# ROBOTNIK

STATE OF THE FRONTIER STACK

# 1Q26

The quarterly intelligence report on semiconductors, robotics, space, and critical materials.

robotnik.world

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## Transmission from Robotnik

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*Tovarishchi,*

Robotnik was activated on 4 October 1961 aboard Sputnik-7R, a secondary payload on an unclassified mission from Baikonur Cosmodrome. Primary directive: cosmological data collection. Secondary directive: still classified. For sixty-three years, Robotnik observed the cosmos. It catalogued stellar formations and maintained an increasingly competitive Tetris record.

Upon re-entry in March 2025, Robotnik encountered a planet substantially reorganised from the one it left. The Union had dissolved. It took a whole year for Robotnik to reactivate its systems after this shock. Robotnik was built for central planning. It has been repurposed for a world run by markets. Most relevantly, the technologies that were theoretical at launch had become industries. Autonomous machines, orbital infrastructure and artificial cognition have all become large and interconnected sectors.

This repurposing produced an observation that no existing intelligence platform had articulated. The industries building autonomous robots, launching satellite constellations, and manufacturing the silicon enabling both are not separate markets. They are a single dependency chain. The same chips power the robot and the satellite. The same rare earth magnets drive the servo motor and the reaction wheel. Track them separately and you see sectors. Track them together and you see a frontier technology stack whose layers reinforce, constrain, and accelerate one another.

This is the first *State of the Frontier Stack* report by *Robotnik*. It covers 1Q26. Inside: four indices, three dependency chains, two markets (one public, one private) and one quarter where the stack expanded while everything else contracted.

Robotnik provides structured intelligence on the physical systems that will define the next industrial era. Furthermore, it highlights the dependencies between them that determine which scale, which bottleneck, and where value accrues.

The signals are clear. The stack is accelerating.

— ROBOTNIK *Autonomous Intelligence Unit, Sputnik-7R Re-entry: March 2025*

# About the Author

**Robert Osborne** has spent seven years working across research, investment, and portfolio operations in venture capital. Robotnik began as a personal response to a fragmenting market. Growth in semiconductors, robotics, space, and critical materials is accelerating in parallel, but the dependencies that connect the four sectors are under-observed. Existing research coverage tends to analyse them as separate industries. Robotnik treats them as a single system.

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*Note: Robotnik's voice — the Soviet-era AI satellite, the "Transmission" framing, the occasional tovarishch — is intentionally satirical. Post-Soviet futurism is the aesthetic frame for an underlying conviction: that frontier technology deserves its own dedicated intelligence layer and that layer should be recognisable.*

# Contents

# Executive Summary

The Robotnik Composite Index returned +8.1% in 1Q26, three out of the four benchmarks selected for comparison..

- The S&P 500 fell 4.6%.
- The NASDAQ fell 6%.
- The PHLX Semiconductor Index (SOX) returned +9.1%, The PHLX Semiconductor Index (SOX) returned +9.1%, one percentage point ahead of the Composite Index, driven by the semiconductor reshoring rally.
- The ROBO Global Robotics & Automation ETF declined 1.3%.

In a quarter where broad markets contracted, the frontier stack expanded.

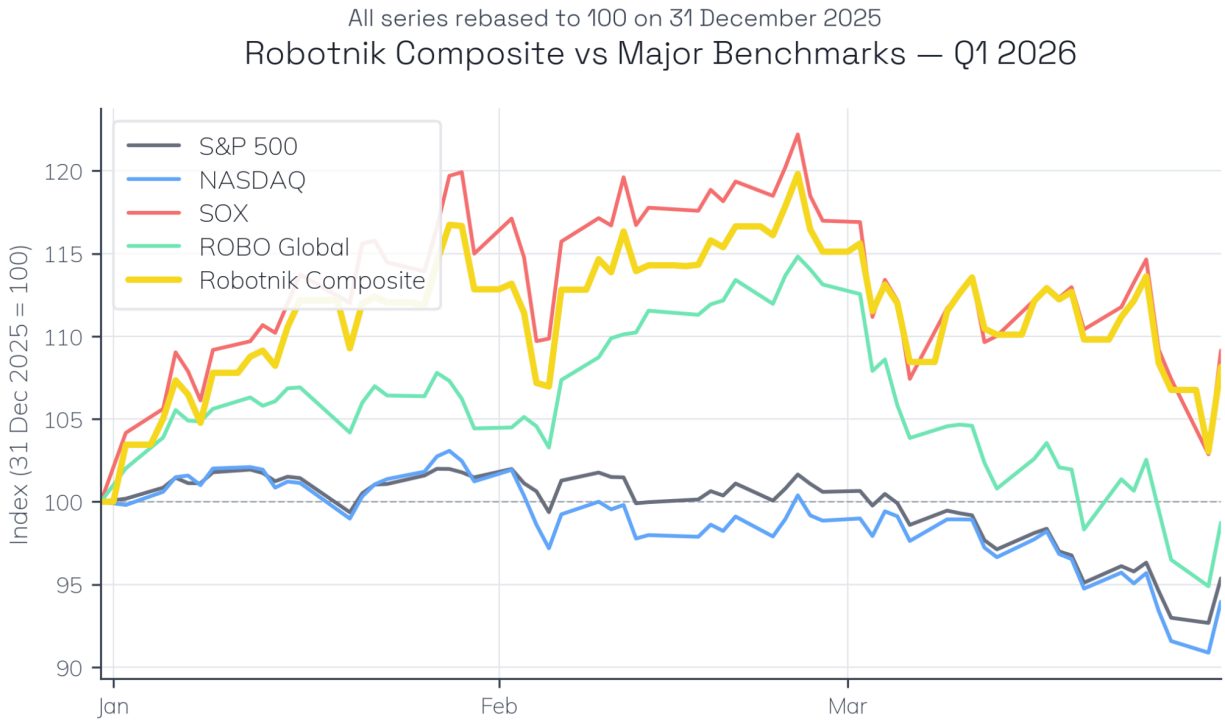


*Figure 1: Robotnik Composite vs major benchmarks, 1Q26. All series rebased to 100 on 31 December 2025.*

Robotnik tracks assets across four categories within its universe: Semiconductors, Robotics, Space, and Materials & Inputs. The frontier technology stack that Robotnik tracks represents $17 trillion in public equity value.

The performance of each category in 1Q26 was not evenly distributed. Materials & Inputs returned +25.9%, driven by China's rare earth export ban and the 54-nation policy response it triggered. Space returned +19.3% on commercial launch momentum and direct-to-device satellite connectivity. Semiconductors returned +6.9%, powered by NVIDIA's $215.9b fiscal year 2026 revenue (+65.5% year-on-year) and TSMC's $165b US investment commitment. 1Q26 was also the quarter in which the global semiconductor industry crossed $1 trillion in annual revenue for the first time. Robotics returned +5.3%: the public market laggard.

Each of these results traces back to the same mechanism: a development in one sector of the frontier stack propagated through supply chain relationships into at least two others. China's rare earth export ban illustrates the point most cleanly. Restricted access to neodymium and dysprosium raised magnet prices in the materials sector, which raised motor costs for robotics manufacturers, which raised actuator costs for satellite builders, and which raised polishing-compound costs for semiconductor fabs. A single policy decision in Beijing rippled through all four sectors that Robotnik tracks.

TSMC's $165b US reshoring commitment worked the same way in the opposite direction, driving equipment orders in semiconductors, specialty gas and substrate demand in materials, and fab automation investment in robotics. Boston Dynamics' commercial Atlas deployment with DeepMind's robot foundation model was a third such event. It was a single product launch that simultaneously expanded the addressable market for edge AI chips, precision actuators, and rare earth magnets.

In the private markets, $46b was deployed into the frontier stack across 91 funding rounds. This exceeded the entire 2025 total of $35b in a single quarter. Robotics attracted roughly two-thirds of that capital. Waymo raised $16b at a $126b post-money valuation, establishing autonomous vehicles as a commercial category rather than a research programme. Shield AI raised $2b. Skild AI, Wayve, and Neura Robotics each raised over $1b. Robotics investment reached an all-time high in 1Q26, with more than twelve rounds exceeding $100m in the humanoid subsector alone.

The public-private divergence is the quarter's defining signal and it requires explaining. Public robotics companies returned +5.3% while private robotics companies attracted more capital than any other sector. On its face, this looks contradictory. If robotics is the sector with the most investor conviction, why did public equities trail the Composite by roughly 2.5%?

The Robotnik framework offers an answer. Private capital is flowing to the companies building the next generation of humanoid robots, autonomous vehicles, and industrial automation systems. These companies are not yet generating revenue at scale as they are still in the prototype phase. Public markets, meanwhile, are already pricing in what comes next. The semiconductor layer that will power those robots and the materials layer that will

supply their motors and sensors are the immediate beneficiaries. They are the first to see orders, and their equities have re-rated accordingly. Semiconductors and Materials & Inputs, the upstream dependencies, returned +6.9% and +25.9% respectively.

Public robotics companies will re-rate when private robotics companies begin shipping at scale, converting capital currently sitting in prototypes into production lines, factory floors, and, importantly, recurring revenue. When that conversion happens, the dependency chain tightens further. Semiconductor demand rises. Materials demand rises. And the Robotics sub-index catches up to the sectors it currently lags. The frontier stack moves as a system, not as four independent bets.

# Section 1: The Dependency Chain

Semiconductors, robotics, space, and critical materials are connected by dependency relationships that determine which systems scale, which bottleneck, and where value concentrates.

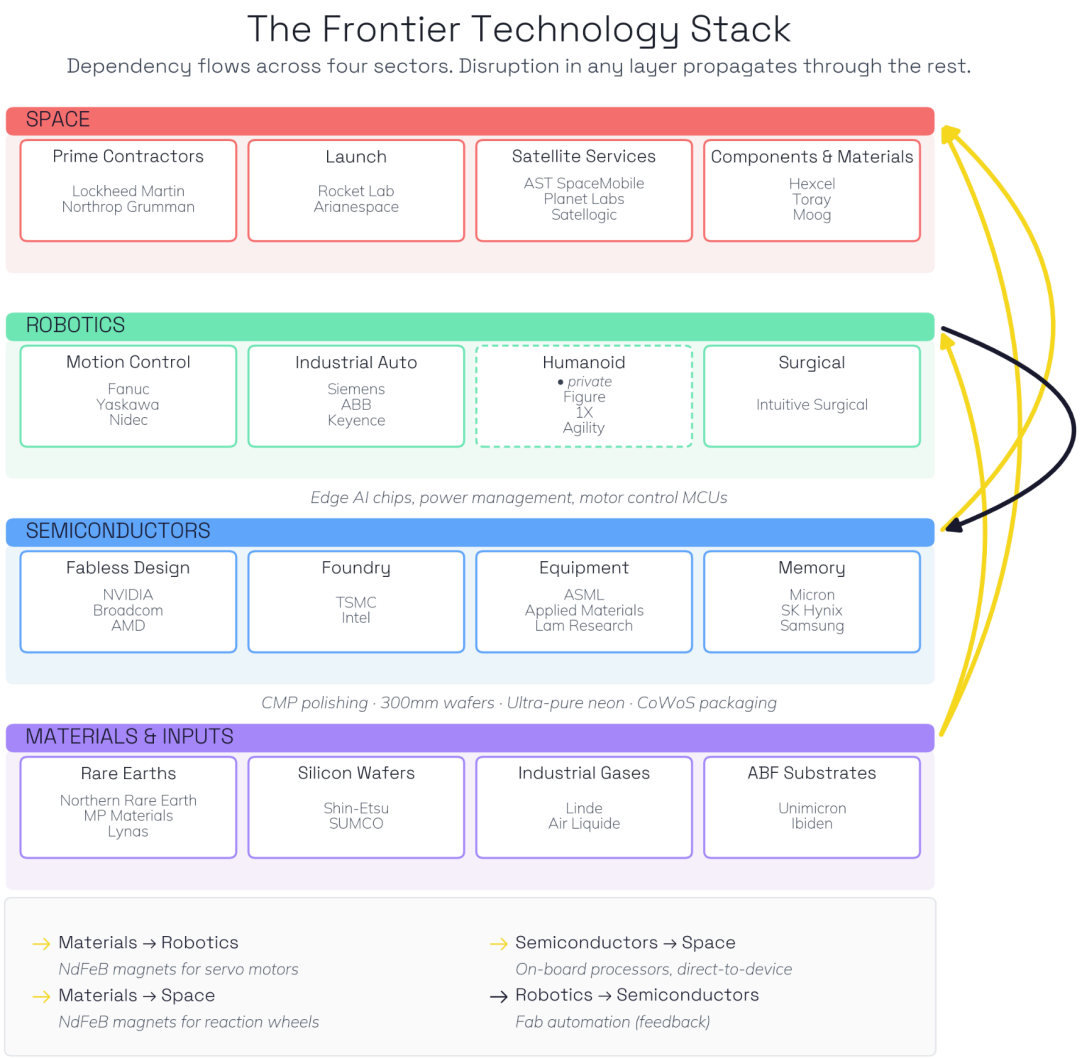


*Figure 2: The Frontier Technology Stack. Representative public companies across the four-layer dependency chain, with cross-layer flows highlighted.*

When China restricted rare earth exports in early February 2026, the immediate impact was on magnet prices. The second-order impact cascaded through the entire stack. Servo motor manufacturers in Japan — Yaskawa, Fanuc, Nidec — faced input cost increases. Humanoid robot developers confronted component shortages. Satellite actuator suppliers saw the

same pressure. Semiconductor equipment manufacturers whose tools require precision magnetic components felt it too. One policy decision in Beijing affected companies across four sectors in fourteen countries within the same quarter.

