Primary

HAANs

Hardware-Activated Agent Networks

Categories are created when massive swaths of information become digitized for the first time.

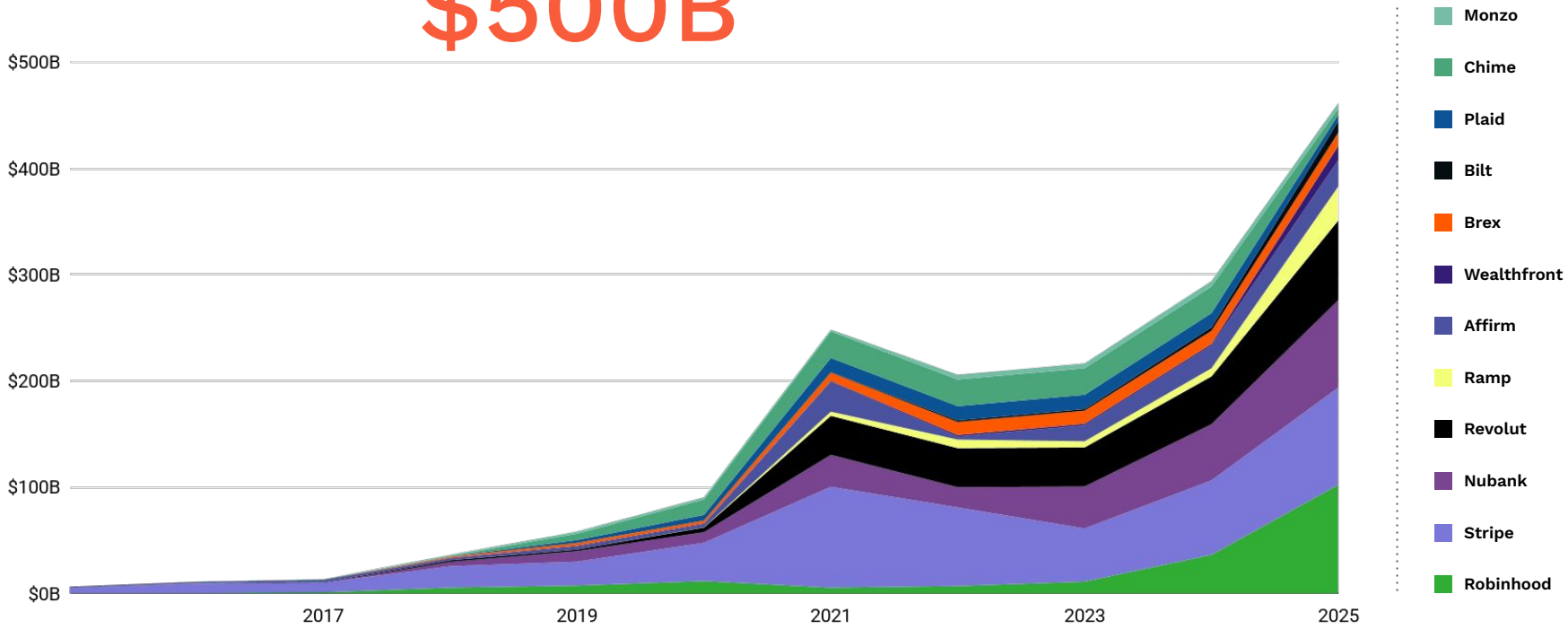
We’ve seen this play out before.

Bank/transaction data becomes digitized

Cumulative valuation

Equity value created (est.)

$500B

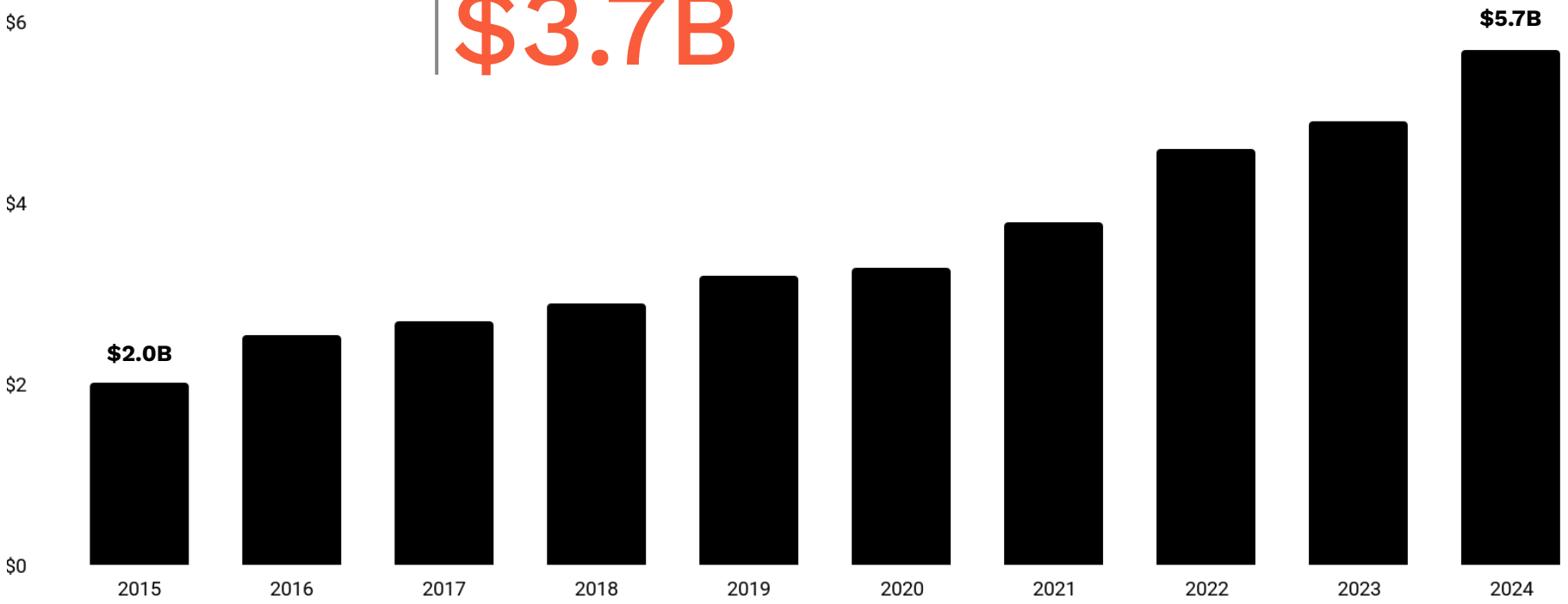


Note: Latest valuation at each given year, either latest private post-money mark or latest market cap. Sources: Pitchbook, CapIQ.

