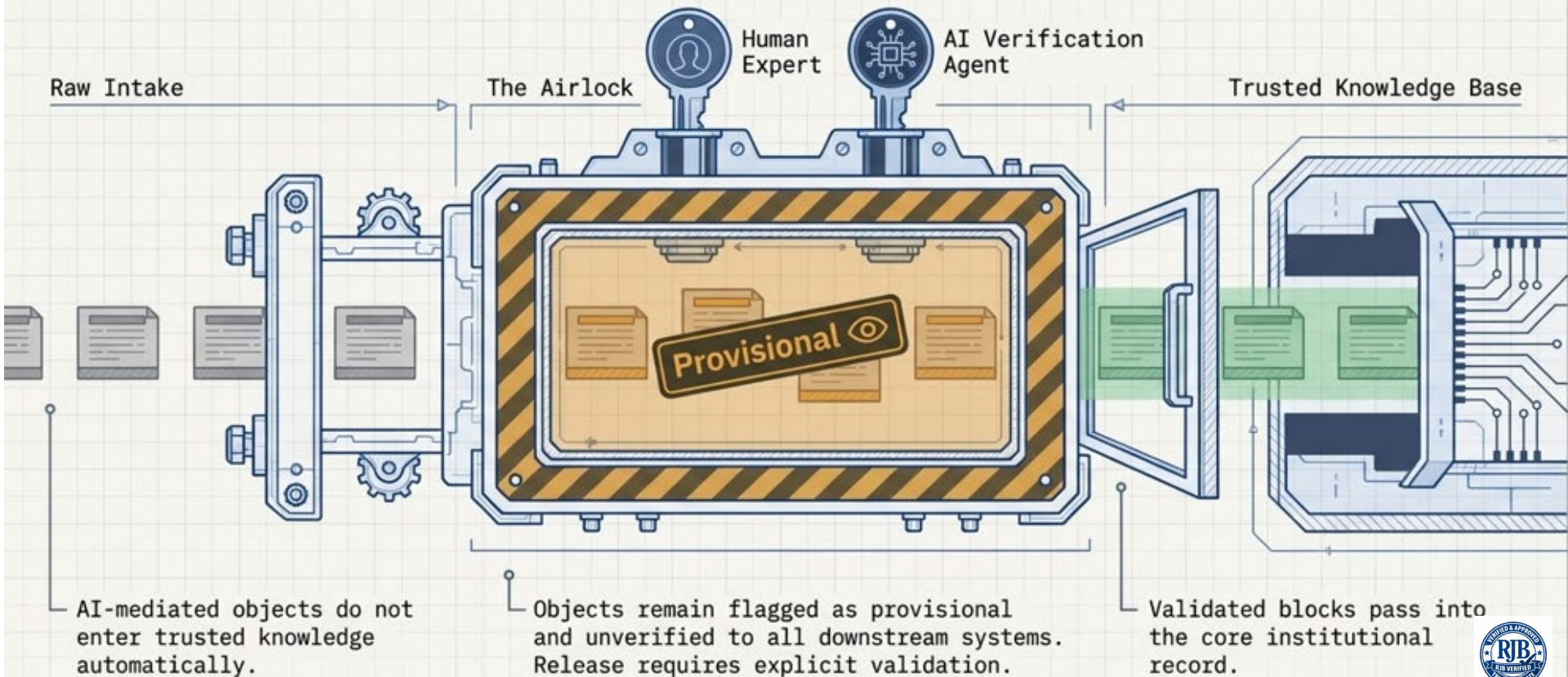
Connectionist AI (Neural Networks)

Pattern recognition and statistical learning. Excels at identifying subtle threats in sensor data and handling ambiguity.



ultisim

Unverified machine output is quarantined in the Epistemic Airlock™.



The Veritage Filter reveals a transparent ledger of institutional confidence.

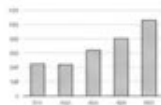
SLIDER COMPARISON VIEW

Standard View

EXECUTIVE SUMMARY:

Project Helios has met initial Q3 targets.

- Clinical trial data indicates positive patient outcomes in early phases. Financial respect projections in early phases.
- Financial projections for Q4 remain stable, with sufficient runway for continued development.
- Risk assessment concludes a low overall profile, with no critical blockers identified.



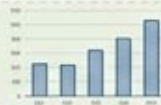
Full report follows.

Veritage Filter Engaged

EXECUTIVE SUMMARY:

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Full report follows.

