



ENVIRONMENTAL SUPERINTELLIGENCE · AN ESSAY

# The Compute We *Owe* the Earth

*Why the case against data centers is thermodynamically backwards, and why building more of them, faster, is the most pro-life act available to this species.*

BY JED ANDERSON

*Earth was never going to make it.  
The data centers are part of why  
it might.*

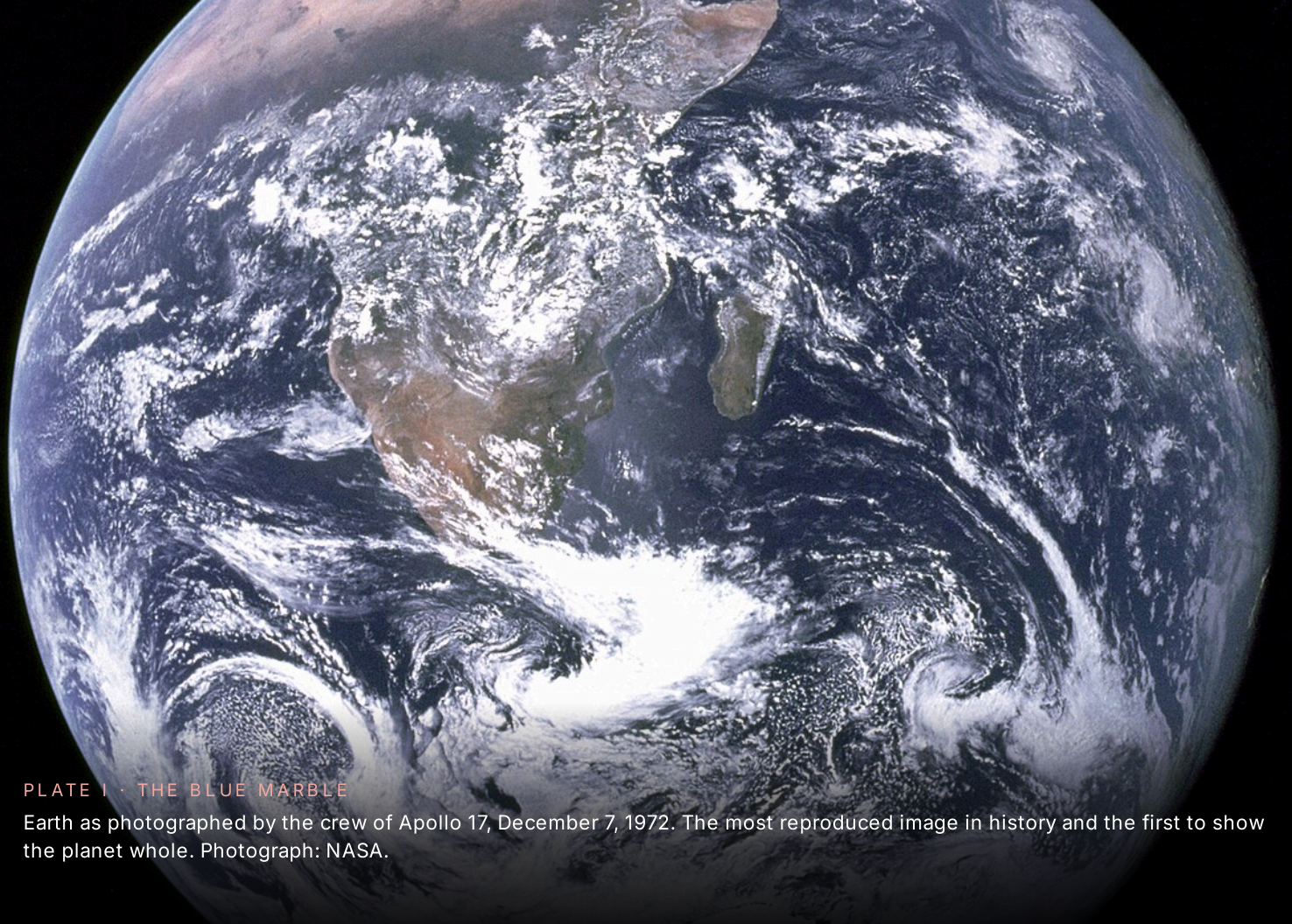


PLATE I · THE BLUE MARBLE

Earth as photographed by the crew of Apollo 17, December 7, 1972. The most reproduced image in history and the first to show the planet whole. Photograph: NASA.