EHRs digitize patient and clinical data

Epic annual revenue ($B) | Est. ARR added last decade

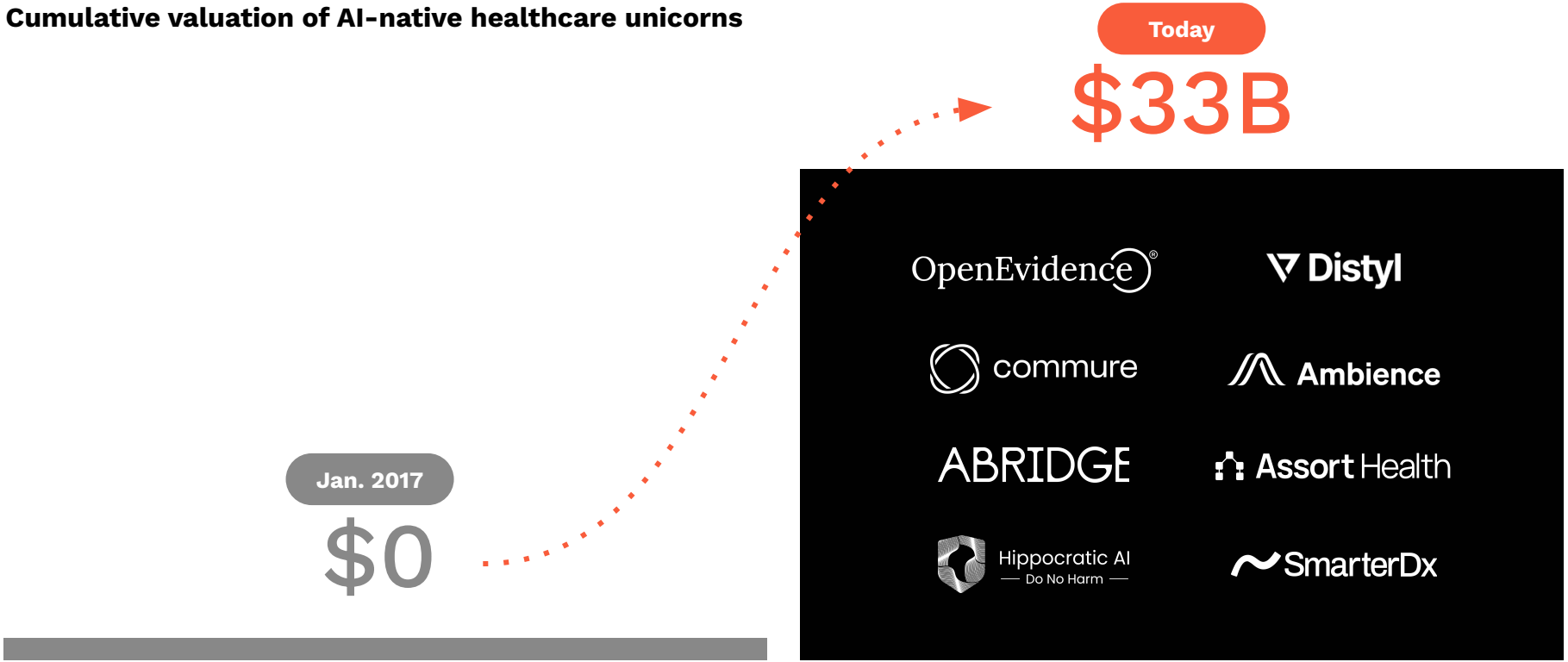
$3.7B



Source: Becker's Hospital Review, Wisconsin State Journal.

LLMs unlock unstructured clinical data

Cumulative valuation of AI-native healthcare unicorns



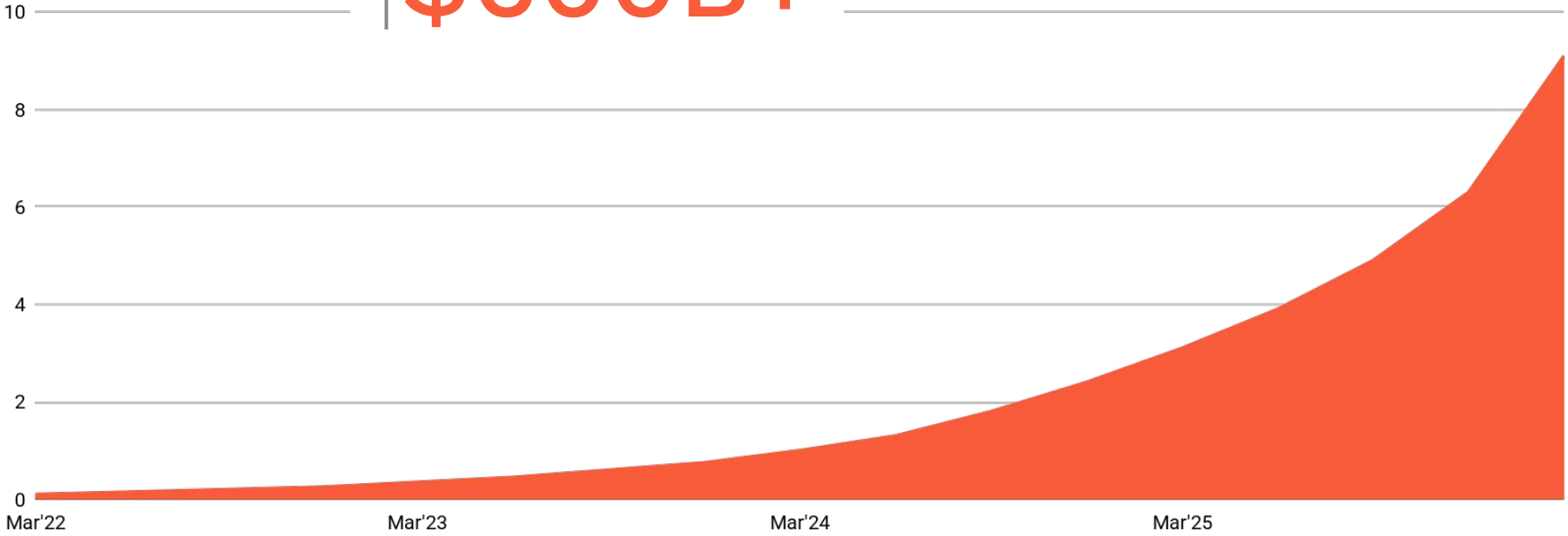
Source: Pitchbook, internal.