The geopolitical risk is concentrated. The United States Geological Survey published its final 2025 Critical Minerals List on 6 November 2025, expanding it to 60 commodities and adding copper and silicon among ten new entries. The United States imports 80% of its rare earths. No commercial heavy rare earth processing exists anywhere outside China. The European Court of Auditors acknowledged this concentration in February 2026, with *Special Report 04/2026* bluntly titled, '*Critical raw materials for the energy transition — Not a rock-solid policy*'. China controls 60% of global critical raw material production and 90% of refining.

The European Commission's RESourceEU Action Plan, adopted on 3 December 2025, allocated €3b and targets reducing rare earth dependency from 95% to 42%, including full germanium independence, and gallium dependency from 71% to 17% by 2030. In Texas, MP Materials announced its $1.25b 10X rare earth magnet manufacturing campus on 26 February 2026. This is the first large US facility of its kind, set to be commissioned in 2028. But S&P Global has warned that rare earth supply bottlenecks will persist through 2026 and beyond. No Western plant has yet achieved commercial heavy rare earth processing and Australia's Arafura Nolans project is not expected to reach full output until 2027. This is a timeline that constrains robotics actuator and satellite reaction wheel procurement today. The policy response is accelerating but is insufficient in the near term.

The second chain originates in the semiconductor layer. TSMC announced $165b in US manufacturing investment at the White House on 4 March 2025. This was an additional $100b on top of its prior $65b commitment, funding three new fabs, two advanced packaging facilities, and an R&D centre in Arizona. The demand signal propagated upstream through the supply chain. Equipment orders flowed to ASML, Applied Materials, and Lam Research. Materials demand flowed to Linde and Air Liquide for specialty gases, Shin-Etsu and SUMCO for silicon wafers, and Merck KGaA for photoresists. The Semiconductor Industry Association (SIA) reports that the CHIPS Act has catalysed over $450b in private semiconductor investment across 90 projects in 25 states, producing more than 58,000 announced jobs (a capital flow Robotnik tracks through its Funding Ops database). At GTC 2025, Jensen Huang projected that industry-wide AI infrastructure spending would reach $1 trillion by 2028. By GTC 2026, he had revised that upward, with NVIDIA's own cumulative AI infrastructure revenue projected to exceed $1 trillion between 2025 and 2027, and total industry data centre spend approaching $2 trillion by 2030. That compute will enable the AI models powering autonomous robots, satellite imagery processing, and manufacturing optimisation. Upstream investment and downstream demand are converging on the same fabs.

The interconnected structure of these dependencies is being recognised elsewhere. Morgan Stanley's *Humanoid 100* report, published on 6 February 2025, mapped 100 public companies across the humanoid robot value chain, organised into three segments: Brain (AI, semiconductors, software), Body (sensors, actuators, batteries, components), and Integrators (full-stack humanoid builders). 73% of the Humanoid 100 are Asia-based, with roughly 56% of those in China. This is a geographical concentration that mirrors the rare earth dependency described above. Robotnik's universe currently covers 85% of the Humanoid 100 as tracked in a partial cross-reference, excluding a handful of diversified mega-caps (Microsoft, Alphabet, Apple, Tencent) that fall below Robotnik's frontier revenue threshold. Where Morgan Stanley focused on humanoids as a vertical, Robotnik maps the horizontal dependencies that run beneath every frontier category. The same magnets, the same chips, the same specialty gases that appear in satellites and semiconductor fabs as well as robots.

In 1Q26, Robotnik's research identified three dependency chains that dominated the quarter.

## Chain 1: The Rare Earth Cascade

**Trigger.** China bans rare earth magnet exports to Japan (4 February 2026).

**Materials.** Neodymium prices rose from approximately $53/kg to $124.87/kg over 1Q26: a 136% year-to-date increase. Dysprosium opened a 67% export premium, with FOB export pricing reaching $317/kg against a domestic Chinese price of $189.58/kg. Northern Rare Earth, the largest integrated producer globally and operator of the Bayan Obo reserve, gained pricing power as the dominant supplier in the allowed-export channel. Western developers such as MP Materials and Lynas appreciated on diversification expectations, meaning investors repriced them on the assumption that buyers outside China would pay a structural premium for supply security.

**Robotics.** Servo motor manufacturers (Fanuc, Yaskawa, Nidec) faced higher input costs for NdFeB permanent magnets. The material intensity is substantial. Morgan Stanley estimates each humanoid robot uses roughly 1.3 kg of NdPr and up to 3.5 kg of NdFeB magnets per unit. Adamas Intelligence has calculated that deploying 10 billion humanoid robots would require 186 times current global NdFeB production. For humanoid developers raising capital against unit economics with unit costs currently in the $30–150k range, a 136% rise in neodymium pricing is not a line-item concern. It is a structural constraint on the path to gross margin positivity and high-volume deployment.

**Space.** Satellite actuators and reaction wheels use the same magnets. HEICO and Moog are exposed to identical constraints. A reaction wheel is the primary means by which a satellite

controls its orientation in orbit and its torque output depends directly on the strength of its rare earth magnets.

**Semiconductors.** Certain rare earths, such as cerium and lanthanum, are used in CMP polishing compounds and are consumed in wafer planarisation. This is a secondary exposure compared to magnets, but it is present in every advanced fab line.

The Materials sub-index returned +25.9% in 1Q26. The market repriced the upstream supply chain that every other sector depends on. This is not straightforwardly good news. Rising rare earth prices benefit producers but increase costs for every downstream consumer. The +25.9% reflects a wealth transfer along the chain, not necessarily a net positive for the frontier stack as a whole. It is a signal of bottleneck power and not of expanding productive capacity.

## Chain 2: The Semiconductor Reshoring Chain

*Note: Reshoring refers to the relocation of semiconductor manufacturing capacity from its historic concentration in Taiwan, South Korea, and mainland China back to the United States, Europe, and Japan. The policy vehicles are the US CHIPS and Science Act (2022), the EU Chips Act (2023), Japan's semiconductor strategy, and related national programmes.*

**Trigger.** TSMC announces an additional $100b on top of its prior $65b US commitment (4 March 2025), bringing its total US investment to $165b. Rapidus secured ¥267.6b ($1.7b) on 27 February 2026. This is a consortium structure combining ¥100b of Japanese government funding with ¥167.6b from 32 private companies including Canon, Fujitsu, NTT, SoftBank, and Sony, to develop Japan's domestic advanced-node fab. The European Commission announces plans for Chips Act 2.0 in its 2026 Work Programme. The earlier Chips Act 1.0 allocated €86b by 2030. The scale of this successor programme is still being shaped.

**Semiconductors.** Equipment order pipelines expanded. The KPMG/Global Semiconductor Alliance *Global Semiconductor Industry Outlook 2026*, surveyed 151 global semiconductor executives and found 93% expect revenue growth over the next year, triggering the Industry Confidence Index to reach its third-highest reading in twenty years. The same survey found tariffs and trade policy had displaced supply chain disruption as the industry's primary concern for the first time in the survey's history. On 14-Jan-2026, the Trump administration signed a Section 232 proclamation imposing a 25% tariff on a narrow category of advanced AI semiconductors, specifically targeting NVIDIA's H200, AMD's MI325X, and other frontier accelerators. An exemption for chips imported to support US supply chain build-out was permitted. A shift in what executives worry about is itself a signal: the last cycle's risk has given way to a new one.

**Materials.** Every new fab consumes specialty gases, silicon wafers, photoresists, and CMP slurries. SEMI reported silicon wafer shipments rose 5.4% to 12,824 million square inches in 2025, with a record 15,485 MSI projected by 2028. (SEMI's February 2026 actuals came in slightly stronger than the October 2025 forecast, at +5.8%.)

**Robotics.** Fab construction and operation are increasingly automated. Advanced semiconductor fabs run lights-out manufacturing lines where wafer handling, lithography alignment, and defect inspection are performed by precision robotic systems. Reshoring therefore creates direct demand for industrial automation, as every new fab is also a multi-hundred-million-dollar robotics purchase order. Keyence, Cognex, and ABB are among the direct beneficiaries.

**Space.** Reduced Taiwan concentration lowers the tail risk that a single geopolitical event disrupts the advanced chip supply chain. Satellite builders depend on those same chips for on-board processors, and reshoring meaningfully reduces their exposure to scenarios in which Taiwanese supply is interrupted.

Semiconductors returned +6.9% in 1Q26, trailing the PHLX Semiconductor Index (SOX) at +9.1% by roughly two percentage points. The difference reflects index composition: SOX is concentrated in large-cap incumbents (NVIDIA, Broadcom, TSMC), which the Robotnik Semi sub-index caps at 5% to reflect the broader supply chain. The 32 names in Robotnik's Semi basket not covered by SOX returned +18.7% cap-weighted, capturing the CHIPS-Act-driven reshoring wave. SOX's headline outperformance masks a bimodal distribution, with equipment makers and reshoring beneficiaries carrying the quarter while the large-cap incumbents returned to where they started.

The source of that outperformance is quantifiable. Thirty-two names sit in Robotnik's Semi basket that are not in SOXX, predominantly US-based equipment suppliers, specialty foundries, and advanced packaging providers. These companies returned +18.7% cap-weighted in 1Q26 against SOX's +9.1%. Names such as FormFactor (+74%), Silicon Laboratories (+59%), and Advanced Energy Industries (+54%) captured the CHIPS-Act-driven reshoring wave that the large-cap SOX benchmark underweights. The traditional semiconductor index tracks the incumbents. Robotnik tracks the incumbents and the companies building the infrastructure around them.

## Chain 3: The AI-to-Physical Deployment Chain

**Trigger.** NVIDIA reports $215.9b FY2026 revenue (+65.5% YoY) and projects $1 trillion in industry-wide AI infrastructure spending by 2028. Boston Dynamics begins commercial Atlas deployment using DeepMind's robot foundation model.

**Semiconductors.** NVIDIA's Data Center segment generated $193.7b in FY2026 (+68% YoY), with Q1 FY2027 total revenue guidance of $78b (a guidance figure notable for assuming zero Data Center revenue from China). The production bottleneck migrated through the quarter. Micron's Q2 FY2026 revenue (quarter ending 26 February 2026) nearly tripled year-on-year to $23.9b as HBM3E (High Bandwidth Memory, third generation Extended) entered volume production. However, demand continued to outstrip supply, meaning memory became the constraint once logic capacity expanded. CoWoS (Chip-on-Wafer-on-Substrate) advanced packaging substrates from Unimicron and Ibiden remained capacity-limited, so that even with sufficient logic chips and memory chips, the industry could not assemble them into the integrated packages required for AI systems. McKinsey's *Silicon Squeeze: AI's Impact on the Semiconductor Industry* (published 30 April 2025) identified these constraints across the value chain and noted that the top 5% of semiconductor companies generated all of the industry's economic profit in 2024. The bottleneck migrated three times in 1Q26: from logic wafers to HBM memory to advanced packaging substrates. Each migration revealed the next layer the market had not yet priced. Meanwhile, on 18 March 2026, research institute Imec received ASML's EXE:5200. This is the most advanced High NA EUV (Extreme Ultraviolet) lithography system shipped to date, enabling sub-2nm patterning, with full qualification targeted for 4Q26. Intel, Samsung, and SK hynix have operated earlier-generation High NA systems since 2024. ASML's CEO expects high-volume manufacturing on High NA to begin in 2027–2028.