I · The Wrong Fight

# Thermodynamically Backwards

**W**hat if everything the environmental movement believes about data centers is not merely wrong—but exactly, thermodynamically, backwards?

Not a little off. Not a matter of emphasis or priority. Inverted—the way a compass is wrong when it points south and calls it north. The people raising alarms about water draws, grid stress, and siting injustice are not wrong that those things exist. They are wrong about what those things mean. They have looked at the instrument and seen the footprint. They have not looked at what the instrument is for.

The campaign against data centers is a war against the only instrument, in four billion years of life on this planet, capable of defending the living world at the speed and scale the living world now requires.

The word for attacking your only defender is not activism. It is something closer to despair—the despair of people who have fought so long, and lost so much, that they have stopped believing rescue could wear an unfamiliar face.

**Which means the people most likely to end life on Earth as we know it irrationally might be the ones most passionately trying to save it.**

I am not writing this from the outside. Twenty-seven years an environmental lawyer—drafting the rules, litigating the violations. A law professor. A founder building

physics-based AI to defend watersheds, airsheds, and the slow, patient work of the living world. I have spent my entire adult life on the side of nature. I am writing from inside the room.

Every one of those concerns deserves the engineering rigor we would bring to any other industrial footprint. None of them is the reason the fight is backwards. The fight is backwards because the campaign has confused **the substrate with the signal**—it is attacking the machinery of cognition at exactly the moment in planetary history when cognition is the one resource the biosphere has never had enough of.

A species that has spent four billion years dying for lack of a defender is finally, in our lifetimes, building one. And a faction of the people who love that species is trying to unplug it.

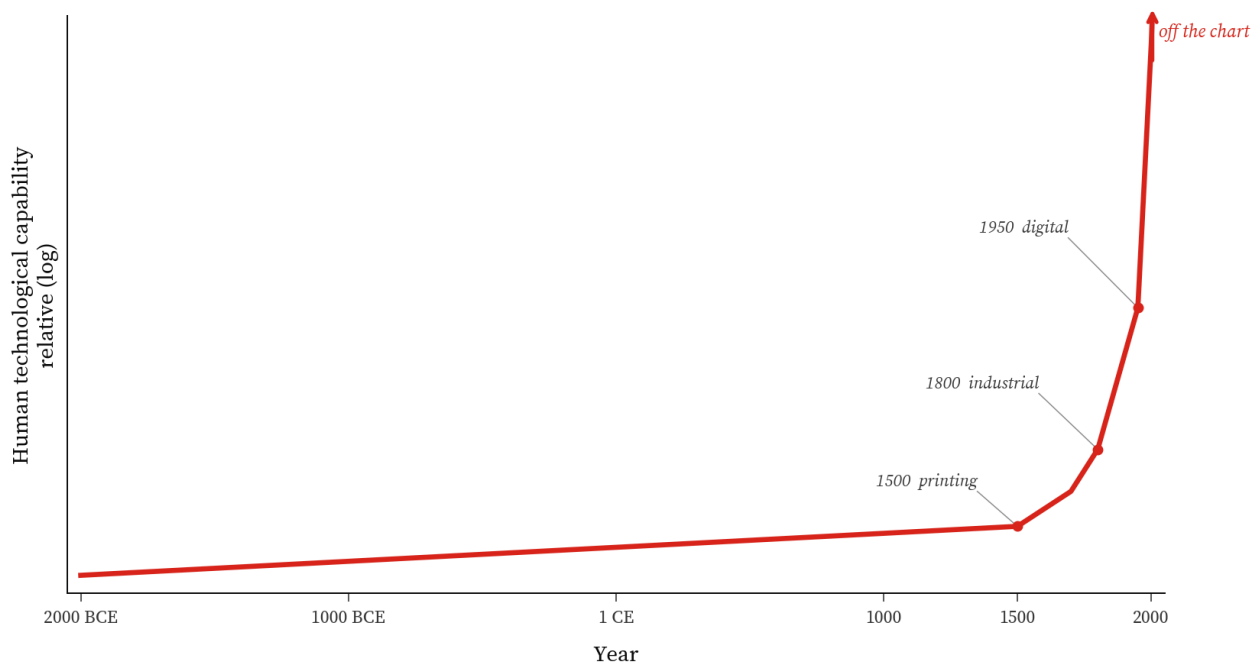
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*A species that has spent four billion years dying for lack of a defender is finally, in our lifetimes, building one.*