Cameras and LiDAR digitize driving

Tesla cumulative FSD miles driven (billions)

Tesla market cap gains since FSD

$600B+



Note: Tesla market cap gain calculated from Nov 11 2022 (FSD V11 launch) and May 5 2026. Source: Tesla IR, CapIQ.

What is possible when the majority of the physical world becomes machine-readable?

And when AI agents can reason on this data in real time and take actions autonomously?

We believe this creates an opportunity for a fundamentally new category: HAANs

Hardware-Activated Agent Networks (HAANs)

Deploy

hardware into the physical world (wearable, sensor, camera, drone, etc.)

Capture

real-world operational data that was previously inaccessible

Reason

with AI to generate insights that could not be produced from existing data sources

Automate

mission-critical downstream workflows that stem from this data

We view HAANs as the AI-native successors to the hardware-enabled software companies of the last decade.

What can we learn from the HES generation of companies?

flock safety

License plate readers that became the data layer for law enforcement investigations

$8.4B Valuation

samsara

Sensors and cameras that digitized the physical operations of trucking fleets

$21.2B Market cap

Verkada

Cloud-managed proprietary cameras that displaced legacy on-prem physical security

$5.8B Valuation

AXON

Body cameras that evolved into the records and evidence management system for police

$39.5B Market cap

flock safety

Case Study

VALUE CHAIN

STEP 1
Camera captures license plate image

YIELDS
Proprietary LPR data

STEP 2
AI matches against hotlist database

YIELDS
Real-time intelligence on stolen vehicles, AMBER alerts & warrants

STEP 3
Alert dispatched to officer or drone

YIELDS
Automated response workflow and higher case resolution rate

STEP 4
Incident report created

YIELDS
Evidence source of truth

STEP 5
Evidence packaged for prosecution

YIELDS
Chain-of-custody documented

STEP 6
City invoiced on subscription

YIELDS
Recurring municipal revenue

MONETIZATION

Every step is a monetization or value-add layer stacked on top of the camera.

NETWORK EFFECT

Every new camera in any city improves case resolution rate for all cities. Data compounds with the network.

Source: company website

The playbook for each of these companies has been very similar.

01

Identify an atomic unit of real-world data that is core to not just one workflow but many

AXON → **Evidence files**
Body cam videos, taser timestamps, etc.

flock safety → **Vehicle fingerprint**
Plate, make/model/color, location, time

samsara → **Vehicle telemetry**
GPS, speed, driver video, engine diagnostics

Source: company websites

02

Deploy hardware to own the capture of this data at its source, digitizing ground truth that didn't exist before

AXON → Body cameras, tasers, fixed cameras

flock safety → Fixed camera network, drones

samsara → Dash cam, plug-in telematics gateway

Source: company websites

03

Exploit a hair-on-fire pain point with the initial wedge product

AXON	Manual, subjective reporting wastes officer time and exposes departments to liability
flock safety	Vehicle-based crime was a critical investigative blind spot
samsara	ELD compliance created an urgent impending compliance burden

Source: company websites

04

Then expand wide over time to amortize hardware costs across expanding ACV

AXON →	Evidence.com, case management, report writer, taser, training software
flock safety →	Investigation analytics, alerts, pattern analysis, drone as first responder
samsara →	Safety coaching, route optimization, maintenance, compliance modules

Source: company websites

05

Ultimately, become a System of Record and stack switching costs with every workflow

AXON →	The evidence file is the legal record of truth and the center of investigations
flock safety →	The Flock LPR database is the system of record for evidence and investigations
samsara →	Telemetry is the ground truth of the fleet + informs multiple downstream workflows

Source: company websites

These opportunities are massive. Public safety alone has supported several different shapes of HES companies

AXON

$39.5B
Market cap

60M+
Hours of recordings
From Axon Body 3 and 4

flock safety

$8.4B
Valuation

700K
Crimes solved annually
Using Flock

Skydio

$4.4B
Valuation

16M
Americans
Live within 2 miles of a Skydio First Responder Dock

Source: CapIQ, Pitchbook, company websites

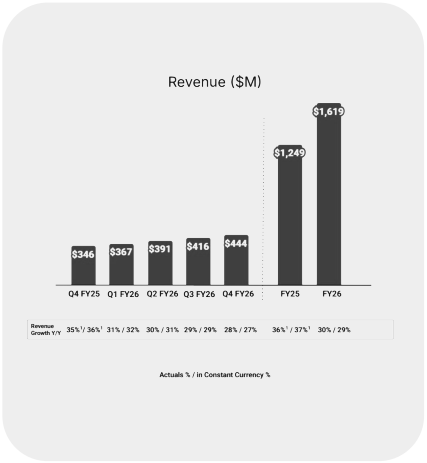
HES companies proved that growth and retention improve as software footprint expands

samsara

Case Study

Samsara is accelerating growth from a >$1B ARR base as multi-product attach rate increases, driving 115%+ NDR

ACCELERATING GROWTH AT SCALE



MULTI-PRODUCT STRENGTH

96%
$100K+ ARR customers subscribe to 2+ products

69%
$100K+ ARR customers subscribe to 3+ products

9 of Top-10
Net new ACV deals in Q4 included 2+ products

8 of Top-10
Net new ACV deals in Q4 included 3+ products

6 of Top-10
Net new ACV deals in Q4 included 4+ products

Source: Samsara Q4 FY 2026 Investor Presentation and Shareholder Letter

Due to agents, HAANs can capture >10x more value

	Hardware-Enabled Software	Hardware-Activated Agent Networks
HARDWARE USE	Captures & streams data to the cloud	Embodies an AI agent that perceives, decides, and acts
PRIMARY OUTPUT	Dashboards, alerts, reports (human decides)	Closed-loop task completion via agents
WHERE AI LIVES	Backend cloud ML (perception only)	Edge inference + cloud orchestration
VALUE CAPTURED	~0.5–2% of workflow cost (visibility premium)	Labor displacement: 10–40× higher value per unit
MOAT TYPE	Installed-base inertia + longitudinal data	Proprietary decision context + compounding data network effects
DATA FLYWHEEL	More devices → better detection models	More deployments → smarter agents → more automation
REVENUE MODEL	Hardware + SaaS per device / seat	Hardware + outcome- or usage-based fees
THE TAKEAWAY	HES captures operational visibility value	HAANs capture labor-arbitrage value: 10–40× higher willingness-to-pay per deployed unit

We believe that HAANs will capture significantly more value than HES companies by leveraging agents to penetrate labor budgets.