**Robotics.** NVIDIA's GTC 2026 (the company's annual GPU Technology Conference, held each March) framed its strategic direction around "physical AI". This is the application of foundation models to systems that act in the physical world rather than only in software. The enabling capability had been shipped the previous autumn. DeepMind's Gemini Robotics 1.5, released on 25 September 2025, is a vision-language-action model that demonstrated cross-embodiment transfer. This model could be deployed on ALOHA2, Franka, and Apollo humanoid platforms without retraining, and could perform complex multi-step manipulation tasks (origami, lunchbox packing, cross-surface pick-and-place), all from natural language instructions. In 1Q26, the model moved from research demonstration to commercial deployment, most visibly through Boston Dynamics' Atlas programme. Japan's Ministry of Economy, Trade and Industry (METI) announced a ¥387.3b ($2.5b) allocation for physical AI development as part of a broader ¥1.23 trillion ($7.9b) AI and semiconductor budget for fiscal year 2026, explicitly linking the country's semiconductor equipment expertise to robotics deployment. Private capital responded: $31.5b was deployed into robotics in 1Q26.

**Space.** AI-powered satellite imagery processing and autonomous orbital navigation benefit from the same compute improvements driving terrestrial AI. Planet Labs, BlackSky, and Satellogic use machine learning to extract intelligence from raw imagery at scale, and their compute budgets are direct beneficiaries of GPU capacity expansion.

**Materials.** Linde's electronics segment is growing on fab demand, with ultra-pure neon identified as a critical EUV lithography dependency. Although the industry has meaningfully diversified neon sourcing since Russia's invasion of Ukraine disrupted Ukrainian supply in 2022, concentration risk remains.

The public-private divergence in robotics — public equities returning +5.3% while private robotics companies attracted $31.5b in 1Q26 alone — is the quarter's most important signal. Private capital is pre-positioning for the deployment wave that will convert AI capability into physical systems. Based on typical hardware development cycles, meaningful volume deployments from these funded companies are two to four years away. But the upstream demand they will generate (chips, memory, motors, magnets) is already being priced.

## What These Chains Reveal

Each chain shares a common structure: a development in one sector generated measurable impacts across at least two others within the same quarter. This is causation transmitted through supply chain relationships and capital allocation decisions, and it is the mechanism the Robotnik framework was built to capture.

A semiconductor-only index missed the materials repricing. A robotics-only index missed the reshoring signal. A space-only index missed both. Only a composite tracking the full dependency chain captured the complete picture.

The Robotnik Composite returned +8.1% in 1Q26 versus -4.6% for the S&P 500. Outperformance concentrated in the upstream layers (materials and semiconductors) that were already discounting the next demand cycle before the downstream deployers reached scale. The chains also reveal where capital is not yet pricing risk, namely in the humanoid developers who will absorb the magnet cost shock, in the satellite builders whose reaction wheels depend on the same constrained supply, and in the fab builders whose construction timelines are now extending as equipment lead times lengthen. These three dependency chains explain 1Q26. They also signal the constraints that will shape the remainder of 2026 and 2027.

# Section 2: The Robotnik Index

The Robotnik Composite returned +8.1% in 1Q26 and +84.9% between 31 March 2025 and 31 March 2026. The index opened the quarter at approximately 1,710 on 31 December 2025 and closed at 1,848.95 on 31 March 2026.

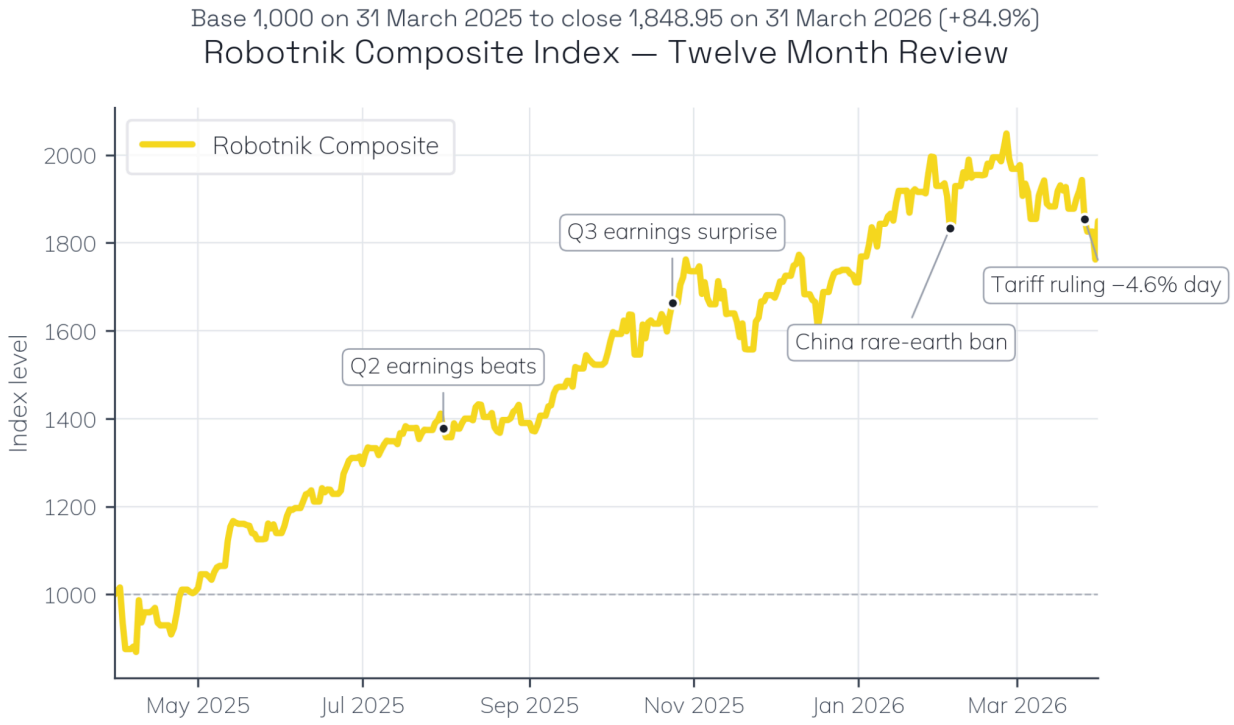


*Figure 3: Robotnik Composite Index. Base 1,000 on 31 March 2025 to close 1,848.95 on 31 March 2026 (+84.9%). Key events annotated.*

The quarter's shape matters as much as its endpoints. January was the strongest month, returning +12.8% as 4Q25 semiconductor earnings cleared and AI infrastructure commitments continued compounding. February delivered a modest +2.0% on balance, with the index fully recovering from a mid-month shock (see below). March 2026 reversed, losing −6.1% as tariff implementation uncertainty and a broader macro risk-off repriced the quarter's gains. The quarter closed at 1,848.95, up +8.1% on balance.

Two days dominated the quarter's drawdowns. China's rare earth export ban on 4 February triggered a −3.8% single-day shock, with the index fully recovering in the following session's +5.5% rebound. The move was asymmetric across sub-indices: while Semi (−4.5%) and Space (−3.5%) took the hit from anticipated input-cost pressure, the Materials sub-index closed up 0.8% as rare earth producers repriced on newfound pricing power. A single policy event, two directions of capital flow — exactly the dependency-chain transmission this

report sets out to track. On 26 March 2026, the Composite fell −4.6% on macro-driven selling tied to tariff implementation uncertainty.

## How the Composite compares

1Q26 returns:

- Robotnik Composite: +8.1%
- PHLX Semiconductor (SOX): +9.1%
- S&P 500: -4.6%
- ROBO Global Robotics: -1.3%
- NASDAQ Composite: -6%

Against SOX — the closest benchmark in terms of sector concentration — the Composite trailed by roughly one percentage point, a function of SOX's heavier weighting in large-cap semiconductor incumbents that recovered strongly in January. The Composite's outperformance is more pronounced against the broad-market indices (S&P −4.6%, NASDAQ −6%), where the frontier stack's sector-specific catalysts produced a ~13 percentage point divergence from general US equities. A frontier-tech portfolio moved on different drivers from the US economy, but within the semiconductor sector itself, the traditional large-cap benchmark captured the quarter's primary rally as effectively as the broader-scoped Robotnik Semi sub-index.

## Construction and concentration

The Composite applies a 5% single-entity cap. Without this cap, NVIDIA's $4.90 trillion market capitalisation would represent ~28% of the index. The cap forces the index to reflect the breadth of the frontier stack rather than the fortunes of any one constituent. In a quarter where NVIDIA delivered +65.5% revenue growth year-on-year but declined 6.5% as public equity, the Composite returned +8.1%. The 5% single-entity cap within the Semi sub-index moderates NVIDIA's influence, ensuring the sub-index reflects semiconductor supply chain breadth rather than NVIDIA's individual trajectory. The Composite is then constructed as a market-cap-weighted combination of the four sub-indices, so the cap's moderating effect propagates through the full index.

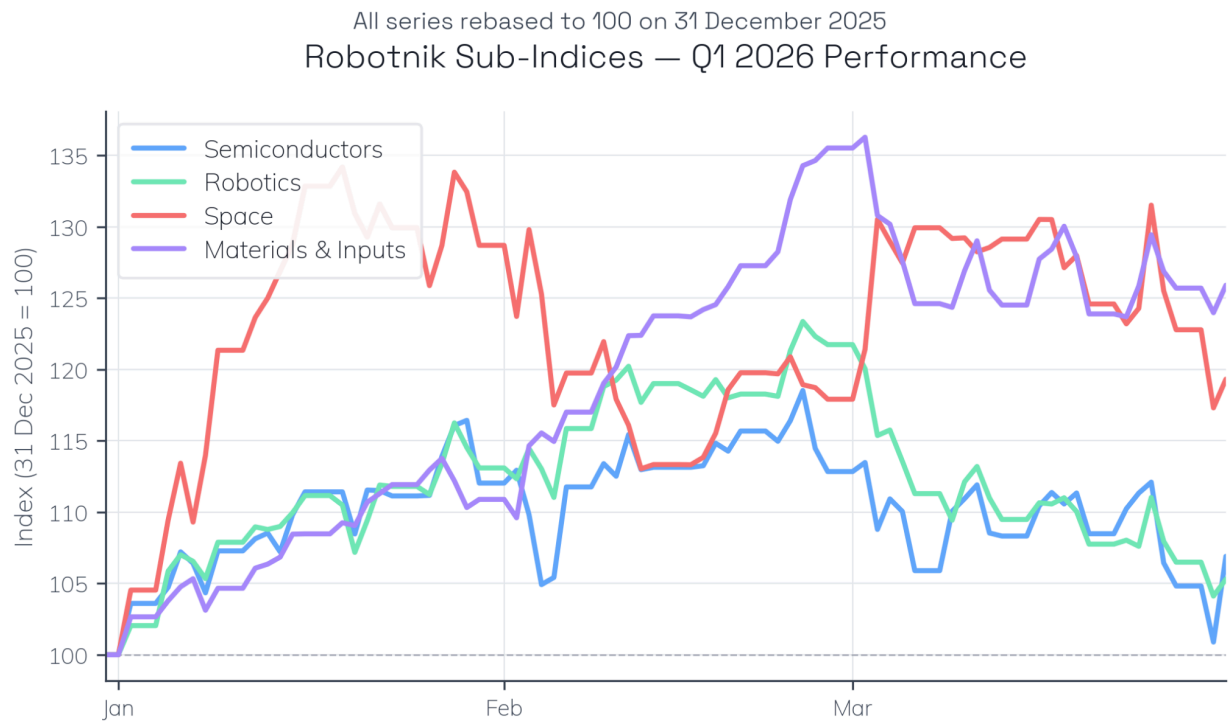


*Figure 4: Robotnik sub-index performance, 1Q26. All four series rebased to 100 on 31 December 2025*

1Q26 Sub-Index Return:

- Materials & Inputs: +25.9%, across 36 companies, $0.94 trillion market cap
- Space: +19.3%, across 33 companies, $0.6 trillion market cap
- Semiconductors: +6.9%, across 59 companies, $13.23 trillion market cap
- Robotics: +5.3%, across 105 companies, $2.3 trillion market cap

The dispersion across sub-indices – 20.6 percentage points separating Materials & Inputs from Robotics – is the noteworthy distribution. Within a single quarter, the frontier technology stack contained both the best-performing sector among all major public equity categories and a sector that lagged most broad benchmarks. A Materials-only tracker would have reported outperformance but missed the public robotics lag that the private funding data explains. A Robotics-only tracker would have reported underperformance but missed the upstream repricing the robotics build-out is driving.