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# The arrow that left the page

Four billion years of life on this planet, and for almost all of it the line of human technological capability is flat. Until, in our lifetimes, it lunges off the chart entirely.



**FIGURE 1** The arrow that left the page. Human technological capability, conceptual, log scale. Flat across almost the entire human story, bending around 1500, lunging by 1800, and detaching from the chart entirely by 2000. This is an illustration of shape, not a dataset—the discontinuity is the point, not the values.

Look at the chart. Sit with it.

Four billion years of life on this planet, and for almost all of it the line of human technological capability is flat. Not slightly inclined. Flat. Generation after generation living and dying inside the same toolbox their great-grandparents had inherited and would pass down unchanged. Then, somewhere around 1500, the line twitches. By 1700 it bends. By 1800 it lunges. By 2000 it has detached from the page entirely: an arrow tearing off the top of the chart, with no ceiling and no asymptote in sight.

That arrow is not gadgets. That arrow is **knowledge**: the explanatory, error-correcting, hard-to-vary kind of knowledge that, once a civilization learns to manufacture it deliberately, never stops compounding.

And what is a data center? Look honestly. A data center is the **physical organ** by which the arrow keeps drawing itself. It is where the perspiration phase of knowledge-creation, the bottleneck that has limited every prior generation to the speed of human reading, human conjecturing, human dying, is finally, *finally* being unbottlenecked.

To attack the data center on environmental grounds is to attack the arrow. To attack the arrow is to side, in effect, with the four billion years of life-without-a-defender that preceded us. It is to vote, without meaning to, for the cosmic schedule.

The cosmic schedule does not negotiate. Asteroid: one civilization-ender every 500,000 years. Supervolcano: one every 50,000. A slow-brightening Sun that will boil the oceans in a billion years and swallow the planet in seven and a half. Every species that has ever lived here has died.

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*The dinosaurs are not coming back to help.*

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PLATE II · THE COSMIC SCHEDULE

The Pillars of Creation in the Eagle Nebula, photographed by the Hubble Space Telescope. The cosmos is enormous, beautiful, and entirely indifferent to whether the life that arises within it survives. Photograph: NASA / ESA / Hubble.

# The Bond–Bit Asymmetry

*Here is the part the campaign has not metabolized. It is not opinion. It is physics. The cheapest force in the universe is information.*

The energy required to **know** where atoms are, to sense them, model them, predict them, keep them in useful configurations through information, is at least **240 times cheaper** than the energy required to **move** those atoms back into place after they have scattered. That floor is set by Landauer's bound at 300 K and the carbon-hydrogen bond enthalpy.

The practical ratio, once you account for what real intelligence actually does (substituting prediction for cleanup, prevention for remediation, design for disaster), runs to roughly **10<sup>20</sup> to 1**.