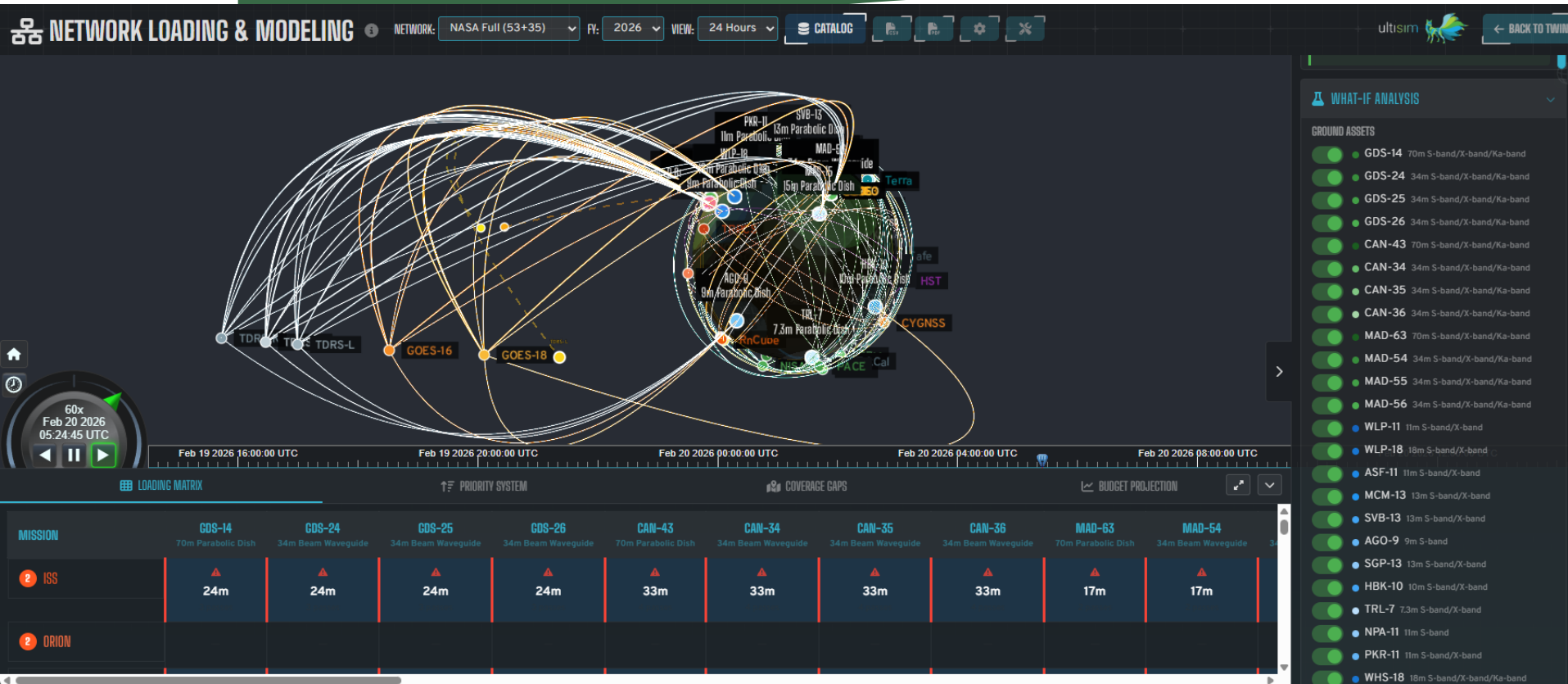


Recorded Challenge: Peer Reviewer

CHALLENGE ID: PEER_REV_002.
DISSENT: Methodology for risk calculation excludes crucial outlier data. Further analysis required.
STATUS: OPEN.

Preserved Dissent: Turn an ordinary document into a transparent ledger.

On-demand view of who endorsed what, when, and at what authority. Disagreements and expert challenges are permanently recorded, rather than silently overwritten. Instantly separates verified human judgment from unexamined assumptions.



NASA DAAC Science Data Fusion 270 Petabytes!

EarthData Discovery

DSP PLATFORM

BETA VERSION 2.10

A federated discovery-and-reasoning surface over NASA's Earth-observation archive

CONVERSATIONAL SEARCH

1/20 - CONVERSATION

+ New

History ▾

GPT Claude

Filters 0 ▾

Pending review 0 ▾

TURN 1

YOU

How has Arctic sea-ice extent changed across the satellite record?

The 50 retrieved granules all come from a single product — NSIDC-0051 Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, v2.0 — held at NSIDC. They are daily and monthly Northern Hemisphere (Arctic) sea-ice concentration grids on a 25 km polar-stereographic grid. The granules span two narrow windows: late October through early December 1978 [e.g. G3177958698-NSIDC_CPRD; G3177958731-NSIDC_CPRD] and early October 1982 [e.g. G3185969460-NSIDC_CPRD; G3186058011-NSIDC_CPRD]. These are the earliest years of the passive-microwave satellite record (Nimbus-7 SMMR launched October 1978), so the retrieval has surfaced the historical baseline end of the time series rather than the full multi-decadal trend.