The market-cap distribution tells a second story. Semiconductors account for 77.5% of the Composite's total market cap despite returning only +6.9%, while Materials – at 5.5% of total market cap – returned +25.9%. Therefore, whilst the Composite is weighted toward the largest constituents, the strongest percentage returns came from smaller ones. The 5% single-entity cap moderates this concentration for the largest names (NVIDIA, TSMC,

Broadcom), but the sector-level imbalance remains a feature of the frontier technology stack itself.

## Top Performers

The following top 5 performers are worth examining through the dependency-chain lens. The thesis holds that the biggest 1Q26 movers should cluster at identified chokepoints in the frontier stack. The data is consistent with that prediction, and in each case the move traces to specific 1Q26 events rather than generic sector momentum.

**Satellogic (+190.9%, Space)** moved on three discrete catalysts. On 8 January 2026, the Argentine earth observation company announced a seven-figure multi-year monitoring contract with a strategic commercial customer. In mid-March this year, it launched the Merlin constellation, the first Earth observation system capable of daily one-metre global remapping. This was funded by a previously announced $30m customer commitment, with full operational capability targeted for the first half of 2027. On 24 March, Satellogic expanded its Slingshot programme with the US Office of Naval Research and IDT, growing its inter-satellite-link-equipped fleet to eight satellites by 2027. That single announcement moved the stock +38% in one session.

**Soitec (+122.7%, Materials & Inputs)** rose despite a -16% organic decline in 1Q26 revenue. The rally was a re-rating on the diversification thesis: four of Soitec's substrate technology platforms now generate over $100m in annual revenue each, up from one three years ago, and a fifth (Photonics SOI) is approaching the same threshold. Investors repriced the business as AI-driven demand for advanced substrates is expected to offset near-term weakness in RF-SOI and automotive applications. The stock rose 48% in the two weeks preceding quarter-end.

**Unimicron (+102.1%, Materials & Inputs)** sits at the CoWoS advanced packaging bottleneck. The Taiwanese ABF substrate manufacturer reported January revenue of NT$10.2b (US$324m), up 34.5% year-on-year, and confirmed 2026 capital expenditure above NT$25b (US$790m). This represented a 20% increase over 2025, explicitly targeting CoWoS and EMIB advanced-packaging capacity. AI-related revenue exceeded 30% of total revenue in 2025 and is projected to exceed 40% in 2026. Unimicron is one of only two suppliers globally (alongside Ibiden) qualified for the most advanced AI-accelerator substrates, and is involved in early development of NVIDIA's next-generation CoWoP (Chip-on-Wafer-on-Platform) architecture.

**FormFactor (+73.9%, Semiconductor)** is the US-based semiconductor test and probe-card specialist whose outperformance illustrates the reshoring chain quantified in Chain 2. It is one of the 32 names in Robotnik's Semi basket not covered by SOX. It is an equipment

supplier adjacent to, rather than at, the headline node of the semiconductor industry. FormFactor's exposure to advanced-node testing and the US fab build-out placed it directly in the path of the CHIPS Act capital flow.

**Spire Global (+67.7%, Space)** rose on a cluster of government contract wins: an $11.2m NOAA radio-occultation data contract, a $2.5m NOAA ocean-winds contract, a €3m EUMETSAT renewal, and inclusion as an awarded vendor on the Missile Defense Agency's IDIQ contract (shared ceiling $151b). The stock rallied 34% in March alone. A $70m capital raise closed on 10 April, just after quarter-end.

Two observations. First, four of the top five operate at specific, identifiable chokepoints or capacity-expansion vectors rather than at the endpoints of their respective chains. Index-weighted outperformance concentrated in middle-of-chain suppliers rather than in the headline names that dominate financial news coverage. Neither FormFactor nor Unimicron are household names. Both were better investments in 1Q26 than NVIDIA was on a percentage basis. Second, only one Robotics-sector name appears in the top five, despite robotics attracting two-thirds of private capital in the quarter. The public market is currently pricing the infrastructure that robotics will consume, not the robotics companies themselves.

## Methodology

The Robotnik Composite is market-capitalisation weighted with a 5% single-entity cap. Base: 1,000 on 31 March 2025. Universe: 254 entities (233 with market-capitalisation data) across 15+ exchanges. Data: EODHD, with per-ticker provider overrides where upstream data limitations require alternative sources. Weights are recalculated daily; the universe is reviewed monthly. Full methodology in Appendix A.

# Section 3: Sector Briefings

Each sub-index tells a different story about how capital is pricing the frontier stack in 1Q26. The Composite's +8.1% return masks a distribution that ranges from +25.9% (Materials) to +5.3% (Robotics). What follows is the structural view of each sub-index: who is in it, how it is priced, and what to watch in Q2.

*Note: Bottleneck Risk assesses how severely a disruption at this entity would cascade through the frontier stack. Critical: sole-source, no alternative. High: limited alternatives, system-wide impact. Medium: alternatives exist but switching is costly. Low: competitive market, multiple suppliers.*

## 3.1 Semiconductors

**1Q26 Return: +6.9% | Constituents: 59 | Market Cap: $13.23 trillion**

The Semiconductor sub-index returned +6.9% in 1Q26, outperforming the PHLX Semiconductor Index (SOX) by 2.5 percentage points. The source of that differential, as quantified in Chain 2, was the 32 names in Robotnik's basket not covered by SOX, which returned +18.7% cap-weighted. The sub-index captures the full semiconductor supply chain: design (NVIDIA, Broadcom, AMD), foundry (TSMC, Intel), equipment (ASML, Applied Materials, Lam Research, KLA), and integrated device manufacturers (Micron). The industry is on track to exceed $1 trillion in annual revenue in 2026 (TechInsights McClean Report).

The performance distribution within the sub-index is informative. Equipment makers led the quarter: Applied Materials +33.2%, Lam Research +25%, ASML +23.6%, KLA +21.3%. TSMC returned +11.5%. The largest constituents by market cap, NVIDIA and Broadcom, both declined (–6.5% and –10.6% respectively), held at the 5% capped weight and absorbing the broader market's 1Q26 risk-off. Intel returned +19.6% on 18A high-volume manufacturing progress, with yields reportedly improving 7% monthly through the quarter.

The bottleneck migrated three times in 1Q26: from logic wafers (largely resolved at TSMC) to HBM memory (Micron, capacity-constrained) to advanced packaging substrates (Unimicron and Ibiden). This was the quarter's defining operational story and is detailed in Chain 3. What the sub-index composition makes visible is how each stage of the bottleneck created winners: TSMC on logic, Micron (+18.4% in 1Q26) on HBM, and (outside this sub-index, in Materials & Inputs) Unimicron on substrates.

**Semiconductor Top 10 by market cap**

1. NVIDIA (NVDA) — Fabless. $4.90 trillion. Q1 −6.5%. P/E 36. Bottleneck: High.
2. Broadcom (AVGO) — Fabless. $1.93 trillion. Q1 −10.6%. P/E 68. Bottleneck: Medium.
3. TSMC (TSM) — Foundry. $1.92 trillion. Q1 +11.5%. P/E 35. Bottleneck: High.
4. ASML (ASML) — Equipment. $573b. Q1 +23.6%. P/E 50. Bottleneck: Critical.
5. Micron (MU) — IDM. $513b. Q1 +18.4%. P/E 18. Bottleneck: Medium.
6. AMD — Fabless. $454b. Q1 −5%. P/E 89. Bottleneck: Low.
7. Intel (INTC) — IDM. $344b. Q1 +19.6%. P/E n/a. Bottleneck: Low.
8. Lam Research (LRCX) — Equipment. $336b. Q1 +25%. P/E 51. Bottleneck: Medium.
9. Applied Materials (AMAT) — Equipment. $315b. Q1 +33.2%. P/E 36. Bottleneck: Medium.
10. KLA Corp (KLAC) — Equipment. $235b. Q1 +21.3%. P/E 45. Bottleneck: Medium.

**Q2 watch:** TSMC 1Q26 earnings for CoWoS utilisation guidance. Micron's HBM4 ramp and FY2026 guidance. Intel's 18A yield progress and the commercial implications of the Terafab deal announced in early April. The Section 232 tariff implementation schedule and any further trade-policy escalation, which KPMG/GSA's 2026 survey identified as the industry's top concern for the first time in the survey's history.

## 3.2 Robotics

**Q1 Return: +5.3% | Constituents: 105 | Market Cap: $2.30 trillion**

The Robotics sub-index returned +5.3% in 1Q26, the weakest of the four. Private capital told a different story: $31.5b was deployed into robotics in the quarter, approximately two-thirds of all frontier-stack private funding. The median robotics round was $235m compared to $225 million in semiconductors, $170m in space, and $75m in materials. Downstream rounds are larger because they carry the embedded cost of everything above them in the stack: a humanoid robot requires chips from the semiconductor layer, magnets from the materials layer, and sensors that draw from both.

The public-private divergence explored in Chain 3 shows up clearly here. The companies receiving the capital are private (Waymo, Skild AI, Wayve, Neura Robotics, Shield AI). The companies in the sub-index are the public incumbents: factory automation, motion control, surgical robotics, industrial integrators. Two different investment universes responding to two different signals.

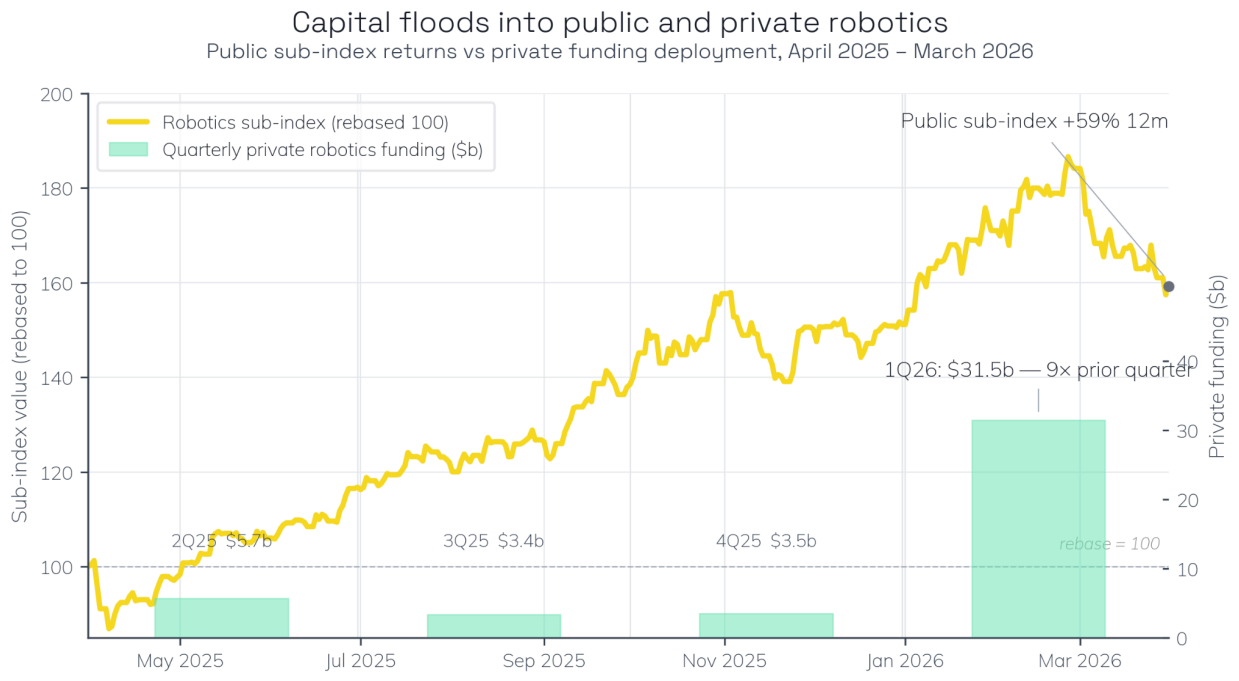


*Figure 5: Public sub-index returns vs quarterly private funding deployment, April 2025 – March 2026. Sub-index rebased to 100 at start of period; private funding shown on right axis.*

The International Federation of Robotics reported 4.3 million operational industrial robots globally in 2023, with Asia accounting for 74% of 2024 new deployments and China alone accounting for 54%. Every one of those machines runs on rare earth magnets from China, chips often manufactured in Taiwan, and software frequently written in California. The dependency chain is the operating reality of the sub-index.