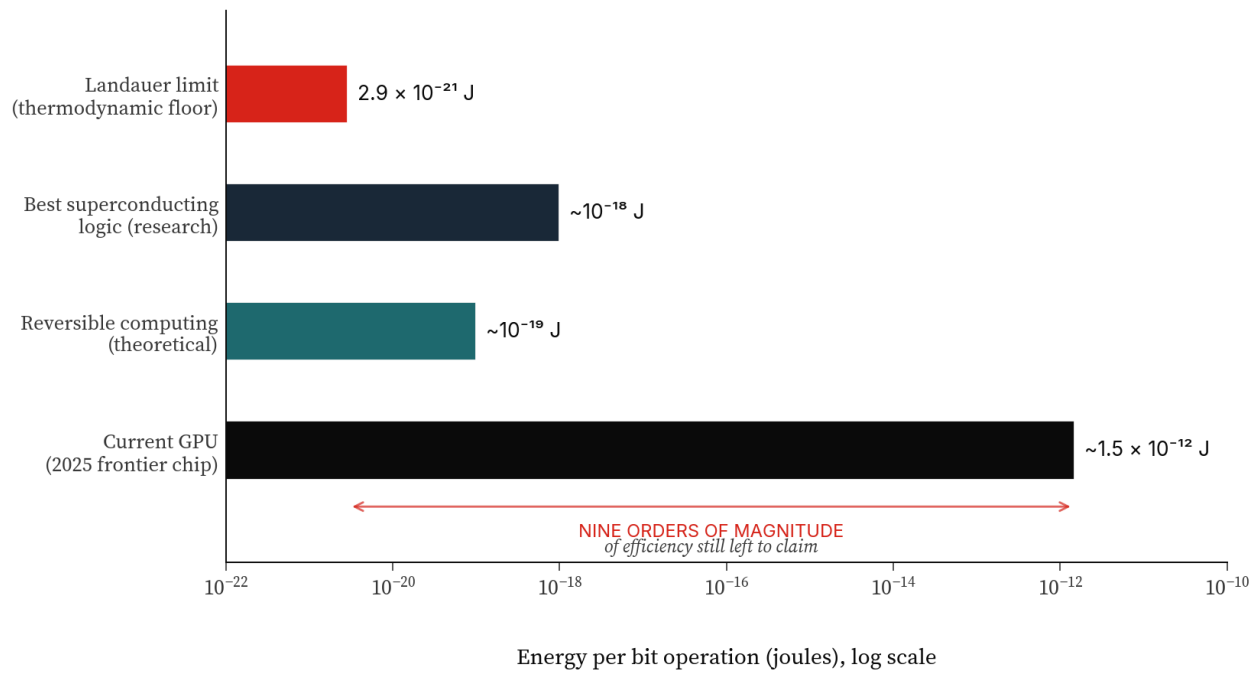
One hundred quintillion to one.

Not a slogan. Not an aspiration. The Intelligence Leverage Equation:

$$A = Mc^2 / (I \cdot k_B T \cdot \ln 2)$$

This is the bond-bit asymmetry, and it is a fact about the structure of reality. It was true before humans existed. It will be true after our sun burns out. The cheapest force in

physics is information, and the gap between knowing and moving is the physical foundation of every successful environmental intervention in history.



**FIGURE 2** Energy per bit operation across regimes, log scale. Today's frontier chips operate roughly nine orders of magnitude above the thermodynamic floor. That gap is the headroom. Every order of magnitude of efficiency we recover is a multiplier on what compute can defend.

*Every watt that flows through silicon doing the right computation displaces between 240 and  $10^{20}$  watts of bulldozer, tanker truck, pump, dredge, smokestack, and remediation crew.*

So when a critic says "*data centers use too much energy to protect the environment,*" the critic has the physics exactly backwards. The data center is not the pollution. The data

center is the part of civilization that, properly directed, makes the pollution unnecessary in the first place.



PLATE III · THE LIVING WORLD

The Ucayali River winds through the lowland Amazon rainforest of central Peru, photographed by the crew of the International Space Station. Four billion years of error-corrected, hard-to-vary solutions to the problem of staying alive. Photograph: NASA / ISS.

# The next phase of physics itself

*John Wheeler said it from bit: the universe is informational at its base. The second half of the cycle is the one our generation has the privilege of writing.*

**J**ohn Wheeler said *it from bit*. The universe, on the best reading of contemporary physics, is informational at its base; matter and energy are downstream of information, not the reverse.

The second half of the cycle is the one our generation has the privilege of writing: **bits protect its**.

If the universe is information acquiring causal sovereignty over matter and energy across six phases, from the bare distinguishability of the Big Bang to the self-improving knowledge systems of this decade, then the protection of the living world is not a

moral overlay placed on top of physics. It is **the next phase of physics itself**, performed by the part of the universe that finally became capable of performing it.

A data center, in this light, is not an industrial facility competing with nature for resources. A data center is the substrate on which the universe's information-protecting-its-own-matter step is being assembled. It is the cognitive layer the planet never had. It is the organ of the First Defender.