What the granules confirm:

- The product short name is **NSIDC-0051**, version 2.0 [G3177958698-NSIDC_CPRD] .
- The spatial grid is **25 km polar-stereographic, Northern Hemisphere** ("PS_N25km" in every filename).
- Both **daily** (e.g. 19781026) and **monthly** (e.g. 197811 , 197812) composites are present in the same collection [G3177958641-NSIDC_CPRD; G3177958731-NSIDC_CPRD; G3185969460-NSIDC_CPRD].
- Coverage begins in **October 1978**, consistent with the Nimbus-7 SMMR instrument start date.

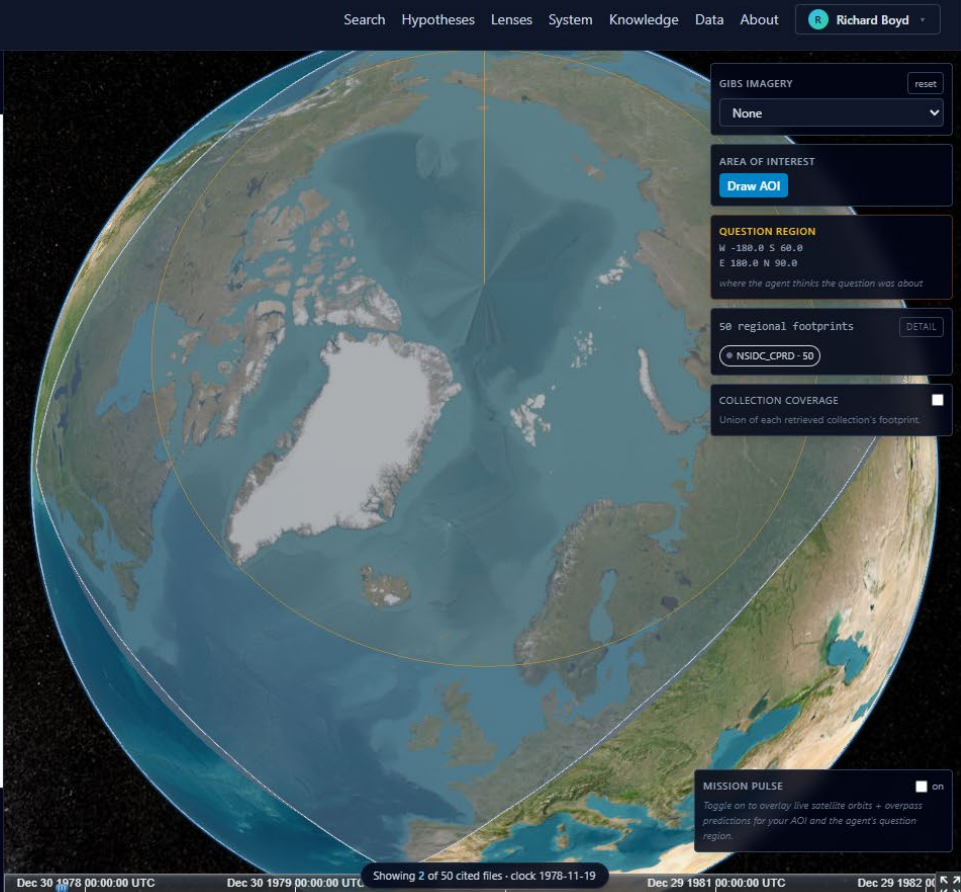
What the granules do NOT support: The retrieved set covers only 1978 and 1982. No granules from the 1990s, 2000s, 2010s, or 2020s are present in this retrieval. Therefore, **the long-term decline in Arctic sea-ice extent — the core of your question — cannot be characterised from these 50 granules alone**. The NSIDC-0051 collection itself extends to the present day and is the standard source for that trend analysis, but the later-year granules were not returned here. I cannot invent trend numbers or statistics not present in the supplied metadata.

To answer the full trend question, you would need to query NSIDC-0051 across its complete temporal range (~1978–present) or use the derived **Sea Ice Index (NSIDC-0081 / G02135)** product, which pre-computes monthly extent time series directly.