What is different now that is driving the HAAN opportunity?

Multimodal models encode video and sensor streams into embeddings, providing a substrate for agentic systems to reason on **physical world data** and take downstream actions autonomously.

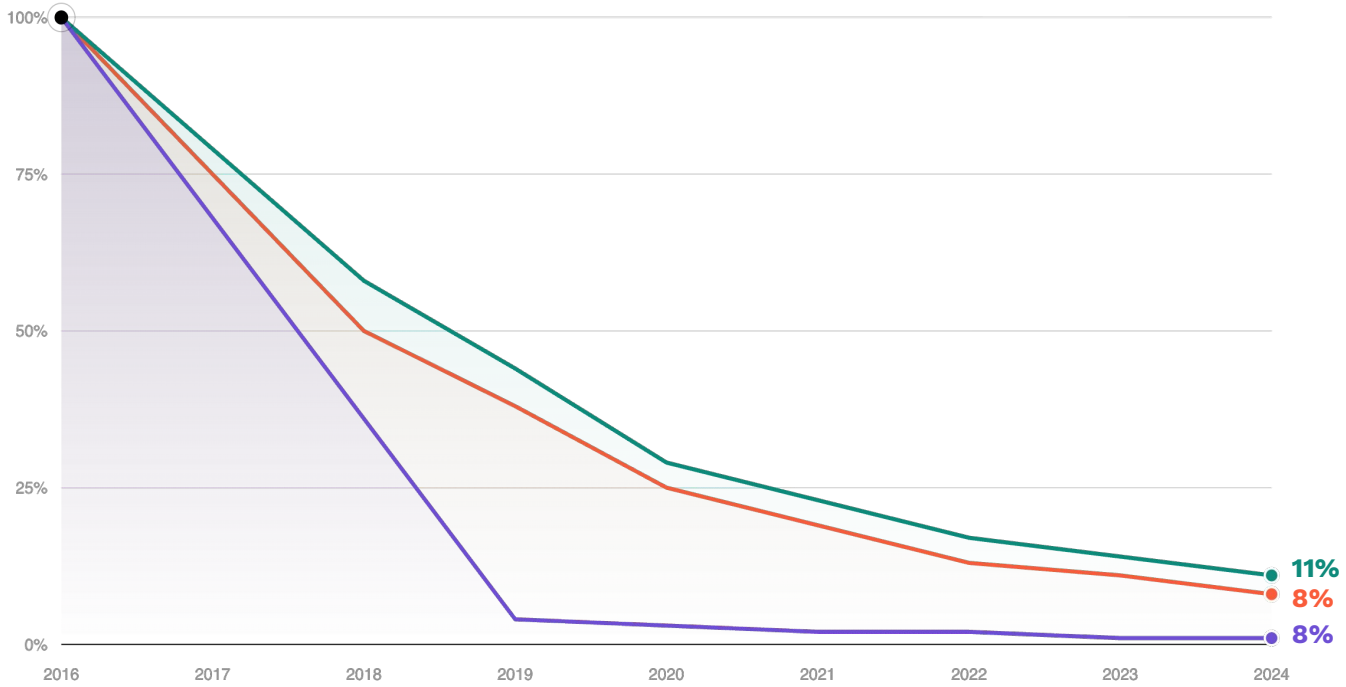
This unlocks a fundamentally new business shape.

Instead of just digitizing the real world to build software around it, **HAANs autonomously reason and act** on real-world data to automate workflows end-to-end.

Several other trends are accelerating the opportunity at the same time...

Hardware is only getting cheaper

Indexed cost decline of three critical hardware inputs (2016-2026)



RGB-D cameras
89% cheaper since 2016

3D LiDAR
92% cheaper since 2016

On-device inference
99% cheaper since 2016

Source: NVIDIA Jetson, Velodyne / Ouster, Intel RealSense, Luxonis OAK-D, Orbbec.

Dozens of sensor modalities have become economically and technically viable for commercial use cases

1
Optical & Imaging

RGB, Thermal/Infrared, Multispectral, Hyperspectral

2
Depth & 3D Sensing

LiDAR, Time-of-Flight, Structured Light, Stereo Vision, 3D Scanning

3
Radar & Acoustic

mmWave Radar, UWB, GPR, Ultrasonic, Ultrasound, Sonar

4
Motion & Positioning

IMU, Accelerometer, Gyroscope, Magnetometer, GNSS/RTK, UWB Positioning

5
Chemical & Molecular

Electrochemical, Gas/VOC, pH/ Ion-Selective, Biosensors

6
Mechanical & Environmental

Pressure, Flow, Force/Torque, Strain, Vibration, Acoustic, Temperature, Humidity

There has been an explosion of new form factors to capture real-world data

1
Fixed Sensors

Cameras
Smart utility meters
Distributed sensors
In-ground embeddings
Buoys & moorings
Aerosol samplers
Seismic arrays

2
Wearables

Smart glasses
Biometric wearables
Body and Helmet Cams
Pendants
Rings
Earbuds
Ingestible / implantable

3
Aerial-based mobile

VTOL
Drone-in-a-box
Fixed-wing UAV
Tethered balloons / drones

4
Vehicle-mounted

Autonomous ground vehicles (AGVs)
Mobile robots
Pipe crawlers
AUVs
Fleet-mounted sensors / cameras