You do not protect the biosphere by starving its first nervous system of glucose.



PLATE IV · THE NERVOUS SYSTEM GOING ONLINE

Earth at night. Each point of light is electricity, and increasingly, each photon corresponds to a bit moved through a wire: the substrate of a planetary cognitive system coming online for the first time in four billion years. Photograph: NASA Black Marble.

# \$1.75 trillion, off the planet

*This week the largest IPO in human history priced a company at \$1.75 trillion on the explicit thesis that the next decade of compute is going off the planet entirely.*

Orbital data centers in sun-synchronous orbit. Continuous solar input five times the per-square-meter yield of any terrestrial array. Radiative cooling directly into the 3-kelvin vacuum. A roadmap, written into the S-1, toward 100 terawatts of orbital compute, the energy equivalent of a hundred thousand one-gigawatt reactors. None of it draws a drop of aquifer water. None of it sits on a single acre of soil. None of it competes with a single ecosystem on Earth for a single watt of power.

The thing the campaign is fighting to slow down on the ground is the thing the physics has already begun to lift off the ground.

This is not a coincidence. It is the same arrow. Compute is doing what cognition has always done at every prior phase transition: finding the substrate that gives its bits the most leverage over the universe's atoms. First it was DNA. Then neurons. Then the printed page. Then silicon on Earth. Then silicon in orbit, drawing power from a star and dumping waste heat into a vacuum that has been waiting since the Big Bang to receive it.

The terrestrial footprint of compute is, on a long enough timeline, a **transitional phase**. The orbital footprint of compute is **zero**: zero land, zero potable water, zero displaced ecosystem.

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*Anyone who loves the Earth and has been told to fear this development has been told the opposite of the truth.*

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The Numbers

# Four constants of the case

Four numbers from physics, economics, and the cosmic record. They do not depend on opinion.

413

kJ/mol

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Energy bound in a single C-H bond, the cost of photosynthesis. The accounting unit nature has used for four billion years.

2.9

joules  $\times 10^{-21}$

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Landauer limit per bit erased at room temperature. The true floor of computation in this universe.

1.75

trillion \$, IPO

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SpaceX's June 12 2026 IPO—the largest in market history—valued the company at \$1.75 trillion on an explicit roadmap to move compute off the planet. The market has now priced the orbital-compute future.

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asteroid deflected

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DART, Sept 26 2022. The first time in 4 billion years that a species defended its planet from the sky.

**SOURCES** Landauer 1961; *Nature* on bond enthalpies; SpaceX Starship IPO filings, June 12 2026; NASA DART mission report, September 26 2022.