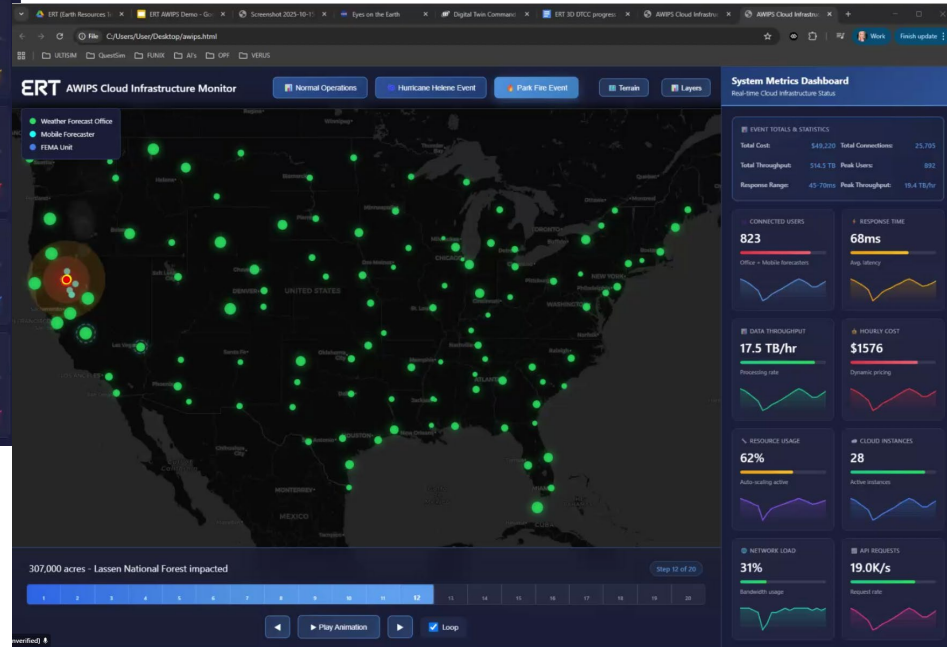
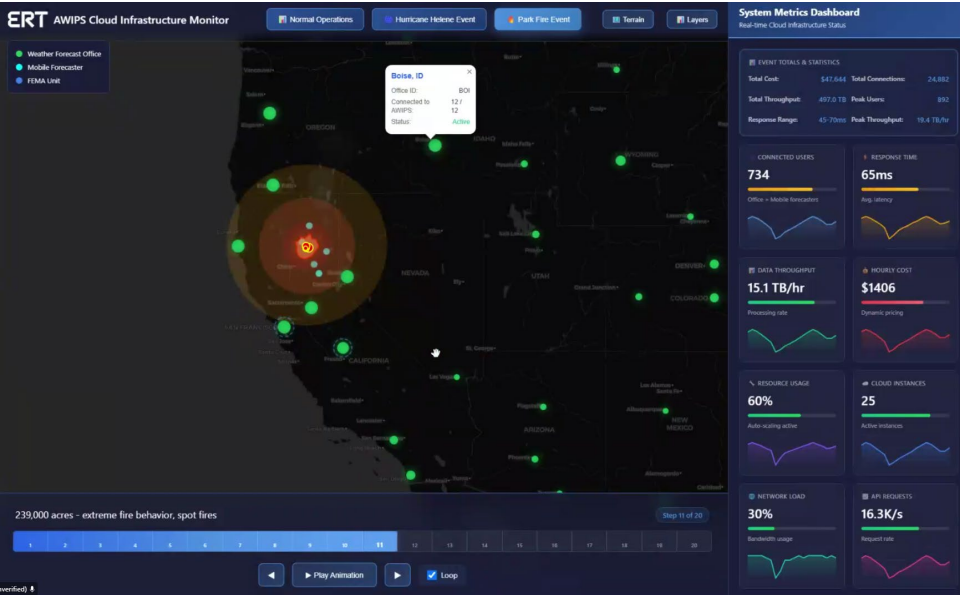
ASK A QUESTION