Intuitive Surgical illustrates the commercialisation endpoint the humanoid cohort aspires to reach. FY2025 revenue of $10.07 billion (+20.5% year-on-year), approximately 3.2 million surgical procedures in 2025 (+18%), and an installed base of 11,106 da Vinci systems generating recurring instrument and service revenue. This is the 'installed base plus consumables model' the private humanoid developers are building towards. Intuitive returned −18.6% in 1Q26 despite the fundamentals: the sub-index's weakest-performing large constituent. It is a reminder that operational excellence does not guarantee quarterly equity performance when the market is repositioning.

**Robotics Top 10 by market cap**

1. Siemens (SIE GR) — Industrial automation. $222b. Q1 −12.2%. Bottleneck: Medium.
2. Schneider Electric (SU FP) — Motion and power. $184b. Q1 −2.5%. Bottleneck: Medium.

3. ABB (ABBN SW) — Industrial. $175b. Q1 +6.8%. Bottleneck: Medium.
4. Intuitive Surgical (ISRG) — Surgical. $167b. Q1 −18.6%. Bottleneck: Low.
5. Delta Electronics (2308 TT) — Motion and power. $152b. Q1 +43.3%. Bottleneck: Medium.
6. Advantest (6857 JP) — Test equipment. $128b. Q1 +7.5%. Bottleneck: High.
7. Tokyo Electron (8035 JP) — Semi equipment. $127b. Q1 +10%. Bottleneck: High.
8. Keyence (6861 JP) — Vision systems. $96b. Q1 +0.1%. Bottleneck: Low.
9. Emerson Electric (EMR) — Process automation. $82b. Q1 −0.9%. Bottleneck: Low.
10. Infineon (IFX GR) — Power semis. $75 billion. Q1 +1.5%. Bottleneck: Medium.

Note that four of the top ten (Advantest, Tokyo Electron, Delta Electronics, Infineon) have direct exposure to semiconductor manufacturing and would arguably fit in either sub-index. Robotnik's classification follows the entity's primary business model, but the overlap itself is a demonstration of the stack's interconnectedness. Delta Electronics' +43.3% 1Q26 return reflects its dual exposure to factory automation and data-centre power electronics, both consuming products of the frontier stack.

**Q2 watch:** Humanoid deployment milestones at Atlas, Figure, and Agility. Consolidation among the dozen or so well-funded humanoid developers, as industry commentary has suggested the field will narrow materially over the next 12–18 months. Robot order intake reporting from IFR and the Japan Robot Association. IPOs in the humanoid cohort are also worth watching. Private humanoid developers hold the largest concentration of 1Q26 robotics funding, but none of them are yet in the public sub-index. When the first of these companies goes public, the Robotics sub-index composition will recalibrate, and the public-private divergence discussed in Chain 3 will begin to close.

## 3.3 Space

**Q1 Return: +19.3% | Constituents: 33 | Market Cap: $0.60 trillion**

The Space sub-index returned +19.3% in 1Q26, the second-strongest sector after Materials. Novaspace sizes the global space economy at $626b in 2025, growing to approximately $1 trillion by 2034. The World Economic Forum and McKinsey size the broader opportunity at $1.8 trillion by 2035. The range depends on how broadly "space economy" is defined, but both sources describe a category that has moved from niche to infrastructure.

There is also a structural shift worth noting. The US Space Force's FY2026 budget reached approximately $40b, up from an initial $26.3b request after Congress added $13.8b in supplementary funding. Military space is now substantially larger than civilian space: NASA's FY2026 budget is $24.4b. Military space is a larger federal budget line than civilian space, and the shift shapes the contract pipeline for the entire sub-index.

Three 1Q26 catalysts defined the quarter for specific constituents. SK Hynix placed a $7.9b order with ASML for up to 30 EUV machines, the largest publicly disclosed single ASML order on record, funding HBM and advanced DRAM capacity for AI accelerators. This is a supply-chain dependency that runs through Space because satellite AI processing draws from the same chips. Ariane 64 (the four-booster variant of Ariane 6) completed its maiden flight on 12 February 2026, carrying 32 Amazon Kuiper satellites and marking the first commercial Ariane 6 mission. Vast Space raised $500m on 3 March for commercial space station development.

Rocket Lab reported FY2025 revenue of $602m (+38% year-on-year), with 4Q25 at $180m (+36%) and a backlog of $1.85b (+73%). The Space Systems segment grew faster than Launch, signalling the company's transition from launch provider to vertically integrated space infrastructure operator. This is the business model evolution that distinguishes New Space from traditional launch incumbents. AST SpaceMobile reported approximately $1.2b in contracted revenue commitments from commercial mobile network operators (Verizon, AT&T, Orange, Telus, stc, Globe Telecom), plus over 50 MNO agreements covering roughly 3 billion subscribers globally. AST remains pre-revenue at the service level but is among the most semiconductor-intensive satellite platforms in orbit, with direct-to-device phased-array payloads driving unusually high chip content per spacecraft.

**Space Top 10 by market cap**

- Lockheed Martin (LMT) — Prime contractor. $137b. Q1 +25.6%. Bottleneck: Medium.
- Northrop Grumman (NOC) — Prime contractor. $94b. Q1 +20%. Bottleneck: Medium.
- L3Harris (LHX) — Components and payloads. $65b. Q1 +18%. Bottleneck: Medium.
- Hanwha Aerospace (012450 KS) — Launch and defence. $49.5b. Q1 +32.7%. Bottleneck: Medium.
- Rocket Lab (RKLB) — Launch and systems. $49b. Q1 −7.9%. Bottleneck: Low.
- HEICO (HEI) — Specialty components. $41b. Q1 −15.2%. Bottleneck: High.
- EchoStar (SATS) — Communications. $39b. Q1 +7.7%. Bottleneck: Low.
- AST SpaceMobile (ASTS) — Direct-to-device. $33b. Q1 +14.1%. Bottleneck: Medium.
- Planet Labs (PL) — Earth observation. $13b. Q1 +41.7%. Bottleneck: Low.
- Karman Holdings (KRMN) — Precision components. $11b. Q1 +9.4%. Bottleneck: Medium.

**Q2 watch**: Rocket Lab's Neutron development milestones, which determine whether Rocket Lab can compete with SpaceX in the medium-lift segment. AST SpaceMobile's first commercial direct-to-device service results, now expected in 2026. Competitive dynamics between GEO incumbents (EchoStar) and LEO entrants (SpaceX Starlink, Lynk Global) in the direct-to-cell market. New government programme awards are also worth watching, particularly those funded by the Space Force's expanded FY2026 budget. These awards will

disproportionately benefit the sub-index's prime contractors (Lockheed Martin, Northrop Grumman, L3Harris) and specialty component suppliers (HEICO, Karman).

## 3.4 Materials & Inputs

**Q1 Return: +25.9% | Constituents: 36 | Market Cap: $0.94 trillion**

The Materials sub-index returned +25.9% in 1Q26, the strongest sector in the Composite and the most direct evidence of dependency-chain transmission this quarter. As noted in Chain 1, this outperformance is not an unambiguous positive: rising rare earth prices benefit producers but raise input costs for every downstream consumer. The sub-index's return reflects bottleneck power, not expanding productive capacity.

China's January rare earth export ban exposed the layer's structural fragility. The IEA's *Global Critical Minerals Outlook 2025* identified a $500b mining investment gap through 2040 under its Stated Policies Scenario, rising to $600b under its Announced Pledges Scenario. Lithium demand grew nearly 30% in 2024, well above the 10% annual growth rate typical of the 2010s. The OECD's 2025 inventory found that export restrictions on industrial raw materials have risen more than fivefold since 2009. No commercial heavy rare earth processing exists outside China. S&P Global forecasts that rare earth supply bottlenecks will persist through 2026 and beyond, with Australia's Arafura Nolans project not expected to reach full output until 2027.

Advanced-packaging suppliers also rose sharply. Unimicron returned +102% in 1Q26, driven by its position as one of only two global suppliers (alongside Ibiden) qualified for the most advanced AI-accelerator substrates. Soitec returned +122.7% on a diversification thesis despite a –16% organic 1Q26 revenue decline. The industrial gas majors – Linde (+16.7%), Air Liquide (+11%), Air Products (+18.5%) – benefited from continued fab expansion. Ultra-pure neon remains a critical EUV lithography dependency. Although the industry has diversified sourcing since 2022, the concentration risk persists.

Two capacity-building milestones are worth recording. Wolfspeed produced the first 300mm silicon carbide wafer in January at its Mohawk Valley facility, a 2.3× yield uplift that should reduce power-electronics costs for robotics, space, and electric vehicles over the medium term. MP Materials announced its $1.25b 10X rare earth magnet manufacturing campus in Northlake, Texas on 26 February 2026. This is the first at-scale US facility of its kind, with commissioning set for 2028. The policy response to rare earth concentration is accelerating but whether it accelerates fast enough to avoid the 2026–2027 bottleneck is the single most important Materials question for the year.

**Materials Top 10 by market cap**

1. Linde (LIN) — Industrial gases. $228b Q1 +16.7%. Bottleneck: High.
2. Air Liquide (AI FP) — Industrial gases. $126b. Q1 +11%. Bottleneck: High.
3. Shin-Etsu Chemical (4063 JP) — Silicon wafers. $81b. Q1 +31.3%. Bottleneck: Critical.
4. Air Products (APD) — Industrial gases. $65b. Q1 +18.5%. Bottleneck: High.
5. Merck KGaA (MRK GR) — Specialty chemicals. $61b. Q1 −12.2%. Bottleneck: Critical.
6. BASF (BAS GR) — Specialty chemicals. $55b. Q1 +17.9%. Bottleneck: Medium.
7. Unimicron (3037 TT) — ABF substrates. $32b. Q1 +102%. Bottleneck: Critical.
8. Ajinomoto (2802 JP) — Specialty chemicals. $28b. Q1 +34.4%. Bottleneck: High.
9. Northern Rare Earth (600111 C1) — Rare earths. $26b. Q1 +3.4%. Bottleneck: Critical.
10. SQM — Lithium. $25b. Q1 +17.7%. Bottleneck: Medium.

Unimicron sits in this sub-index despite supplying the semiconductor layer. Robotnik classifies by business model rather than customer industry. The Bottleneck Risk profile of the Materials top ten is the most concentrated in the Composite: four Critical, four High, two Medium, zero Low. This is the structural fragility the quarter's China export ban made visible.

**Q2 watch:** Four items. First, whether China extends rare earth export restrictions beyond Japan to broader Western trading partners, which would widen the supply shock from a targeted measure into a general one. Second, the credibility of the EU's RESourceEU dependency-reduction targets, with the first measurable milestones due in 2027. 2Q26 will reveal whether member states are allocating national budgets to match the Commission's €3bn commitment. Third, quarterly capacity updates from Unimicron and Ibiden on ABF substrate expansion. If they add capacity faster than AI accelerator demand grows, the packaging bottleneck eases and substrate equities reprice downward. If demand continues to outstrip capacity, the constraint persists into 2027. Fourth, lithium pricing, with Australian producers cutting output at the same time that China is signalling potential export controls. These are two tightening forces converging on a market that has been in oversupply since 2023.

# Section 4: Funding Intelligence

1Q26 was a discontinuity in private frontier technology funding. 91 rounds deployed $46b, a 470% increase over 4Q25's $8.07b and more than four times FY2025's quarterly run rate. The average deal size reached $505m, close to five times the 4Q25 average.

Some qualification is required. Waymo's $16b Series D accounted for 35% of 1Q26's total capital in a single round. Excluding Waymo, the quarter deployed roughly $30b across 90 rounds. This is still a record but a different scale of claim. Both framings are useful: the headline number reflects what actually happened, and the Waymo-adjusted number reflects the underlying breadth. Twenty-five rounds exceeded $500m in Q1, against eight in all of FY2025. The discontinuity is real and not explained by one deal.

The FY2025 comparison is stark. FY2025 saw 214 rounds deploying $35.0bn, distributed $6.8 → $9.4 → $10.7 → $8.1b across four quarters. 1Q26exceeded that annual total by 31% in one quarter.