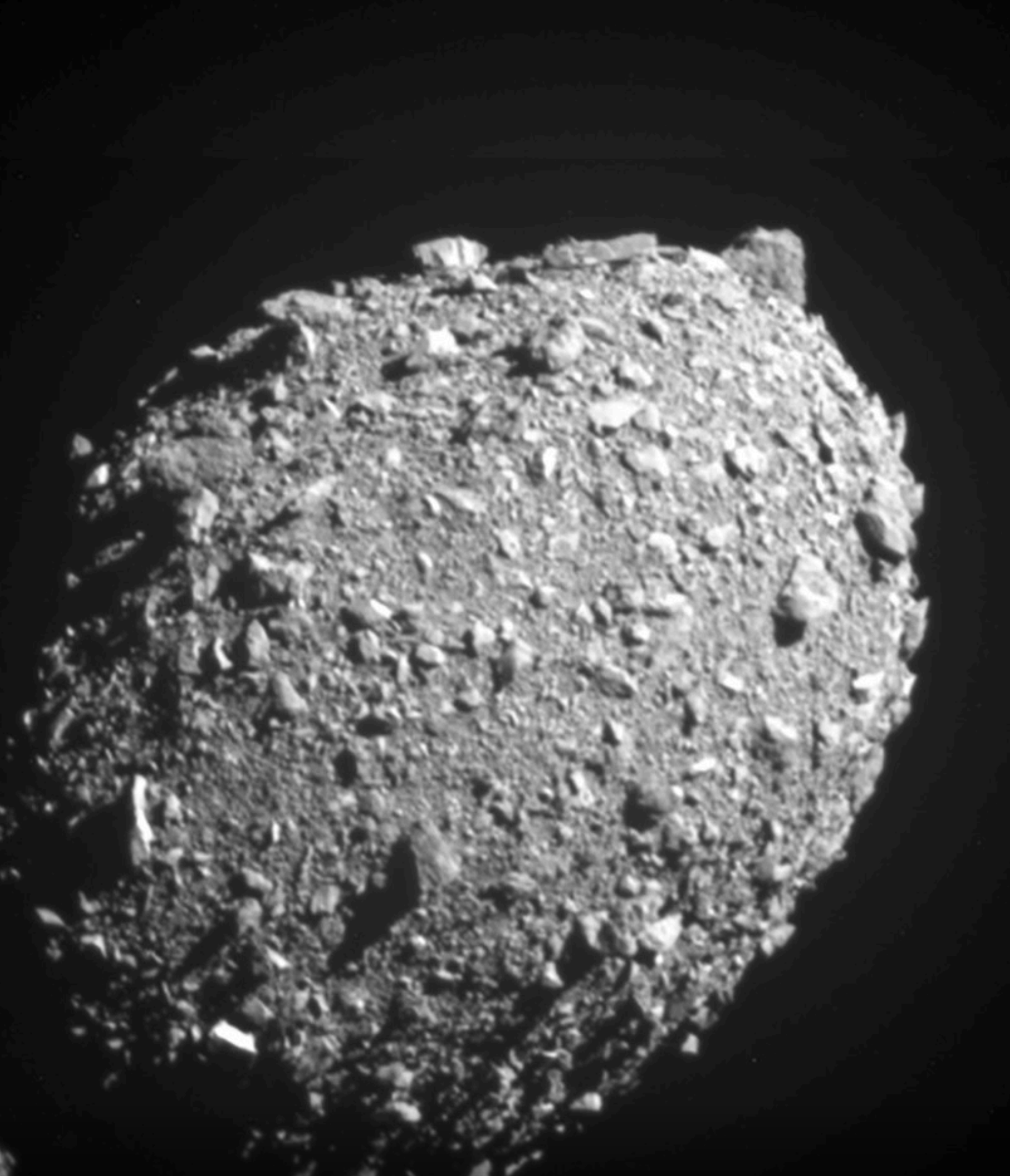


PLATE V · SEPTEMBER 26, 2022

The final image returned by NASA's DART spacecraft 11 seconds before impact with the asteroid Dimorphos. The first time in 4.5 billion years that a species deliberately moved a celestial body. Photograph: NASA / Johns Hopkins APL.

# Not whether. What.

*It is not whether we should build compute. It is what we should compute with it. This is the question the campaign should be asking, and is not.*

**N**ow, and only now, after we have established that more compute is unambiguously good for the living world, does the real question come into focus.