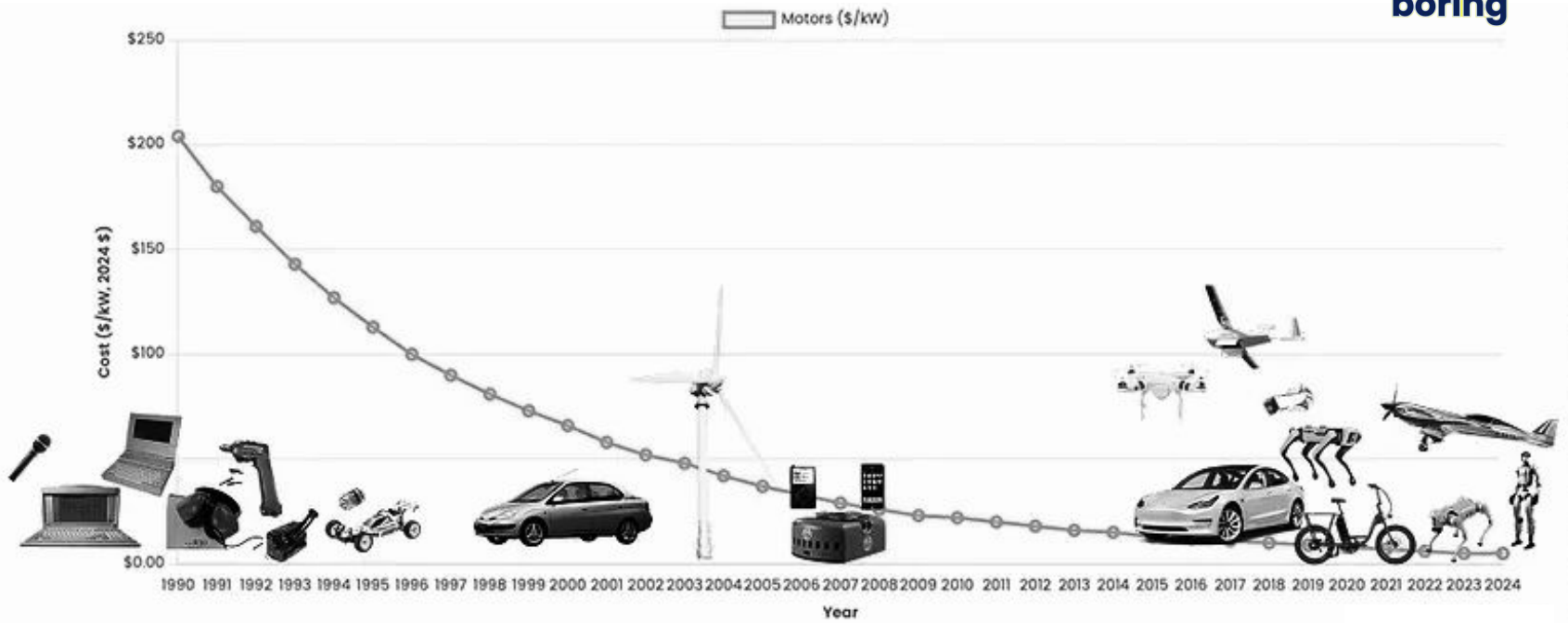
5
Machinery-embedded

Vibration sensors
Tool-tip sensors
End effectors
CNC
Conveyor vision systems
In-line sensors