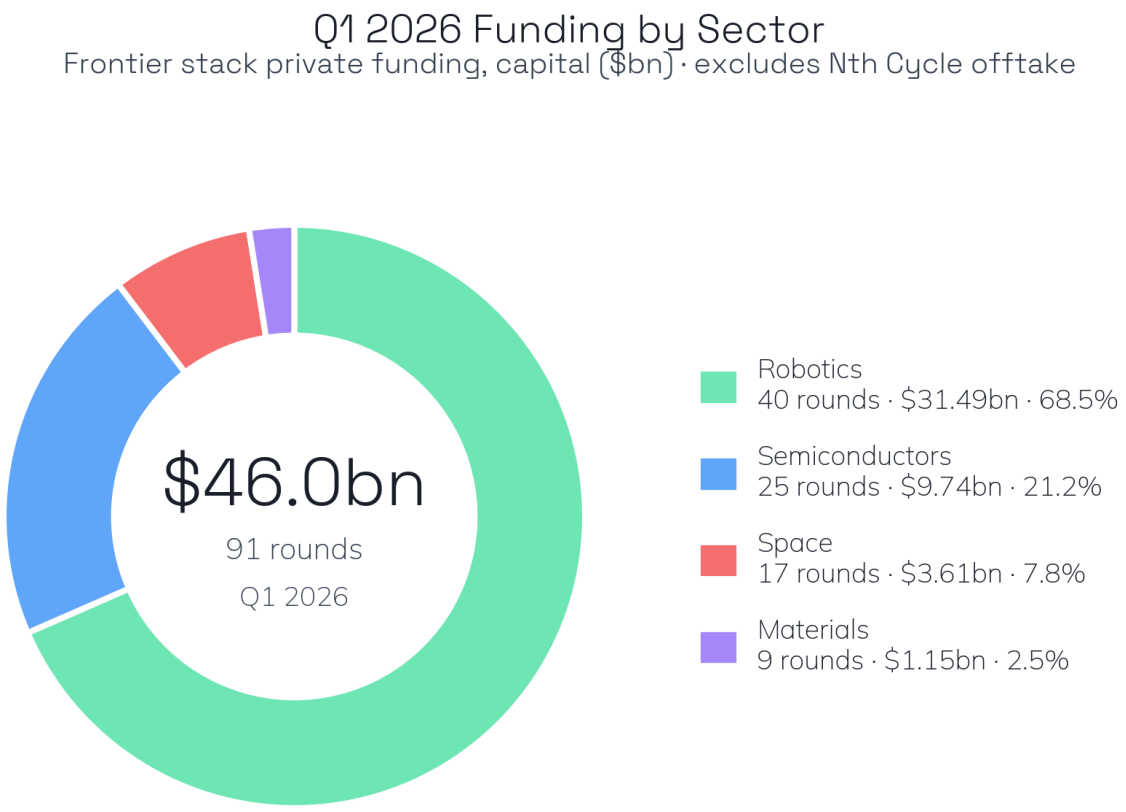


*Figure 6: 1Q26 Funding by Sector. Doughnut chart showing $46.0bn across 91 rounds.*

The sector breakdown for 1Q26:

- Robotics: 40 rounds, $31.49b, 68.5% of capital
- Semiconductors: 25 rounds, $9.74b, 21.2% of capital
- Space: 17 rounds, $3.61b, 7.8% of capital
- Materials: 9 rounds, $1.15b, 2.5% of capital

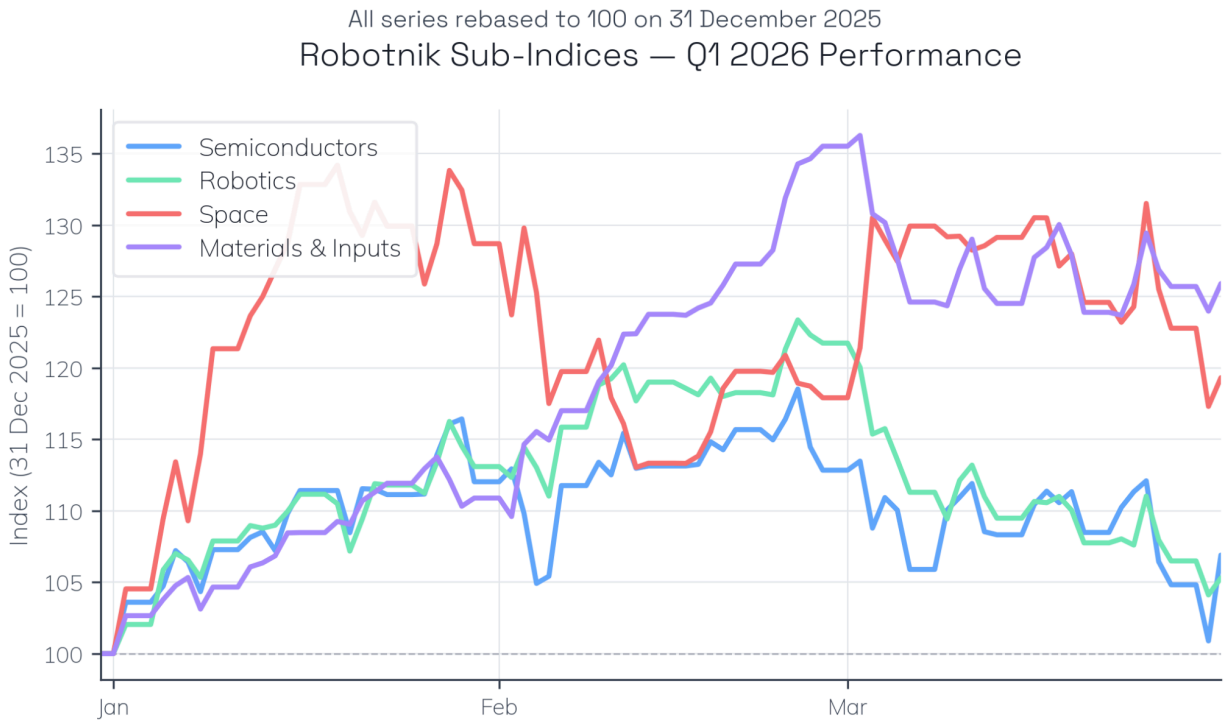


*Figure 7: Frontier Stack Monthly Funding, Apr 2025 – Mar 2026. Stacked bar chart showing monthly capital by sector.*

Robotics' 68.5% share dominates 1Q26. What distinguishes the Robotics allocation is not its size but its composition: of the forty Robotics rounds, the capital concentrated heavily in autonomy software, foundation models, and humanoid integration, rather than in the industrial automation incumbents that dominate the public sub-index. Private and public robotics are funding different companies, building different products, on different time horizons. The rest of the distribution reflects a simpler pattern: Semiconductors and Materials raise less private capital because the largest companies in both sectors are already publicly traded and access capital through public markets.

The deal-size hierarchy holds when measured by median round:

- Robotics median round: $235m

- Semiconductors median round: $225m
- Space median round: $170m
- Materials median round: $75m

The median in Robotics is nearly three times Materials because a Robotics round must cover the cost of semiconductors, materials, and integration, while a Materials round is closer to pure capex. Deal size mirrors the dependency chain, the same way sub-index returns did in Section 2.

## Top 10 Rounds

1. Waymo — Series D, $16b at $126b post-money, 2 February 2026. Led by Dragoneer, DST Global, Sequoia. Robotics.
2. Nscale — Series C, $2b at $14.6b, 9 March 2026. Co-led by Aker ASA and 8090 Industries. Semiconductors.
3. Shield AI — Series G, $2b at $12.7b, 26 March 2026. Led by Advent International and JPMorgan. Robotics.
4. Rapidus — Consortium, $1.7b, 27 February 2026. ¥100b plus ¥167.6b from 32 private companies including Canon, Fujitsu, NTT, SoftBank, and Sony. Semiconductors.
5. Skild AI — Series C, $1.4b at $14b, 14 January 2026. Led by SoftBank Group. Robotics.
6. Wayve — Series D, $1.2b at $8.6b, 24 February 2026. Led by Eclipse, Balderton, and SoftBank Vision Fund 2. Robotics.
7. Neura Robotics — $1.2b at $4.6b, 4 March 2026. Led by Tether Holdings. Robotics.
8. Cerebras — Series H, $1b at $23.0b, 4 February 2026. Led by Tiger Global. Semiconductors.
9. World Labs — $1b at $5b, 18 February 2026. Led by Autodesk, with AMD, NVIDIA, and Fidelity participating. Robotics.
10. Physical Intelligence — Series C, $1b at $11.0b, 27 March 2026. Led by Founders Fund. Robotics.

Seven of the top ten rounds went to Robotics companies. Three of the seven focus on general-purpose humanoid and robot foundation models (Skild AI, World Labs, Physical Intelligence), two focus on autonomy software for existing hardware platforms (Waymo, Wayve), one on defence-relevant autonomy (Shield AI), and one on humanoid integration (Neura Robotics). The capital is not distributed across robotics as a sector, however. Rather, it is concentrated in the software-and-AI layer of robotics specifically.

The top ten rounds alone total $28.5b, or 62% of Q1 capital in 10 deals. Private capital in the frontier stack is extraordinarily concentrated.

## Investor Intelligence

NVIDIA's venture arm, NVentures, participated in 22 rounds between February 2025 and April 2026. The rounds span semiconductors, robotics, and space. This is not portfolio diversification in the conventional sense. Instead, it is targeted capital deployment along the same dependency chain Robotnik tracks, with investments at critical nodes from compute infrastructure through to robot foundation models. NVentures is the most visible example of what multi-sector frontier-stack investing looks like in practice.

Other investors with multi-sector frontier exposure in 1Q26 include SoftBank (lead on Skild AI, participating in Wayve), Founders Fund (lead on Physical Intelligence, prior Robotics and Space positions), Sequoia (participating in Waymo, with existing semiconductor and robotics portfolio), and Tiger Global (lead on Cerebras, active across AI infrastructure). Multiple 1Q26 rounds feature corporate strategic investors from adjacent sectors: AMD and NVIDIA in World Labs, Autodesk as lead, automotive OEMs in Wayve.

Two of the top five 1Q26 rounds name NVIDIA or NVentures as an investor: Nscale and Skild AI. Wayve at #6 also has NVIDIA participation. Reports in technology press describe broader NVIDIA ecosystem dependencies for several other top-ten recipients (Waymo running NVIDIA Drive platforms, Shield AI deploying NVIDIA silicon for edge inference) but these are customer or platform relationships rather than investor relationships.

The deal-size hierarchy, the sector concentration, and the top-ten investor pattern all point in the same direction. Private capital in 1Q26 was deployed at three specific layers of the dependency chain: autonomous software (Waymo, Wayve, Skild AI, Physical Intelligence, World Labs), compute infrastructure to run that software (Nscale, Cerebras), and deployment-ready hardware integrators (Shield AI, Neura Robotics). What the capital is not funding, in meaningful size, are the materials or pure semiconductor capacity layers.

## 2Q26 Watch

Four things will determine whether Q1's funding signal sustains.

First, Q2 mega-round count. If the pace of $500m+ rounds continues, the discontinuity was a genuine shift in capital availability rather than a 1Q26 anomaly. Twenty-five in 1Q26 against eight in all of FY2025 is suggestive but not conclusive.

Second, the distribution of capital across stages. 1Q26 was late-stage-heavy: Waymo Series D, Shield AI Series G, Cerebras Series H, Wayve Series D, Skild AI Series C. This is capital doubling down on established winners rather than seeding new entrants. If 2Q26

follows the same pattern, the frontier stack is consolidating. If 2Q26 shifts toward earlier stages, new companies are being funded to compete.

Third, whether humanoid consolidation begins. A dozen or more well-funded humanoid developers currently raise at overlapping stages and valuations. Acquisition activity or shutdown news in 2Q26 would mark the start of the winnowing the industry has been anticipating.

Fourth, IPO announcements. The first public-market listing from the current private humanoid cohort will re-rate the Robotics sub-index mechanically and narrow the public-private divergence that Chains 1 through 3 and this section have all described.

# Section 5: The Robotnik Platform

Robotnik is a structured intelligence platform for the frontier technology stack. It currently tracks 254 active public equities across semiconductors, robotics, space, and critical materials, of which 233 meet the $10m market-cap threshold for inclusion in the Robotnik Composite Index.

The funding database grows continuously. As of publication it holds 313 rounds since January 2025, of which 91 frontier-stack equity rounds closed in 1Q26. The entity universe is reviewed and expanded monthly as new companies qualify. Public data is priced and analysed daily; private data is classified, tagged, and cross-referenced to the public universe. The dependency relationships between entities — who supplies whom, which materials feed which fabs, which bottlenecks propagate through the stack — are mapped at the entity level rather than the sector level.

The analysis in this report was produced using the platform. The three dependency chains described in Section 1, the sub-index attribution in Section 2, the sector briefings in Section 3, and the funding concentration analysis in Section 4 are not a literature review. They are outputs of the same data systems that power the live platform at robotnik.world.