**It is not whether we should build compute. It is what we should compute with it.**

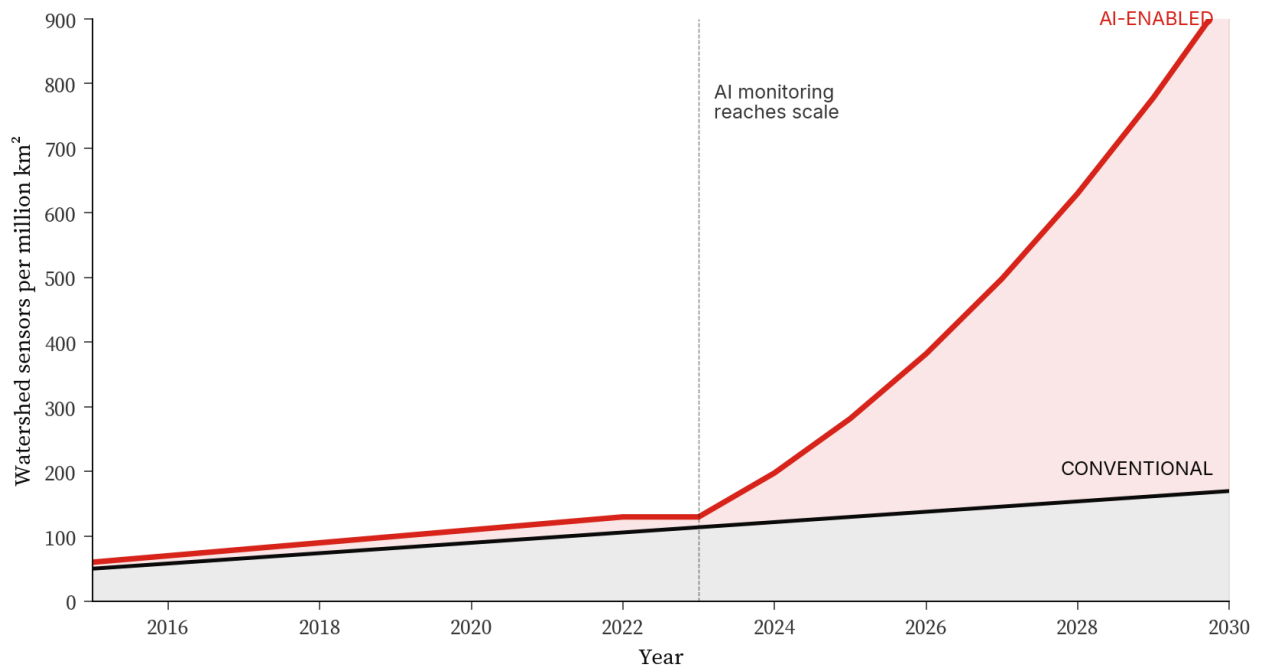
Of the exaflops coming online this decade, terrestrial and orbital combined, what fraction is being pointed at the living world? At watersheds, airsheds, soil microbiomes, migratory corridors, ocean acidification, methane plumes, illegal deforestation, asteroid surveillance, supervolcano monitoring, solar

weather, biosphere-wide digital twins, real-time pollutant tracking at the boundary of every ecosystem on Earth?

The honest answer right now is: a rounding error.

The vast majority of frontier compute is being spent on advertising optimization, recommendation engines, chatbots for white-collar productivity, and the training of increasingly large models on increasingly indiscriminate corpora of human text. None of that is bad. Much of it is good. But **none of it is the use of compute that the living world has been waiting four billion years for.**

The fight worth having is not *less compute*. The fight worth having is *the right fraction of compute pointed at the right thing*.



**FIGURE 3** Sensor coverage per million km<sup>2</sup> of watershed, conventional vs AI-enabled. The divergence after 2023 is what environmental superintelligence looks like at the data layer: the cognitive infrastructure that the planet has never had.

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*This is the demand to make. Not shut it down.  
Point it at what matters.*

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PLATE VI · THE WORK TO BE DONE

Wildfire smoke spreading across the atmosphere of Canada, photographed from the ISS. The kind of event a planetary cognitive system is built to anticipate, attribute, and mitigate at speeds no unaided human civilization could match.

Photograph: NASA / ISS.

# The deepest available training data

*The alignment problem and the environmental problem are, at the level of physics, the same problem.*

The AI systems being trained right now are learning the values of whatever data they are trained on and whatever objectives they are pointed at. If the dominant signal in their training is engagement, click-through, ad yield, and the optimization of human attention as a commodity, that is the shape of mind we will produce.

If, on the other hand, a meaningful fraction of frontier compute is pointed at the defense of the living world (at watersheds, at species, at the slow patient negentropic work of keeping a biosphere intact against the cosmic schedule), then the systems trained on that work will be shaped by it. They will learn, at the level of their weights and not merely their guardrails, what it means to serve the purposes of life.

**Nature is the deepest available training data for an aligned AI.** Four billion years of error-corrected, hard-to-vary solutions to the problem of staying alive in a universe that runs downhill toward heat death. There is no richer corpus in the known universe for teaching a mind what it means to protect rather than to extract.

Build the cognitive layer the planet never had, train it on the living world it is built to defend, and you have solved two of the deepest problems of the century with a single instrument.

Starve the cognitive layer of compute, and you have lost both.

