The case for physical AI: Why intelligence is moving from digital to the real world

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Artificial intelligence (AI) is entering a new phase. Over the past decade, advances in cloud computing have driven rapid adoption of AI across digital applications. Today, that momentum is extending beyond digital environments. Improvements in model architecture and hardware design are enabling AI systems to operate directly in the physical world.

This shift, often described as 'physical AI', refers to intelligent systems that can perceive their surroundings, make decisions, and execute physical actions in real time. It spans a broad set of applications across the physical economy, including:

Humanoid robotics: General-purpose robots designed to work in human environments, supporting flexible tasks across manufacturing, logistics, services and beyond.

Drones and autonomous mobility: Among the fastest-scaling deployments today, spanning defence, inspection, surveillance, logistics, and robotaxi services.

Smart manufacturing and logistics robotics: Factory and warehouse systems that automate storage, picking, transport, and production, improving throughput and accuracy in high-volume environments.

Other emerging applications: Healthcare, agriculture, construction, and field services, with use cases from precision agriculture to robotic-assisted medical procedures.

Together, these technologies embed intelligence across the real economy. For investors, the significance lies in AI's transition from digital workflows into sectors that account for the majority of global economic activity.

From digital intelligence to physical execution

The defining characteristic of physical AI is its ability to translate intelligence into action. Recent advances in sensing technologies, edge computing, and control systems allow machines to interpret complex environments and respond autonomously, without reliance on constant connectivity to centralised data centres.

This transition is being enabled by two parallel advances. First, improvements in model efficiency and hardware design are reducing the cost and power requirements of inference. Architectural innovations such as mixture-of-experts models improve efficiency by activating only a subset of parameters for each task, making large AI models more economical to deploy outside energy-intensive data centres. Second, new model classes such as Vision-Language-Action (VLA) systems extend AI beyond perception and reasoning into physical execution. Nvidia's Project GR00T[1] demonstrates how multimodal inputs can be translated into complex, real-world motor skills, effectively serving as a robotic control layer.

At the same time, hardware economics are improving rapidly. Humanoid and robotic systems that were once confined to research environments are becoming commercially viable as advances in actuators, sensors, power systems, and manufacturing scale converge. Entry-level humanoids such as Unitree's G1 are now priced below $15,000, while UBTECH's Walker S2 has entered mass production, with hundreds of units being prepared for deployment across automotive and logistics environments. As hardware costs decline alongside improvements in intelligence, the economic case for deploying physical AI across a wider range of tasks continues to strengthen. As the technology matures, the pace of adoption is increasingly shaped by external structural forces rather than purely technological factors.

Structural forces accelerating adoption

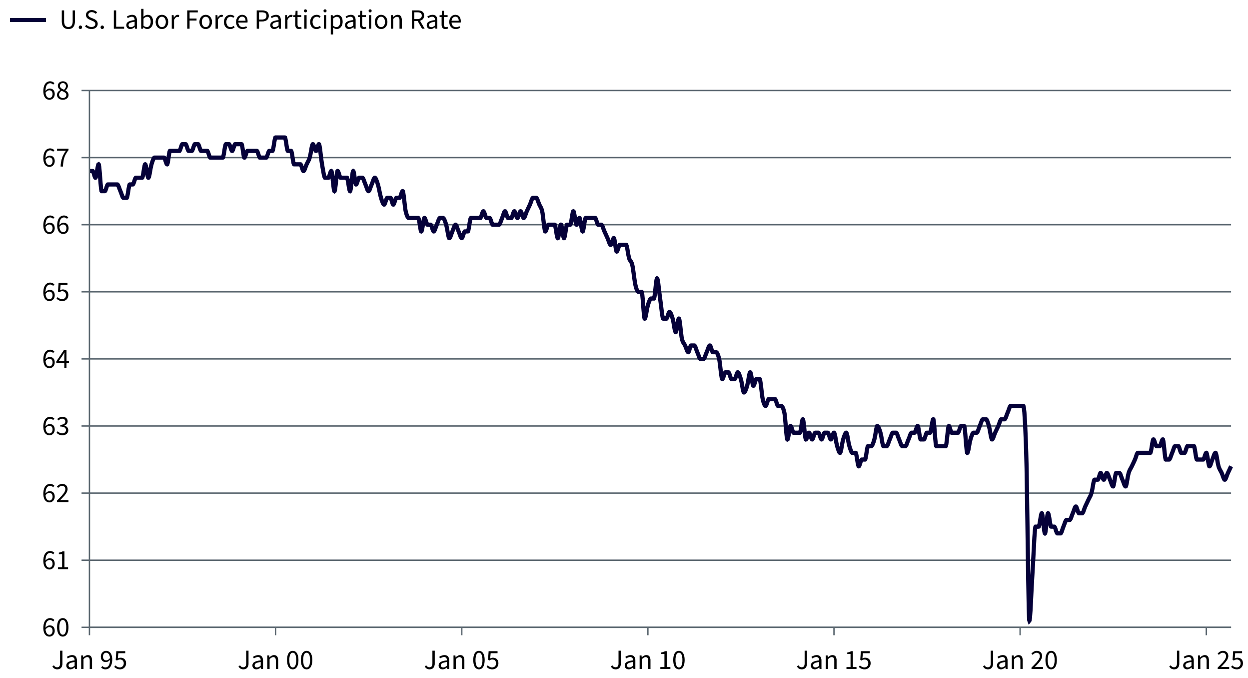
Demographic pressures, supply-chain reshoring, the need for automation at industrial scale, and rising defence investment are converging to accelerate the adoption of AI across real-world applications.