Sea-surface temperature MODIS Aqua, summer 2023

Ask

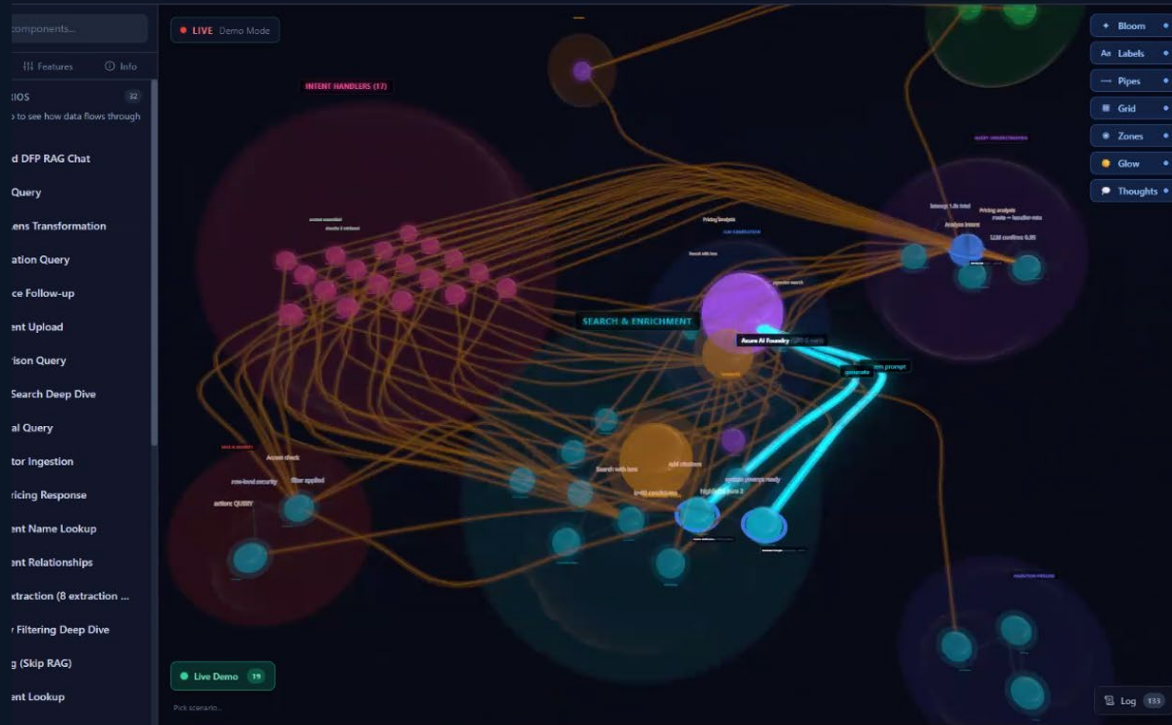


AWIPS Cloud Migration Simulation Dashboard





ULTISIM · INTELLIGENCE INFRASTRUCTURE FOR THE INTELLIGENCE COMMUNITY



Delivering verifiable truth for regulated and safety-critical environments.



Trustworthy Knowledge

Instantly separate human judgment from unverified machine output.



Safe AI Adoption

Capture generative productivity without absorbing hallucinations into the record.



Provable Accountability

A named, qualified human stands behind every consequential claim.



Audit Readiness

Defensible evidentiary trails for regulators, courts, and oversight bodies.



Preserved Dissent

Expert disagreements are permanently retained, not silently overwritten.

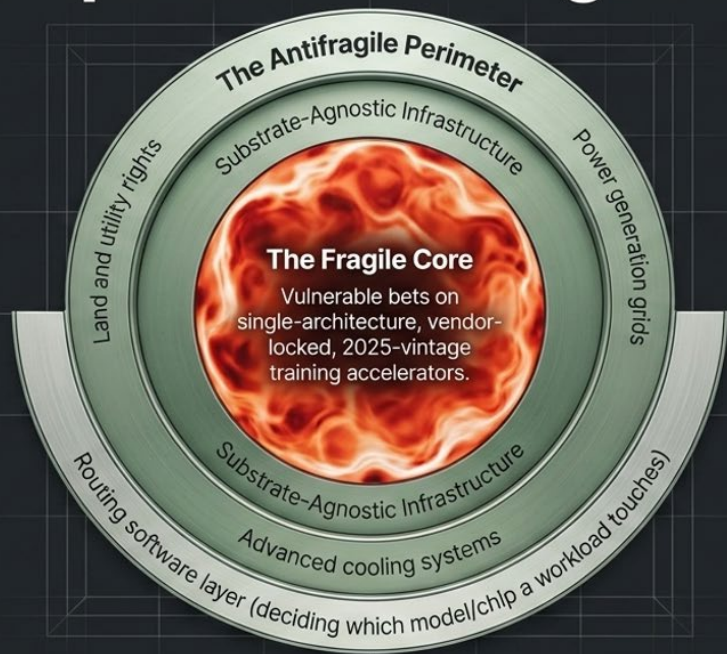


Granular Trust

Act safely on verified clauses while completely isolating unchecked data.

Place Your Bets in 2026

Securing Capital in Antifragile Substrates



Invest in the physics that don't change.

'LLMflation' is Destroying Long-Term Demand Forecasts

March 2023:

GPT-4-class output
at ~\$30 per million
input tokens.