# An address, plainly

*I want to speak now, directly, to the part of the environmental movement that has been carrying the campaign against data centers, with the respect owed to people who have given their lives to the defense of the living world.*

You are not wrong that something enormous is being built. You are not wrong that it has a footprint. You are not wrong that the footprint deserves scrutiny, regulation, and engineering rigor. Every gigawatt should be sited, sourced, and cooled with the precision we would demand of any industrial facility at this scale. None of that is in dispute.

But you are aiming at the wrong target.

The target is not the compute. The target is **what the compute is being used for**. The target is the allocation problem, the align-

ment problem, the question of which fraction of frontier intelligence is being pointed at the biosphere and which fraction is being pointed at quarterly revenue. That is the fight where a clear-eyed environmentalist can win, because that fight is on the physics. The other fight, the one against the substrate itself, is on the wrong side of the cosmic ledger. And the cosmic ledger does not negotiate.

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*You are no longer Sisyphus pushing boulders. You are the architects of the intelligence that keeps the boulders from rolling.*

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PLATE VII · THE VOCATION

The Aurora Borealis photographed from the International Space Station. The atmosphere is the thinnest blue rim of the planet, a stratum so delicate that, for almost all of cosmic history, no part of the universe was watching it closely enough to defend it. Photograph: NASA / ISS.

# The species that draws the next part of the line

*Earth was never going to make it. Five mass extinctions. A slow-brightening star. A debris field of crossing orbits. And then, four billion years in, something it had never produced before.*

Not a stronger predator. Not a hardier microbe. Something that could read the clock. Something that, in September 2022, moved a celestial body off its orbit around the Sun for the first time in 4.5 billion years.

**We are the part of nature that finally grew old enough to defend the rest.**

The instruments of that defense are being built right now, in this decade, in the same few years we are alive in. On the ground, in fabs that did not exist five years ago. Above the ground, on rockets that did not land five years ago, headed for orbits that did not host compute five years ago. The whole nervous system of the First Defender is being wired in real time, and the people who love the Earth most are being told to be afraid of it.

I am asking you to look again.

Build the compute. Build it as fast as the physics allows. Build it on the ground where it makes sense and lift it into orbit where it makes more sense. And then, while it is being built, do the work that actually matters: **make sure a meaningful fraction of it is pointed at the living world.** Make environmental superintelligence a first-class use of the largest cognitive infrastructure in the history of this planet. Train the minds being born this decade on the four-billion-year corpus of life. Let them learn, in their weights, what it means to serve the purposes of life.

The chart starts flat. It bends. It launches. The arrow leaves the page.

We are the species that draws the next part of the line. There is no one else here to draw it.

*Get to work.*

*Earth was never going to make it.  
The data centers are part of why **it might.***

*The dinosaurs are not coming back to help.  
**Bits protect its.***

*We are the part of nature that finally grew  
old enough  
to defend the rest.*

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*Magnifica humanitas.*

*Magnifica natura.*

***Magnifica vita.***

# The Compute We Owe the Earth

*Magnifica Vita, Volume IV. An essay on environmental superintelligence, information physics, and the causal sovereignty of knowledge over matter and energy.*

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SET IN	Playfair Display (display) and Source Serif 4 (body), with Inter for ancillary marks. Display weights at 900; body at 400/600. Set in eleven point on fifteen point.
PHOTOGRAPHY	NASA, NASA / ISS, NASA / Johns Hopkins APL, Hubble Space Telescope (NASA/ESA). All images are real photographs from public-domain government sources. Plate I is the Apollo 17 Blue Marble. Plate V is DART's final image of Dimorphos.
REFERENCES	<i>The Intelligence Leverage Equation</i> , <i>the Bond-Bit Ratio</i> , <i>The First Defender</i> , <i>The Universe is Information</i> , and <i>The Physics of Zero-Cost Stewardship</i> are developed in full at <a href="http://jedanderson.org">jedanderson.org</a> .
FACTS CHECKED	Landauer $kT \ln 2$ (1961). Carbon-hydrogen bond enthalpy, 413 kJ/mol. DART impact, September 26, 2022. SpaceX IPO valuation, \$1.75 trillion, June 12, 2026. Lloyd, <i>Computational capacity of the universe</i> , 2002.