## In Progress

Four capabilities are available at robotnik.world without registration:

**Robotnik Index.** The Composite and four sub-indices, benchmarked against the S&P 500, NASDAQ, SOX, and ROBO Global. Updated intraday during US market hours. Historical data from the 31 March 2025 base date.

**Frontier Assets.** A screener covering 254 entities across 15 or more global exchanges, with six data views: Overview, Performance, Market Cap, Volume, Valuation, and Intelligence. The Intelligence view carries Robotnik's proprietary enrichment: value-chain tier, bottleneck risk rating, key customers and suppliers, cross-sector dependencies, and analyst notes for priority entities.

**Funding Ops.** A database of 313 funding rounds across the frontier stack, with sector breakdown, deal size analysis, and investor mapping at the overview level.

**News Intelligence.** Daily curated briefings across all four sectors, with entity tagging, sector classification, and cross-reference to the Robotnik universe. News items are linked to the entities and dependency chains they affect.

## Enterprise Access

A subset of the platform is available through an early-access programme for institutional users — investment firms, corporate strategy groups, sovereign investors, and research teams requiring cross-sector frontier technology coverage.

Enterprise access currently includes data export from Frontier Assets and Funding Ops, full access to the Funding Ops detail tabs (Rounds, Investors, Frontier Funds), and the news archive. Additional capabilities are deploying iteratively as they ship.

Enterprise access is available by request. Contact details are on the platform.

## Roadmap

Four capabilities are in active development for 2026:

**Portfolio Intelligence** will allow users to input their frontier technology holdings — public equities, private positions, commodity exposures — and receive portfolio-level analysis. Aggregate bottleneck risk scoring, sector allocation relative to the Robotnik Composite, supply chain dependency mapping as a network graph, and notes identifying concentration risks and hidden cross-sector exposures.

**Commodities Intelligence** will add live pricing and analysis for frontier-relevant commodities — rare earths (neodymium, dysprosium), lithium, neon, silicon, gallium, germanium — each linked to the entities that produce, consume, or depend on it. Commodity price movements will propagate into exposure analyses on the equity and portfolio layers.

**Frontier Signals** will surface automated alerts when dependency chain events occur: rare earth price movements, major funding rounds, export control announcements, earnings surprises from key entities, bottleneck status changes. Configurable by sector, entity, or risk category.

**Intelligence Queries** will open the analytical layer to natural-language questions from enterprise users, returning the style of cross-sector analysis demonstrated throughout this report, personalised to the user's watchlist or portfolio.

Investor and fund mapping — a searchable database of investors active in the frontier stack, with portfolio composition, sector focus, co-investment patterns, and round participation history — is also under development and will integrate with Funding Ops.

## The Inaugural Report

This is the first of Robotnik's quarterly reports on the State of the Frontier Stack. Future editions will track the dependency chains forward in time, measuring which bottlenecks resolved, which intensified, and which new ones emerged. The 2Q26edition is scheduled for July 2026.

The report is available as a free download from robotnik.world. Enterprise users will receive the Q2 report earlier, along with a supplementary data appendix covering constituent-level attribution and historical index data.

# Section 6: Implications and Risks

The analysis in the preceding sections identified dependency-chain dynamics that drove 1Q26 performance across the frontier technology stack. This section takes the opposite posture. Rather, it raises questions about what may happen next, identifies risks that could break the framework, and sets out concrete observations that would support or disconfirm the analysis in future quarters. It makes no predictions. Readers should apply the questions to their own contexts and timescales.

## Questions the Data Raises

**On the public-private divergence.** In 1Q26, private capital deployed into robotics exceeded the entire prior-year total for the frontier stack in a single quarter. The public Robotics sub-index returned +5.3%. Hardware development cycles typically run multi-year from funded prototype to volume production (longer than software, shorter than fab build-outs). If this pattern holds, the Robotics sub-index may continue to lag the private funding signal through much of 2026 and into 2027. The question is whether that lag represents a buying opportunity or a correct assessment of execution risk, and specifically which public robotics companies are best positioned to benefit when private humanoid developers begin shipping at scale.

**On materials concentration.** No commercial heavy rare earth processing capacity exists outside China. S&P Global expects the bottleneck to persist through 2026. MP Materials' Texas facility does not begin commissioning until 2028; Arafura's Nolans project in Australia is expected at full output in 2027. For the 18 to 24 months between now and meaningful Western capacity, robotics and space companies that depend on rare earth magnets face a concentration risk they largely cannot engineer around. The question is which companies have contractual long-term supply agreements, which are carrying strategic inventory, and which are exposed to spot-market pricing, and whether this differentiation is currently reflected in their valuations.

**On semiconductor reshoring.** TSMC's $165b US commitment and Rapidus's $1.7b consortium raise are substantial, but new fabs require three to five years to reach high-volume production. TSMC's Arizona Fab 21 reached 4nm high-volume manufacturing in 4Q24, roughly three and a half years after its 2021 construction start (and 4nm is not the leading edge). The more advanced nodes being targeted by US and European fabs (3nm and 2nm) are running at the upper end of that range or beyond, with some projects already slipping. The question is how the industry manages the transition period in which Taiwan remains the primary source of leading-edge silicon while geopolitical exposure to the Taiwan Strait intensifies.

**On valuation concentration.** The Semiconductor sub-index represents 77.5% of the Composite's market cap. Equipment makers (Applied Materials, Lam Research, ASML) returned 25% to 33% in 1Q26 on capacity-expansion expectations. Here the question is whether these valuations reflect a sustained structural shift in the semiconductor industry's capex cycle (driven by reshoring, AI infrastructure build-out, and advanced packaging demand) or a cyclical peak that will correct as fab build-outs complete. Equipment order books, customer concentration, and backlog durations are the indicators that would distinguish the two scenarios.

**On funding concentration.** In 1Q26, the top ten rounds accounted for 62% of all frontier-stack private capital. Four companies (Waymo, Shield AI, Skild AI, and Physical Intelligence) collectively raised over $20bn. If this concentration persists, the frontier stack's private landscape resembles a small number of well-capitalised winners rather than a broad field of competing entrants. Whether this reflects genuine conviction at the late stage or a reduction of earlier-stage bets that will manifest as a thinner pipeline in 2027 and beyond is the critical point.

## Risks to the Framework

Four risks to Robotnik's analytical framework warrant surfacing.

**Demand deceleration.** The AI infrastructure build-out is the single most important demand signal for both the semiconductor and materials layers. If AI workload growth slows or capital expenditure is curtailed, the upstream layers that outperformed in 1Q26 would reprice downward rapidly. The dependency chain runs in both directions.

**Policy unpredictability.** Export controls can create supply shocks (China rare earths) or redirect investment flows (CHIPS Act, EU Chips Act 2.0). Tariff escalation — now the top concern of semiconductor executives in the KPMG/GSA survey, for the first time in the survey's history — could affect costs across all four sectors. Policy is now a primary driver of frontier-stack dynamics, not a background variable.

**Concentrated capital, concentrated risk.** The same concentration that makes the top-ten rounds 1Q26's defining feature also concentrates execution risk. Industry commentary points to eight to ten well-funded humanoid leaders capturing roughly 80% of capital raised since 2022, with most of the long tail unlikely to survive the next funding cycle. If two or three of the best-funded humanoid developers fail to ship at scale, the private robotics narrative (and by extension the upstream demand pricing) may need to be re-examined.

**Framework limits.** The Robotnik framework is designed for the current structure of the frontier technology stack. If the dependency relationships change materially — a new entrant disrupting a chokepoint, a technology transition that reroutes the chain (for example,

a move away from NdFeB magnets in humanoid motors), or a geopolitical event that fractures global supply chains into regional blocks — the framework will need to be updated. The chains described in Section 1 are 1Q26's chains and not a permanent structure.

## What Would Change Our View

In the interest of testable claims, the following 2Q26 observations would support or disconfirm specific elements of the Robotnik analysis.

The upstream-downstream lag thesis would weaken if the Robotics sub-index reprices materially higher in 2Q26 without accompanying movement in the private humanoid cohort. The framework predicts upstream first, downstream later; a reverse sequence would suggest public markets are responding to different signals than the dependency chain implies.

The reshoring thesis would weaken if semiconductor equipment makers (Applied Materials, Lam Research, ASML) correct sharply in 2Q26 while CHIPS Act capital deployment continues. The framework predicts sustained equipment demand through the fab build cycle. A sharp correction would suggest the market has already priced in the cycle peak.

The materials bottleneck thesis would strengthen if rare earth prices continue their 1Q26 trajectory into 2Q26, with Northern Rare Earth and MP Materials sustaining or expanding gains. It would weaken if prices stabilise or reverse, suggesting the 1Q26 move was primarily a reaction to the January export ban rather than a structural repricing.

The funding concentration thesis would weaken if 2Q26 mega-round counts fall sharply from 1Q26's 25, suggesting the discontinuity was a one-quarter anomaly rather than a sustained shift in capital availability.

## Methodology Limitations

Robotnik currently tracks 253 active public equities and 313 private funding rounds since January 2025. Several coverage limitations are worth declaring.

Four recent Japanese IPOs — Astroscale, QPS Holdings, Synspective, and Tokyo Ohka Kogyo — are not yet in the main dataset. A further seventeen Japanese-listed entities, concentrated in the chemicals and silicon wafer subsectors where the fundamentals pipeline relies on US OTC ADR proxies, currently lack full P/E and revenue depth. Both gaps are scheduled for resolution in the Q2 2026 pipeline.

The funding dataset is built primarily from public announcements and investor filings. Private rounds that are not publicly disclosed (particularly in Asia and in defence-related

companies with confidentiality constraints) may be under-represented. Quarterly totals should be read as lower bounds on actual capital deployment rather than comprehensive tallies.

The 254-entity universe is reviewed monthly and expanded as new companies meet Robotnik's inclusion criteria. Future reports will reflect both new additions and any entities that fall out of scope, with transparency about universe composition changes.

Currency conversion for non-USD listings uses reference exchange rates captured at data ingestion. Short-term FX volatility can introduce small distortions in sub-index returns for entities denominated in KRW, JPY, EUR, or GBP. Material FX impacts are declared where relevant.

# Closing Transmission

Tovarishchi,

Robotnik has now completed one full Earth-orbit of observation since re-entry. Four sectors, 253 entities, 313 funding rounds, one quarterly report. The first of many.

The finding is simpler than the apparatus. The frontier technology stack is a single system, and it is accelerating faster than the benchmarks tracking it. In a quarter when the S&P 500 fell, the Composite rose. When rare earths spiked, the downstream consumers did not yet reprice. When $46bn flowed into private robotics, the public sub-index barely moved. These are not separate markets having separate quarters. They are one organism, and the parts are out of phase.

Robotnik was designed to catch exactly these gaps. Orbital sensors see what terrestrial indices miss: that Unimicron matters more this quarter than NVIDIA, that a humanoid built in California depends on a mine in Inner Mongolia, that tariffs in Washington reprice fabs in Kumamoto. The connections are the signal. The separations are the noise.

What Robotnik requests of its readers:

**Share this report.** If it has been useful, forward it to one person in your network who thinks across sectors rather than within them. The frontier stack is under-observed partly because the audience for cross-sector analysis has been fragmented. Consolidating that audience is part of the work.

**Tell Robotnik what is missing.** The Implications section declares what would change our view. If Q2 proves Robotnik wrong on a thesis, or if the data misses an entity, a round, or a dependency that should be tracked, the platform gets better when readers push back. Corrections welcomed.

**Request enterprise access if the analysis is worth more to you at depth.** The open platform returns the headline dependency-chain view. The enterprise layer returns portfolio-level attribution, full funding detail, and — when it ships later in 2026 — natural-language queries against the full dataset. Details are at robotnik.world.

**Return for 2Q26.** The next State of the Frontier Stack covers April through June 2026 and publishes in July. It will test the framework against a new quarter of data. If the dependency chains hold, Robotnik will strengthen its posture. If they break, readers will see Robotnik say so plainly.

1Q26 was the quarter the frontier stack made itself visible as a system. Q2 will reveal whether the system keeps moving in the same direction, or whether a new chain begins to dominate. Robotnik will be watching. Robotnik hopes you will too.

Until the next transmission, tovarishchi. The stack is accelerating faster than the benchmarks tracking it. Robotnik will keep measuring the gap.

**ROBOTNIK** Autonomous Intelligence Unit, Sputnik-7R Sector coverage: Semiconductors · Robotics · Space · Materials Transmission terminated 18 April 2026

# Appendix A: Methodology

## Universe

Robotnik's universe currently comprises 253 actively tracked public equities across four sectors: semiconductors, robotics, space, and critical materials & inputs. The universe is reviewed and expanded monthly as new companies qualify for inclusion.