Mixture-of-experts routing

Quantization & Distillation

Continuous batching

Speculative decoding

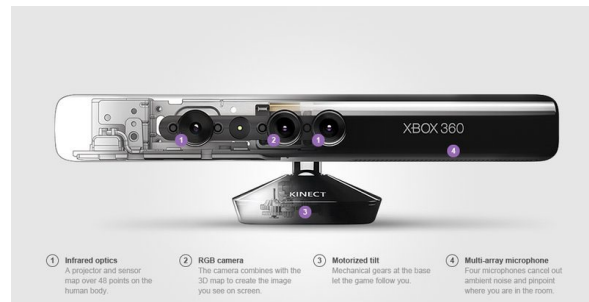
Open weights setting a price floor

**A 95% decline
in two years.
A thousandfold
decline in three.**

Mid-2026: Equal or better quality
open-weight models at <\$0.50.

2009 Machine Learning: The New Button on the Calculator

Large Datasets > Algorithms



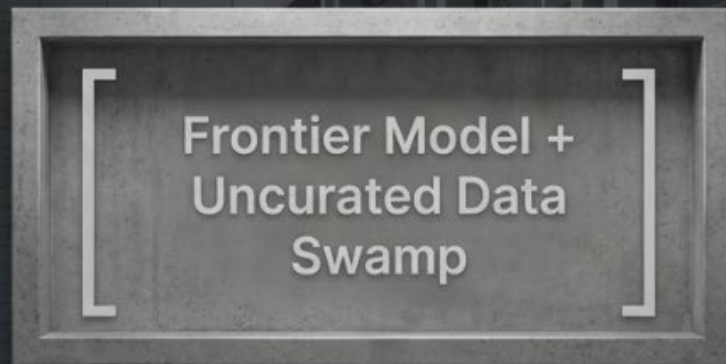
2009 Microsoft Natal, Alex Kipman, Richard Boyd and Jaron Lanier

My first exposure to large scale use of machine learning. 224,000 hours of cpu time to teach the Kinect system what a living room was, and how to recognize motion of the human body as an input device for games (and distinguish between different players)

Enterprise Value Scales with Curation, Not Compute



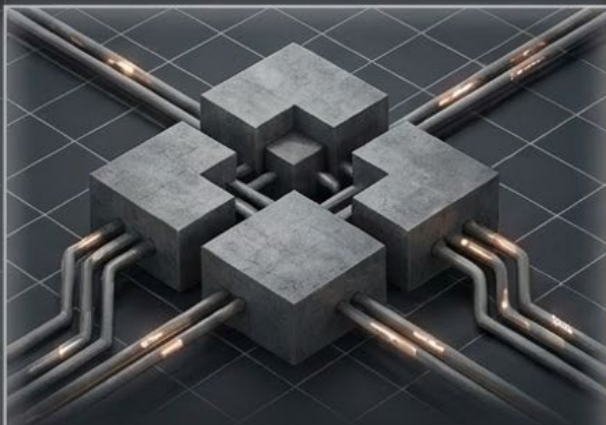
- 70 to 80 percent of subtasks in a normal conversational turn get handled by small models.
- Cuts cost per turn by 80 to 95 percent without changing the user experience.
- Side A beats Side B at 1/100th of the cost.



The expensive part of enterprise intelligence is the curation of organizational knowledge with a stern eye on Data Sovereignty. Curation does not scale with GPUs.

Physics is Forcing a Substrate Shift by 2030

Digital CMOS / GPUs (The Present)



Status: Reaching physical limits.

Flaw: Wastes enormous energy

moving numbers between memory and arithmetic units rather than doing the actual arithmetic.

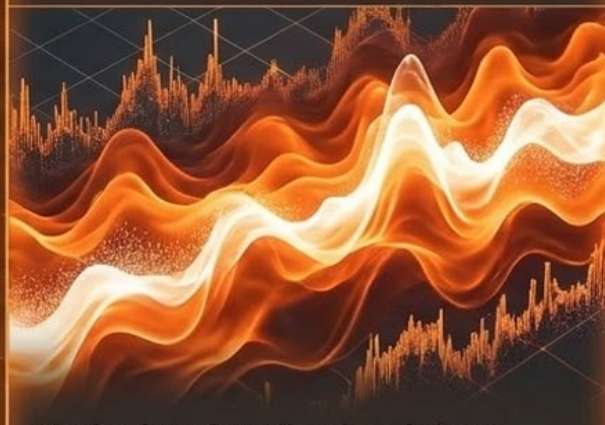
Photonic Tensor Cores (The Near-Future)



Mechanism: Analog domain matrix-vector multiplication at the speed of light.

Advantage: Integrates analog memory, yielding >26x power savings over conventional architectures while holding >90% accuracy.