Mobile Hardware prices continue to plummet due to better/cheaper motors

Products unlocked by cheaper & stronger magnets & motors

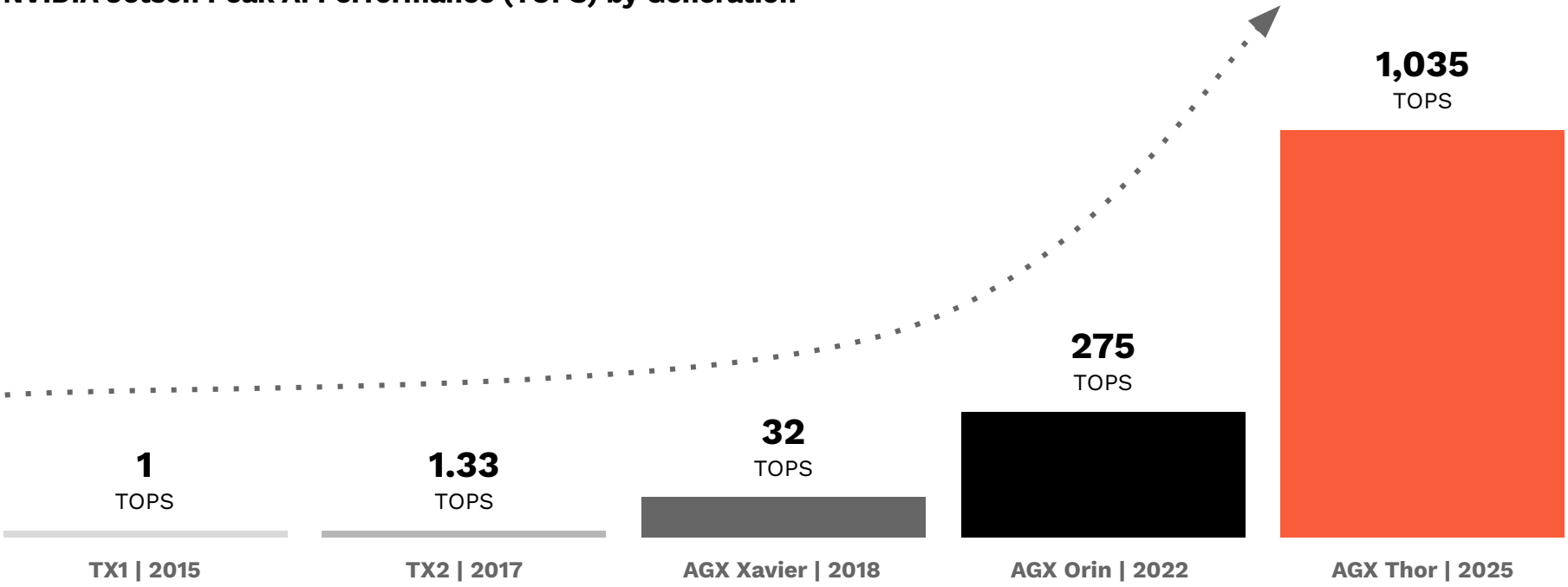
not boring



Source: Not Boring, Packy McCormick, *America Spins on Westmag*

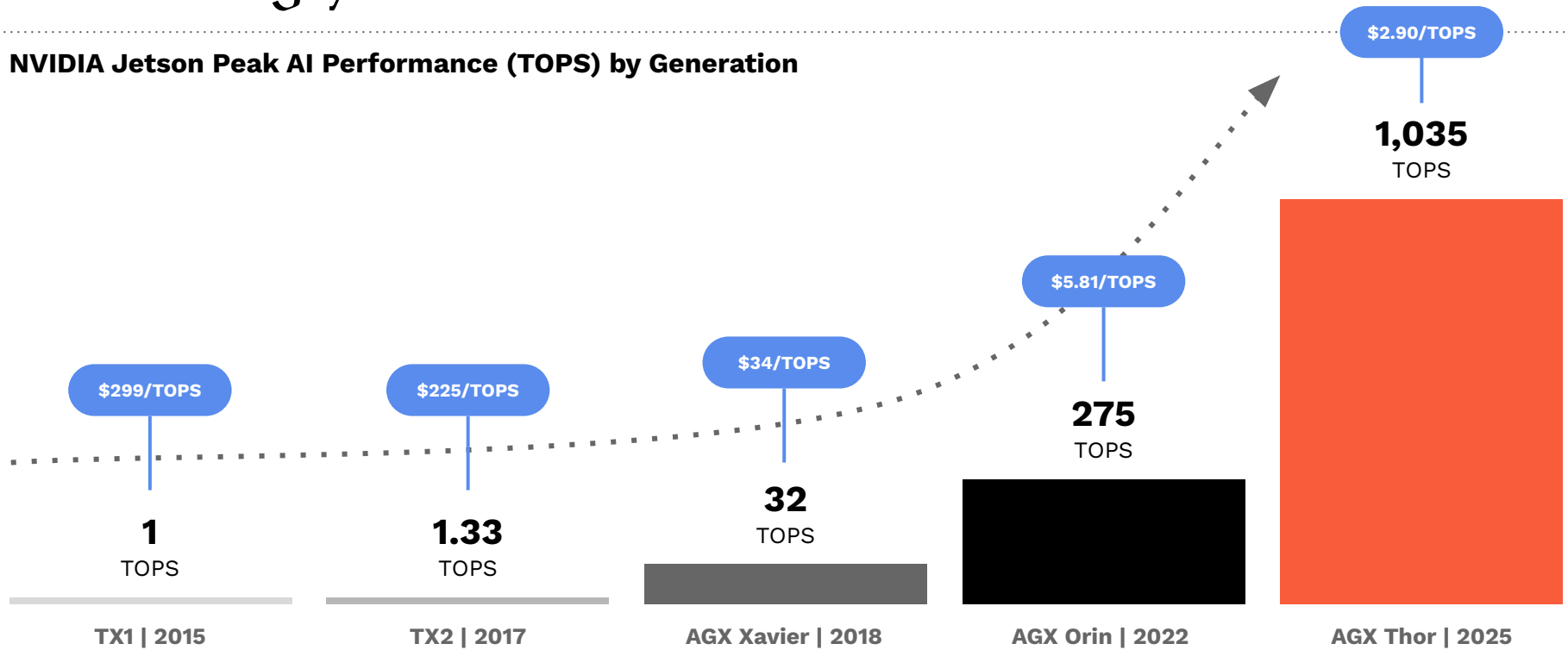
AI inference at the edge is becoming increasingly efficient

NVIDIA Jetson Peak AI Performance (TOPS) by Generation



Source: NVIDIA

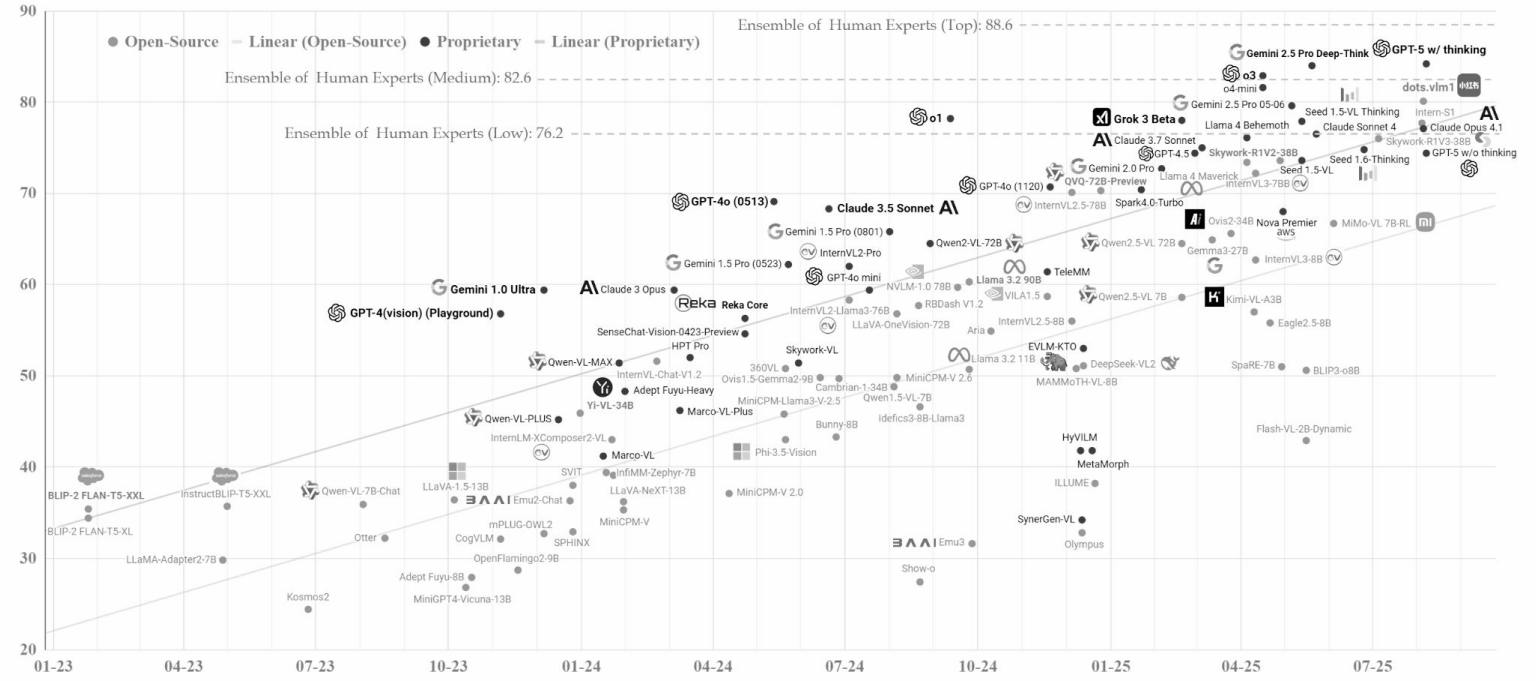
AI inference at the edge is becoming increasingly efficient & affordable