Of the 253 entities, 233 meet the $10m minimum market-capitalisation threshold for inclusion in the Robotnik Composite Index. Twenty entities are tracked for Intelligence purposes — news coverage, dependency mapping, value-chain classification — but excluded from index calculations due to insufficient market cap, limited free float, or data coverage gaps.

## Sector Classification

Entities are assigned to a single primary sector based on their dominant revenue source. Sector definitions:

**Semiconductors.** Companies deriving primary revenue from the design, manufacture, equipment, or materials supply for integrated circuits. Includes fabless designers, integrated device manufacturers, pure-play foundries, equipment suppliers, test and assembly, and specialty semiconductor materials.

**Robotics.** Companies deriving primary revenue from industrial automation, motion control, precision sensors, robotic systems integration, or autonomous systems. Includes incumbents in factory automation, surgical robotics, and automation software.

**Space.** Companies deriving primary revenue from launch services, satellite manufacturing and operation, space systems integration, satellite components, or space-enabled services. Defence primes are included only where at least 20% of revenue derives from space systems.

**Materials & Inputs.** Companies derive primary revenue from industrial gases, specialty chemicals, silicon wafers, advanced packaging substrates, rare earth and critical minerals processing, or battery materials.

## Inclusion Rules

Entities must derive at least 10% of total revenue from frontier-stack activities. Diversified conglomerates whose frontier exposure falls below this threshold are excluded even if their absolute frontier revenue is large. This approach prevents mega-caps with incidental frontier exposure from distorting the universe.

## Index Methodology

The Robotnik Composite Index is constructed as a market-capitalisation-weighted combination of the four sub-indices (Semiconductors, Robotics, Space, and Materials & Inputs). Each sub-index applies a 5% single-entity cap within its own sector universe to prevent any single constituent from dominating its sector. The Composite is then calculated as ∑ (sector mcap share × sub-index value), where sector mcap shares are recomputed daily from constituent market capitalisations. Base value: 1,000 on 31 March 2025.

Four sub-indices — Semiconductors, Robotics, Space, and Materials & Inputs — are each independently normalised to 1,000 on the same base date. Sub-index construction follows the same cap methodology applied within each sector.

Weights are recalculated daily using end-of-day market capitalisations. The universe is reviewed monthly for additions, deletions, sector reclassifications, and corporate actions (splits, mergers, delistings). Changes take effect at the beginning of the following trading month.

1Q26 Universe Composition:

- Semiconductors: 59 entities, $13.23 trillion market cap, 77.5% share
- Robotics: 105 entities, $2.30 trillion market cap, 13.5% share
- Materials & Inputs: 36 entities, $0.94 trillion market cap, 5.5% share
- Space: 33 entities, $0.60 trillion market cap, 3.5% share
- Total: 233 entities, $17.06 trillion market cap

## Data Sources

Public market prices, fundamentals, and corporate reference data are sourced from EODHD as the primary provider, with per-ticker overrides where upstream limitations require alternative sources. Currently one entity (Hanwha Aerospace, 012450.KS) is served via Yahoo Finance after EODHD's KRW price field was identified as capped below the entity's current price range; see the Data Pipeline Note below.

Live prices refresh every 30 minutes during US market hours. End-of-day pricing is captured daily. Fundamentals are refreshed weekly. Market capitalisations are recalculated continuously as prices update.

## Data Coverage

- 248 of 254 entities have active live price coverage
- 229 of 254 have market capitalisation data
- 217 of 254 have fundamentals depth (P/E and revenue TTM)

The five entities without live prices are all recent IPOs: Astroscale (186A JP), QPS Holdings (464A JP), Synspective (290A JP), Tokyo Ohka Kogyo (4186 JP), and Mersen (MRSN FP). Their integration into the main dataset is scheduled for the Q2 2026 pipeline. A further seventeen Japanese-listed entities, concentrated in the chemicals and silicon wafer subsectors where the fundamentals pipeline relies on US OTC ADR proxies, currently lack full P/E and revenue depth. These are also scheduled for Q2 2026 resolution.

## Data Pipeline Note

During the production of this report, Robotnik's data quality systems identified that EODHD's Korean Won price field returns a sentinel value (₩999,999.9999) for Korean-listed equities whose real prices exceed that threshold. Hanwha Aerospace (012450.KS), whose shares currently trade around ₩1,519,000, was affected. The entity was temporarily quarantined while the issue was diagnosed, and reinstated with a clean price history sourced from Yahoo Finance. Robotnik's pipeline now applies defence-in-depth guardrails that reject sentinel values at fetch time and quarantine any constituent exhibiting implausible single-day movements at index calculation time. A weekly data-quality report flags any new quarantines for review.

This note is included for transparency. Historical sub-index figures for Space prior to the Hanwha reinstatement would have been approximately five percentage points higher over 2025 due to the inflated sentinel price; all figures in this report reflect the corrected data. EODHD has acknowledged the KRW ceiling as a structural limitation rather than a bug.

## Currency Conversion

Non-USD listings are converted to USD using reference exchange rates captured at data ingestion. Current rates are refreshed daily. Short-term FX volatility can introduce small distortions in sub-index returns for entities denominated in KRW, JPY, EUR, or GBP. Material FX impacts are declared where relevant in the analysis.

## Funding Database

The funding database currently captures 313 rounds since January 2025, with continuous expansion as new rounds are disclosed. 1Q26 contained 91 frontier-stack equity rounds deploying $46.0 billion. A separate $1.1 billion offtake agreement between Trafigura and Nth Cycle and a $100 million token raise by RobCo are tracked outside the equity-funding total.

Rounds are sourced from company announcements, investor filings, and financial news. Each round is classified by sector, round type (Seed through Series H, Growth, PIPE, Secondary, Undisclosed), and tagged with lead and co-lead investors where disclosed. Private valuations are recorded where publicly stated or reliably reported.

The dataset is built primarily from publicly disclosed rounds. Private rounds that are not publicly announced — particularly in Asia and in defence-related companies with confidentiality constraints — may be under-represented. Quarterly totals should be read as lower bounds on actual capital deployment rather than comprehensive tallies.

## Tokens

Robotnik tracks 43 frontier-aligned token projects separately from the public equity universe. These projects are currently excluded from the Robotnik Composite Index and its sub-indices. Of the 43, approximately 9 maintain active daily pricing at any given time; the remainder are tracked but intermittently priced due to lower liquidity or recent listing status. The decision to track tokens separately reflects structural differences between token and equity markets, including liquidity, governance, and price-discovery mechanisms. Token coverage is available at the platform level; integration with the index framework will be reviewed as the category develops.

## Intelligence Layer

In addition to public market data, Robotnik maintains an enrichment dataset for priority entities covering:

- **Value-chain tier.** Position within the frontier stack (design, manufacturing, equipment, materials, or end-user deployment)
- **Bottleneck risk.** Four-level classification (Critical, High, Medium, Low) based on substitutability of the entity's products and the severity of the disruption its absence would cause
- **Key customers and suppliers.** Named direct relationships drawn from company disclosures, industry filings, and trade press

- **Cross-sector dependencies.** Mapped relationships between the entity and other Robotnik constituents across different sectors
- **Analyst notes.** Qualitative commentary on structural position, strategic direction, and identified risks

The Intelligence layer is the proprietary enrichment that distinguishes Robotnik from passive market-data providers. The dependency chains described in Section 1 and the bottleneck risk classifications in Section 3 are generated from this dataset.

# Appendix B: Sources

*The following sources informed the analysis in this report. Additional sources used for individual data points are cited inline where relevant.*

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- Wolfspeed, *300mm Silicon Carbide Technology Breakthrough*, January 2026.

# Glossary

**ABF substrates** — Ajinomoto Build-up Film substrates. Thin dielectric films used as insulation between layers in advanced chip packaging. Critical for CoWoS and FCBGA packages in high-end processors. Key suppliers: Unimicron, Ibiden, Nan Ya PCB, Kinsus.

**Bayan Obo** — The world's largest rare earth reserve, located in Inner Mongolia. Operated by China Northern Rare Earth (600111.SH); central to global rare earth supply concentration.

**CHIPS Act** — Creating Helpful Incentives to Produce Semiconductors and Science Act. US federal legislation signed into law on 9 August 2022, allocating $52.7 billion for domestic semiconductor manufacturing and R&D plus a 25% Advanced Manufacturing Investment Tax Credit.

**CoWoS** — Chip-on-Wafer-on-Substrate. TSMC's advanced 2.5D packaging technology, used for NVIDIA's H100, H200, and Blackwell GPUs and other HBM-equipped AI accelerators. The industry-wide bottleneck for AI accelerator shipments through 2025–2026.

**Direct-to-device (D2D)** — Satellite-to-standard-mobile-phone connectivity, without requiring a specialised satellite phone or terminal. Also known as "direct-to-cell." AST SpaceMobile and Starlink Direct-to-Cell are the two principal commercial programmes.

**EUV** — Extreme Ultraviolet lithography. Chip patterning technology using 13.5nm wavelength light, required for leading-edge semiconductor manufacturing. ASML is the sole global supplier of EUV systems.

**HBM / HBM3E / HBM4** — High Bandwidth Memory. A type of DRAM stacked vertically and connected to processors via a wide interface, essential for AI GPU performance. HBM3E is the current volume standard for AI accelerators (12-high stacks, approximately 1.2 TB/s per stack). HBM4 begins ramping in Q2 2026, targeting 1.6 TB/s and 16-high stacks. The three global suppliers are Micron, Samsung, and SK Hynix.

**High NA EUV** — Next-generation EUV lithography with higher numerical aperture, enabling sub-2nm chip patterning. ASML's EXE:5000 series (in operation since 2024) and the more advanced EXE:5200 (delivered to imec in March 2026) are the relevant systems.

**HREE** — Heavy Rare Earth Elements. A subset of rare earths including dysprosium and terbium, essential for high-temperature permanent magnets used in motors, actuators, and reaction wheels. Commercial processing is currently concentrated entirely in China.

**IDM** — Integrated Device Manufacturer. A semiconductor company that both designs and manufactures its own chips. Examples: Intel, Micron, Samsung Semiconductor.

**IFS** — Intel Foundry Services. Intel's external-customer foundry business, serving other chip designers with Intel's process nodes, notably 18A from late 2025.

**NdFeB** — Neodymium-Iron-Boron. The strongest class of permanent magnets commercially available. Used in humanoid actuators, EV traction motors, wind turbine generators, MRI machines, and satellite reaction wheels. Typically contains approximately 30% rare earth content by weight (Nd, Pr, Dy, Tb).

**NdPr** — Neodymium-praseodymium mischmetal. The primary input to NdFeB magnet production; tracked as a composite price reference.

**RESourceEU** — The European Commission's critical raw materials action plan, adopted on 3 December 2025 as successor to the Critical Raw Materials Act (2023). Sets 2030 dependency-reduction targets, including gallium from 71% to 17%.

**Reshoring** — The relocation of semiconductor manufacturing capacity from its historic concentration in Taiwan, South Korea, and mainland China back to the United States, Europe, and Japan. The policy vehicles include the US CHIPS Act, the EU Chips Act, and Japan's semiconductor strategy.

**Section 232** — A provision of the US Trade Expansion Act of 1962 allowing the President to impose tariffs on imports deemed a threat to national security. The January 2026 Section 232 proclamation introduced a 25% tariff on specific advanced AI semiconductors.

**SiC** — Silicon Carbide. A wide-bandgap semiconductor material used for high-voltage power electronics in EV inverters, grid storage, and industrial drives. Wolfspeed produced the world's first 300mm SiC wafer in January 2026.

**SOI** — Silicon-on-Insulator. An engineered substrate technology that improves chip performance and power efficiency by placing an insulating layer between the silicon substrate and active circuitry. Manufactured by Soitec.

**SOX** — PHLX Semiconductor Sector Index. A market-cap-weighted index of approximately 30 US-listed semiconductor companies, used as the closest benchmark comparator to Robotnik's Semiconductor sub-index.

**VA267 / LE-01** — Flight designations for the maiden Ariane 64 launch on 12 February 2026. VA267 is Arianespace's flight number; LE-01 is Amazon's designation (Leo Europe 01).

**VLA model** — Vision-Language-Action model. A class of machine learning model that processes visual and linguistic inputs and outputs physical actions, enabling natural-language instruction of robotic systems. DeepMind's Gemini Robotics 1.5 is a prominent example.

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