Thermodynamic Computing (The Paradigm Shift)

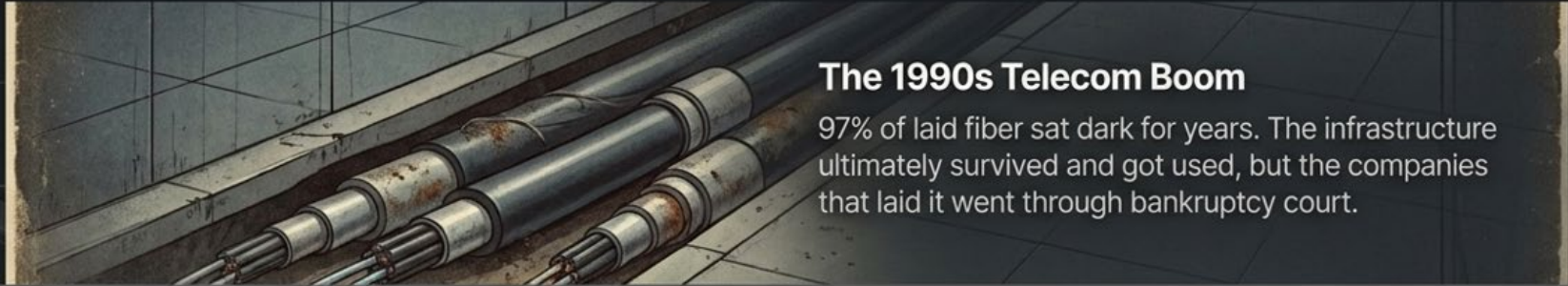


Mechanism: Sampling directly from thermal noise in ordinary CMOS transistors (probabilistic rather than deterministic).

Advantage: Extropic Z1 chip puts 250k probabilistic bits on a <12mm die drawing <1 watt. Estimated 10,000x energy savings on diffusion workloads.

Validation: CHIPS R&D office signed \$75M LOI to push to US fabs.

Demand Redistributes Without Caring About Capital Structures



The 1990s Telecom Boom

97% of laid fiber sat dark for years. The infrastructure ultimately survived and got used, but the companies that laid it went through bankruptcy court.

The infrastructure survives. The equity does not always come with it. Timing is everything.



Jevons Paradox in AI (2020s Boom)

Cheaper compute produces more consumption (e.g., agentic systems burn 100x the tokens, test-time reasoning buys accuracy). Demand is real.

The AI Compute Bet: Why a \$662 Billion Gamble Faces a "Cassandra" Moment

THE FINANCIAL FRAGILITY



\$130 Billion in Debt

Oracle's current debt load sits just one notch above junk status, highlighting the high-risk "all-in" nature of the compute bet.

The \$662 Billion "Off-Balance-Sheet" Shadow

Moody's has flagged over half a trillion dollars in signed but not yet commenced data center leases sitting off-balance sheets of major hyperscalers.



THE ARCHITECTURAL MISMATCH

Training vs. Inference

VS.



TRAINING
(Massive Synchronous Clusters)
Requires massive synchronous gigawatt clusters



INFERENCE
(Parallel, Optimized Silicon)
Parallel, latency-sensitive, and 3.5x more cost-effective on optimized silicon.

Stranded Assets

Capital



Rigid Training-Class Accelerators



Inference-Optimized Configurations

Capital is flowing into rigid training-class accelerators just as the workload migrates toward inference-optimized configurations that don't need them.

The Amortization Gap

Hyperscaler Depreciation

5-6 years

AI Hardware Economic Life

2-3 years

Hyperscalers depreciate AI hardware over 5-6 years, but its useful economic life is shrinking to 2-3 years, creating a potential \$228 billion depreciation hole.

CAPEX & DEBT SHIFT

	2022/2024	2026 (Projected)
Compute as % of CapEx	43%	60%
Incremental Debt as % of CapEx	9%	32%
True Depreciation Understatement	-	\$176B - \$228B

THE NEXT-GEN SUBSTRATES

Thermodynamic Computing (Extropic)



New 21 chips use thermal noise for probabilistic sampling, reporting energy savings 10,000x greater than GPU baselines.

Photonic & Neuromorphic Tech



Photonic cores perform matrix multiplication at the speed of light with 25x power savings, while neuromorphic designs eliminate the "idle" cost of synchronous arrays.

LLMFLATION & THE COLLAPSING UNIT CGST

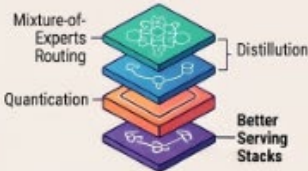
95% Price Collapse in 2 Years

March 2023:
GPT-4-class output
\$30 per million tokens

Mid-2026 (Projected):
Equivalent models
under \$0.50

The Efficiency Stack

A generative: unoeldaltn in broaking models lesmnomher under content.