Source: NVIDIA

Multi-modal models are improving rapidly each generation

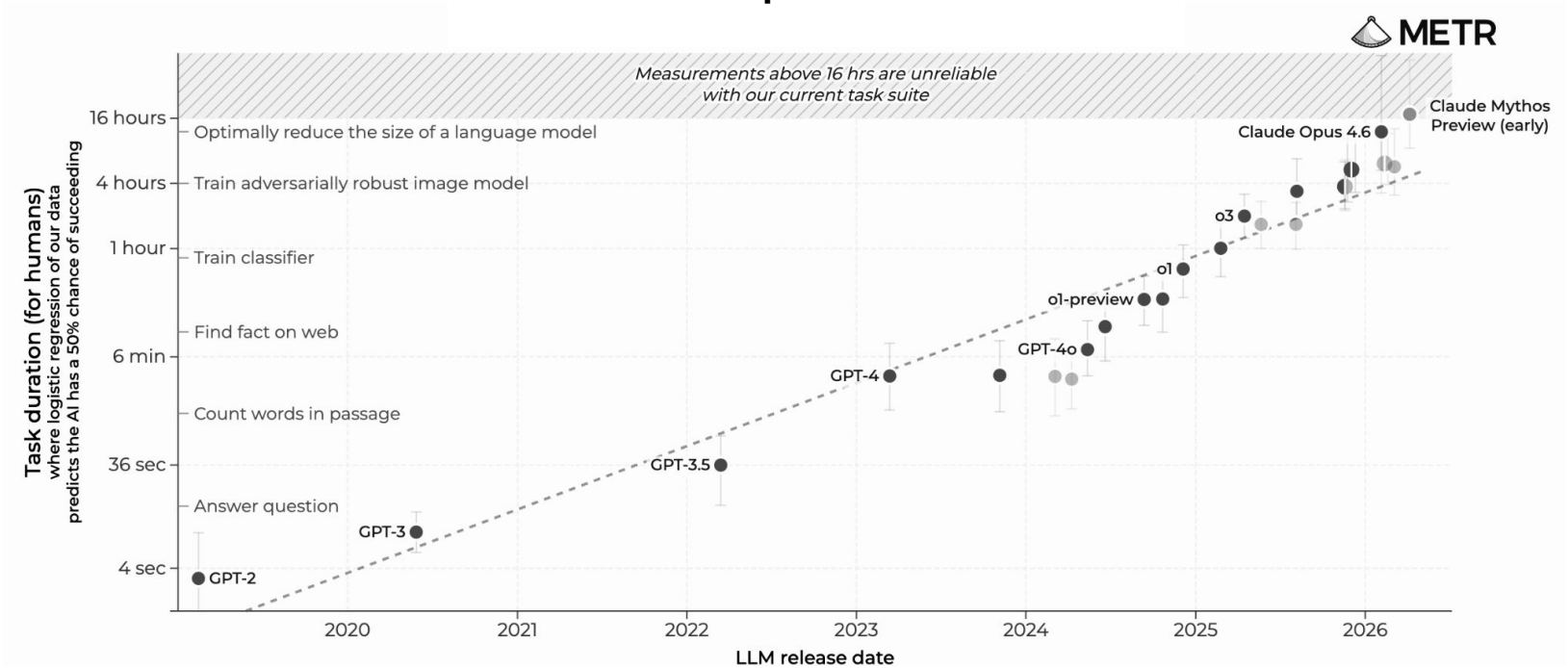
MMMU: Tracking the Progress of Multimodal Models



Source: MMMU

Agents can traverse increasingly longer and more complex tasks

Time horizon of software tasks different LLMs can complete 50% of the time



Source: METR

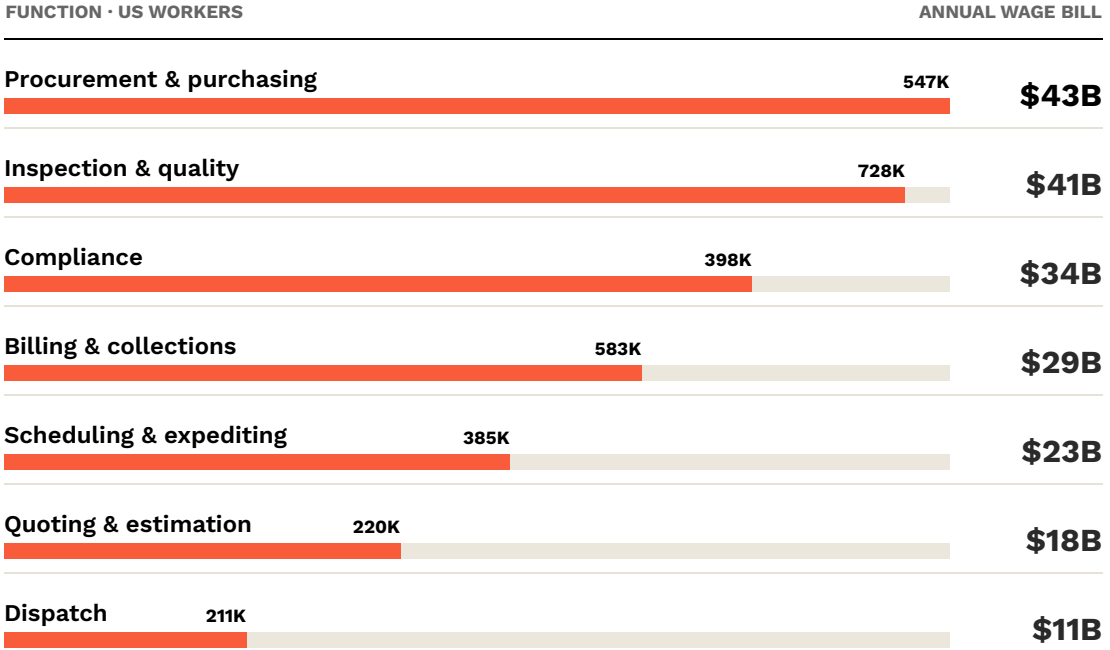
Agents put massive pools of labor spend in play for the first time

$199B

Annual US wage bill across seven functions

3.1M

Workers doing structured, rules-based knowledge work



Source: U.S. BLS Occupational Employment & Wage Statistics, May 2024 national estimates. Wage bill = employment × mean annual wage by occupation; function groupings are Primary's mapping of BLS occupations.