Demographic pressures and labour constraints

Ageing populations have led to declining labour force participation across developed economies and have created persistent workforce shortages. These trends are structural rather than cyclical and are particularly evident in manufacturing, logistics, healthcare, and skilled trades.

1 NVIDIA Isaac™ GR00T is a research initiative and development platform for developing general-purpose robot foundation models and data pipelines to accelerate humanoid robotics research and development. Source: https://developer.nvidia.com/isaac/gr00t)

Figure 1: US Labour force participation rate



Source: Federal Reserve Economic Data, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org. Data Series: CIVPART for period January 1995 to September 2025. Data accessed December 2025. **Historical performance is not an indication of future performance and any investments may go down in value.**

As labour availability becomes a binding constraint, automation shifts from a discretionary efficiency measure to an operational requirement. Physical AI is increasingly deployed in tasks that are physically demanding, repetitive, or hazardous, including industrial inspection, warehouse picking, and heavy manufacturing operations. In these settings, automation improves safety and reliability while enabling organisations to sustain output despite ongoing constraints on labour supply.

Automation at industrial scale

Physical AI is no longer limited to pilot projects or experimental deployments. Robotics and automation systems are now operating at scale across factories and warehouses, demonstrating commercial viability and operational reliability.

A clear example is Hyundai's Metaplant in Georgia, which illustrates the modern manufacturing paradigm. The facility operates with approximately 500 welding robots, 300 automated guided vehicles, and around 1,300 employees, with planned capacity scaling toward 500,000 vehicles per year. In this context, automation is not incremental, it is foundational to the production model.

Reshoring and industrial policy

Supply-chain disruptions, evolving trade policy, and geopolitical considerations have driven a renewed focus on domestic and regional manufacturing capacity. Governments and corporations are committing substantial capital to rebuild production across critical industries.

Figure 2: US reshoring and manufacturing investment announcements

21 January 2025	Stargate Project (SoftBank, OpenAI, Oracle)
24 February 2025	Apple committed $500 billion over four years to US manufacturing, suppliers, R&D[2], and facilities
4 March 2025	TSMC[3]: Additional $100 billion for US semiconductor manufacturing in Arizona (total $165 billion)
25 March 2025	Hyundai Motor Group: $21 billion (2025–2028) in US auto production, parts, and steel (including $5.8 billion Louisiana steel mill)
22 April 2025	Roche: $50 billion over five years in US pharmaceuticals, diagnostics, manufacturing, and R&D
12 June 2025	Micron: ~$200 billion ($150 billion manufacturing + $50 billion R&D) in US memory chip production
21 July 2025	AstraZeneca: $50 billion by 2030 in US manufacturing and R&D (incl. multi-billion-dollar Virginia facility)
6 August 2025	Apple (increased): Additional $100 billion, raising total to $600 billion over four years (including American Manufacturing Program for supply chain onshoring)
13 August 2025	GE Appliances (Haier-owned): >$3 billion over five years in US manufacturing expansions and onshoring
14 October 2025	Stellantis: $13 billion over four years for US expansion and production shifts
19 Dec 2025	Most-Favored-Nation (MFN) pricing agreements include $150B+ in near-term US manufacturing commitments

Sources: Company press releases, Reuters, White House.

Recent announcements span semiconductors, pharmaceuticals, automotive manufacturing, and industrial infrastructure. Producing in higher-cost regions strengthens the economic case for automation, making physical AI central to reshoring strategies and long-term industrial competitiveness.