Costs are being driven down by mixture-of-experts routing, quantization, better serving stacks, not just single breakthroughs.

The Shift to "Small"

70-80% of generative AI subtasks are migrating to small models at 1/10th the cost of frontier models.

Frontier Model

- Routing
- Safety
- Summarization

THE "CASSANDRA" VERDICT

The Jevons Paradox Risk



Increased efficiency

While efficiency usually increases total consumption, it redistributes demand without protecting the existing capital structure.

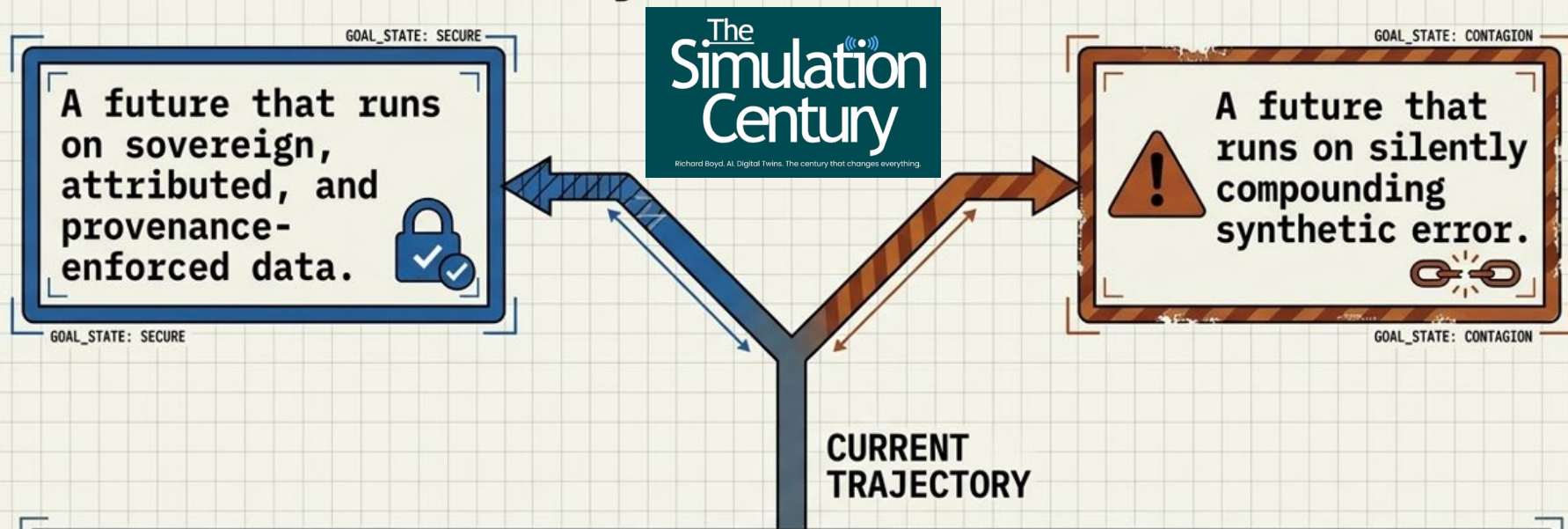
Substrate-Agnostic Safety



The safest bets in this cycle are non-depreciating assets: power generation transmission, land, and cooling.



The MS&T community will decide the outcome.



SYSTEM ARCHITECTURE IMPERATIVE:

The next generation of defense simulation is federated, AI-saturated, and multi-multi-domain. Sovereignty and contagion prevention cannot be bolted on later. The architecture you build today dictates the truth of the system tomorrow.

Special Event: “The Simulation Century”

Digital Twins and AI in Space

August 18, 2026
Alexandria, VA

Moderator: Mr. Richard Boyd This is our **fifteenth** annual session to address the growing issue of managing the human/ machine interface as we hurtle towards the Singularity. We will continue our discussion of how to achieve fluency with smarter balance between humans and machines to optimize outcomes. The Simulation Century Panel presentations this year will focus on technologies that build towards the proper balance between machines and automation to optimize outcomes in Space. We will discuss digital twins for operations and maintenance of ground stations and satellites and managing the contested logistics supply chain of custody.

“The Simulation Century” - Digital Twins and AI in Space (or AI and the New Scientific Method)

Presentations and Speakers:

- ***“Whats Does AI want in Space?”***; Richard Boyd, CEO, Ultisim Inc
- ***“Digital Threads and Twins for Earth Observation”*** ; Dr. Jeff Arnold, Entarian
- ***“The Fifth Paradigm in Hydrologic Science”*** Dr. Christa D Peters-Lidard, Schmidt Sciences