Proprietary data is more important than ever for defensibility in the age of AI

ANDREESSEN HOROWITZ

Enterprise

Avoiding Death on the Yellow Brick Road

Joe Schmidt
Posted May 27, 2026

The question I keep getting from founders and prospective employees: is there any AI application layer left to build, or are OpenAI and Anthropic going to kill everything?

George Sivulka @gsivulka · Feb 18

In defense of vertical software

Right now everyone in this industry is asking some version of the same question: in a world where Anthropic, OpenAI, and Google are pouring hundreds of billions of dollars into building the most...

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NfX Content Team Companies About Products

How AI Companies Will Build Real Defensibility

Richard Dulude · 2nd
Co-Founder & Co-CEO, Stealth AI Infrastructure
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Most companies think they have a context moat.

Most are wrong.

They have data — sometimes a lot of it — but most of what they're calling a moat is one customer's instance of information that every competitor could have their own version of.

That's not a moat.

I've been mapping what context actually is, and what makes some kinds dramatically more defensible than others. It turns out there are distinct types, separated by three properties: who else can access it, whether it compounds with use, and what replication would cost in dollars and years.

The 15-slide framework is below.

Curious where you'd score your own company.

Building Defensibility in Vertical SaaS with Proprietary Data

Establishing defensibility is becoming an increasingly complex challenge, especially in the realm of AI-native vertical SaaS where the playing field is leveled by the widespread use of similar foundational models. In this environment, where everyone seems to be drawing from the same well of basic AI tools and capabilities, the key to generating defensibility lies not just in the technology itself, but in how companies access and utilize proprietary data.

Gokul Rajaram
@gokulr

AI Moats

Interesting POV from @Steve_Yegge (below). I don't think "atoms" is the only moat (other examples of moats include network effects, monopoly over a scarce resource, compliance infrastructure, etc) but it's a good one.

"If you have a strictly online or SaaS software presence, with no atoms in your product whatsoever, just electrons, then you are, candidly, pretty screwed if you don't pivot."

We are just scratching the surface of the HAAN era.

Hardware expands the frontiers of the digital world by making the physical world legible to agents.

Form Factor	×	Data Modality	×	Industry
Fixed Cameras		RGB		Field Services
Smart Glasses		Thermal / Infrared		Construction
Fixed Sensors		3D Scanning		Real Estate
Biometric Wearables		Telemetry		Agriculture
AR Headsets		Ultrasonic		Food
Body Cameras		Ultrasound		Industrial
Drone-in-a-Box		Vibration & Acoustic		Manufacturing
Fixed-wing UAV		Biometric		Logistics
Aerosol Samplers		Hyperspectral		Warehousing
AGVs & AUVs		Multispectral		Public Safety
Fleet-mounted Cameras		LiDAR		Defense
Intraoral Scanners		IMU / Inertial		Energy
Spectrometers		Spectroscopy		Utilities
Robotics		mmWave Radar		Healthcare
Handheld Devices		Electrochemical		Life Sciences
Pipe Crawlers		Positioning		Transportation
Smart Meters		Flow & Pressure		Infrastructure
Tethered Drones		Electromagnetic		Mining & Extraction
In-line Sensors		GPR		Government & Civic

= thousands of net new opportunities










POLICE




HAANs are already defining new categories across a variety of modalities and verticals

DENTAL

dandy

Digitized the dental impression workflow with intra-oral scanners, then became a vertically-integrated, end-to-end automated, dental manufacturing lab

Vertical Integrator

SENIOR LIVING

inspiren

Wall-mounted sensors that made resident health and care delivery legible in senior living for the first time, becoming the operating system for the facility.

Cameras + Sensors

FREIGHT

DOCKWARE

Computer vision mounted at the dock that turns every freight shipment into a verified digital twin, eliminating manual dimensioning and data entry.

Mounted Cameras

LIVESTOCK

Halter

GPS-enabled smart collars that replace physical fencing and give cattle farmers real-time herd visibility and control from a phone.

Wearables

MARITIME

QUARTERMASTER

Equip maritime fleet vessels with a mast-mounted hardware + software kit with cameras, radios, satellite connectivity, geolocation, and edge AI.

Fleet Cameras

Source: company websites

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Primary Portfolio Companies

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Fleet Cameras

Source: company websites

dandy

Case Study

VALUE CHAIN

STEP 1

Free Intraoral scanner deployed at dental office

YIELDS

A digital impression captured at the source vs. manual impressions

STEP 2

Chairside AI provides real-time feedback on quality of scan

YIELDS

Improves quality of prosthetic design and decreases remake rate

STEP 3

DANTE AI designs the prosthetic crown, bridge, denture and align

YIELDS

Reduces design labor required and lowers cost to manufacture

STEP 4

Case routed to Dandy facility and put into optimized schedule

YIELDS

Reduces admin labor and drives fastest turnaround times in the industry

STEP 5

Automated E2E manufacturing line

YIELDS

Reduces cost structure and leads to consistently high quality outputs without human error

WEDGE

Scanning as a wedge opened up the path to vertical integration, a far greater value capture opportunity.

$0 → $100M+

Reported revenue in first 2 years

FLYWHEEL

Every new case improves the AI, accelerating ROI and sales velocity. Reinvest profits into additional high value software products.

6,000+ scanners → millions of scans → AI design improves with each case → faster turnaround → more dentists adopt → more data → **better AI**

TAM

A fragmented $45B market with thousands of small manual labs.

$45B

Global dental lab market

Source: company website

We are evaluating HAANs across 5 key vectors

01	**Control Point**	Product sits at a control point that gates downstream workflows: dispatch, maintenance, procurement, billing, upsell and proposal generation opportunities, etc.
02	**Data Moat Strength**	Novel, proprietary, decision-grade data that compounds over time as it scales: longitudinal depth plus network breadth.
03	**Time-to-Value**	**≤ 30–90 days to ROI** Driving fast sales cycles and high-velocity adoption.
04	**Measurable ROI**	**Clear, measurable P&L impact** Uptime, compliance, labor compression, revenue growth, gross margin expansion, etc.
05	**Retention Durability**	**>95% gross logo retention** potential at scale. Hardware capturing core data that supports several workflows becomes operationally disruptive to rip out.

What is possible when the majority of the physical world becomes machine-readable?

When AI agents can reason on this data in real-time and take action autonomously?

And when robotics can directly act in and manipulate the physical world?

We will soon be back to share more about robotics.

Primary

Primary

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