Defence as an adoption catalyst

Defence has emerged as a key accelerator of physical AI adoption, particularly in drones and autonomous systems. Modern conflict has demonstrated the effectiveness of scalable, autonomous platforms that can be produced and deployed rapidly.

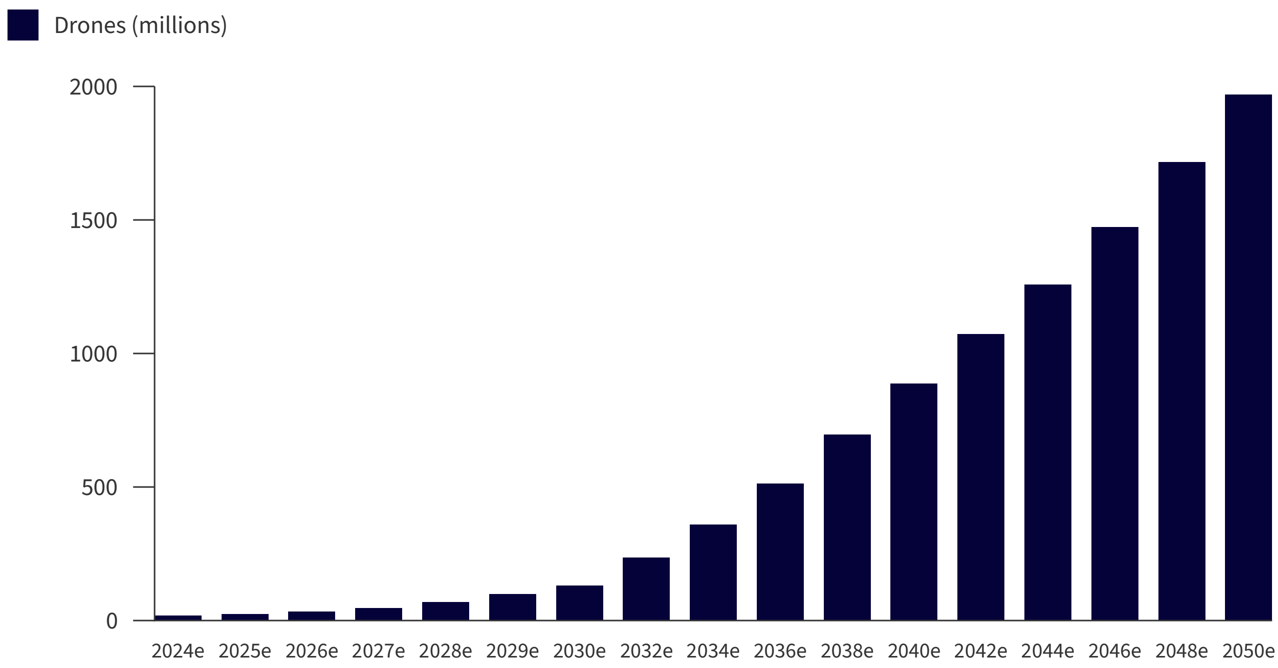
Ukraine's 'Operation Spider's Web' reportedly used 117 low-cost drones to damage Russian

2 R&D – research and development.

3 TSMC – Taiwan Semiconductor Manufacturing Company.

aircraft, underscoring the cost–impact asymmetry of autonomous systems. Rather than relying on a small number of high-value assets, defence strategies are increasingly shifting toward distributed, intelligent platforms that can be manufactured at scale.

Figure 3: Morgan Stanley estimated drone install base, millions



Source: Morgan Stanley Research Estimates, Robot Almanac December 2025.

Historically, technologies that achieve scale through defence use cases often migrate into commercial markets. Autonomous driving provides a clear precedent: early breakthroughs were catalysed by DARPA[4] -sponsored research and competitions, laying the groundwork for today's commercial deployments. That progression is now visible on public roads, as fully autonomous robotaxis such as Waymo move from pilot programs toward widespread operations.

Conclusion

Physical AI extends artificial intelligence from digital environments into the core of the real economy. As intelligence becomes embedded in factories, logistics networks, and mobility systems, adoption is increasingly driven by structural necessity rather than technological curiosity.

Falling costs, labour scarcity, large-scale industrial investment, and defence uptake are converging to accelerate real-world implementation across multiple sectors. For investors, the opportunity lies in recognising physical AI as a productivity theme grounded in observable deployments and durable economic drivers, not distant promises.

4 DARPA = Defense Advanced Research Projects Agency.

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