Robotics Capability Framework: A common foundation for the next era of intelligent robotics

MANIFESTO

Why the robotics ecosystem needs a common language

Richard Grisenthwaite
Chief Architect, Arm

At Arm, we believe the next phase of robotics requires more than just advances in AI and compute. It needs a shared foundation that allows intelligent robotic systems to be described consistently without constraining innovation. As a company that works across silicon, software, AI, devices, infrastructure and developer ecosystems, rather than building finished robots ourselves, Arm is uniquely positioned to help bring the industry together around this core challenge and this manifesto is an invitation to join us in that task.

Intelligent robotics will shape the next era of computing in the physical world. As robots move beyond controlled environments into more varied, dynamic and human-centered environments, they will increasingly need to perceive, adapt and collaborate alongside people. This transition creates tremendous opportunities but also places new responsibilities on the industry.

Today, terms such as *autonomous*, *intelligent*, *adaptive*, *collaborative*, *contextual* and *self-improving* are already widely used as part of the robotics conversation, but they do not always carry consistent meaning across vendors, use cases, operating environments or supervision models.

This lack of consistency makes robotic systems harder to compare, more difficult to integrate and more challenging to assess, creates friction across the ecosystem.

Customers need greater understanding of the capabilities of robotic systems available to them. Regulators and insurers need clearer ways to understand capability and risk. Developers and integrators need a common language that helps them build and innovate across an increasingly diverse ecosystem.

That is why Arm is introducing Robotics Capability Framework – an architecture-agnostic reference framework designed to provide a common way to describe robotic capability, operating context, supervision, and assurance. Rather than prescribing how robots should be built, the framework is intended to make capability claims easier to understand, systems easier to compare and assurance expectations clearer, while preserving the freedom for companies to innovate and differentiate.

This is not the final destination, nor is it intended to become an Arm-only initiative. Robotics will continue to evolve through advances in AI models, sensing, compute, safety, software and regulation, and any common language must evolve alongside it.

We see Robotics Capability Framework as a practical starting point, and invite robotics companies, developers, customers, regulators, researchers and industry partners to help shape it into a trusted foundation for the next generation of intelligent robotics.

Imagine a world of trusted intelligent robotics

Imagine a world where intelligent robots work safely and reliably alongside people, helping hospitals move supplies, supporting rehabilitation, improving manufacturing, operating in warehouses, inspecting critical infrastructure, assisting emergency response and making agriculture more productive and sustainable. These systems will increasingly operate in dynamic, real-world environments where they must adapt to changing conditions while remaining understandable, predictable, and trustworthy.

That future is becoming a reality. In a recent report, McKinsey explains that physical AI and robotics as the next frontier of AI, arguing that embodied intelligence could change how people live and work by 2040. It has also described a future of work shaped by partnerships between people, AI agents and robots.

MARKET PERSPECTIVE

"Technology alone does not drive adoption. Scaling robotics will require greater industry alignment on how technical capabilities, compatibility, safety, security and regulatory considerations are defined and understood. A common framework helps establish a shared foundation that will bring greater clarity to capability requirements and help accelerate adoption across the industry."

Syed Alam, Partner
McKinsey & Company

Robotics is advancing along two axes. The first is scale: robots are being deployed widely, with the International Federation of Robotics reporting more than 4.28 million industrial robots operating in factories worldwide and annual installations exceeding half a million units for the third consecutive year.

The second is capability: advances in AI, sensing, compute, and software are expanding what robots can perceive, reason about, adapt to and do in real-world environments. It is this second shift that makes shared language more urgent. As robots become more intelligent, the industry needs clearer ways to describe what that intelligence means in practice, including the task, environment, supervision model, safety expectations and level of human involvement.

A robot in a hospital, a warehouse robot, and a domestic assistant may all be described as intelligent, but each operates under different expectations. A robotic arm in a controlled industrial cell is not the same as a mobile manipulator operating near untrained people. The same words — autonomous, adaptive, collaborative, intelligent — can imply very different capabilities, responsibilities and risks depending on the task, environment, supervision model and failure mode.

The robotics industry therefore needs a common framework that is broad enough to serve many use cases, precise enough to support trust, and flexible enough to preserve innovation.

The challenge: Different statements have different meanings

The intelligent robotics industry is still taking shape. Its markets, deployment models, safety expectations, regulatory approaches and business models will continue to evolve for years. However, the language formed now may influence how intelligent robotics are procured, assured, regulated, insured, invested in and trusted for decades.

This makes timing crucial. Without common terminology and shared expectations, fragmented definitions may harden into market structure. Different vendors, customers, regulators and ecosystem partners may continue to use the same words to mean different things, making comparison, assurance and trust harder than they need to be.

The challenge is becoming more urgent as robotic capabilities improve at pace, including through learning, adaptation, and self-improving systems. The industry needs stable language that can keep up with this change without locking the ecosystem into today's architecture, models or deployment patterns. Today, one company's "autonomous" robot may require continuous human supervision, while another may use the same word for a

system operating independently within a bounded environment. “AI-enabled” may describe anything from a perception model to a planning system, learning loop or broader agentic reasoning stack. “Collaborative” may refer to a safety-rated industrial arm, mobile robot operating near workers, or service robot interacting with the public.

DEPLOYER PERSPECTIVE

“As robotic systems become more adaptive, connected and capable, the industry needs a clearer way to understand what those capabilities mean in real deployment environments. From a cyber-risk and insurance perspective, consistent capability language is essential: it helps customers compare systems, help insurers and risk owners assess exposure, and gives the wider ecosystem a stronger foundation for trust as intelligent robotics scale at pace.”

Peter Armstrong, Managing Director
Cyber Risk Insights Limited

“A common language for robotics capabilities can help simplify product development, improve integration and accelerate the path from innovation to deployment. Bringing the ecosystem together around a common framework helps create a more consistent foundation for collaboration and innovation across the robotics value chain.”

Bingchuan Sun, Product Director
Lenovo Vehicle Computing

The problem is not only semantic; it is structural. Inconsistent language means:

- Requirements are harder to write;
- Systems harder to compare;
- Integration harder to plan;
- Safety reviews harder to frame;
- Insurance and operational risk harder to assess;
- Regulation harder to reference without endorsing a specific technology, architecture or vendor;

Investment decisions harder to make because technical maturity and market readiness are described through claims that are not always comparable.

Insurability is a fourth pillar of market confidence alongside procurement, integration and regulation. A common capability language can help risk owners and insurers understand how evolving robotic capabilities should be addressed, supported and scaled in real deployment environments.

The automotive industry demonstrated the value of shared capability frameworks for describing increasingly automated systems. However, robotics presents a broader challenge, as the range of machines are diverse with no single dominant operating domain. A robot may navigate, manipulate, inspect, assist, assemble, deliver, coordinate, collaborate, protect, monitor or respond. It may interact with trained operators, untrained workers, consumers, patients, public authorities or the general public.

Therefore, the same capability claim can imply different risks depending on embodiment, environment, task, failure mode and supervision model.

Insurance and operational risk is harder to assess as its particularly important for insurers and operational risk owners, who need consistent capability language to understand explore, compare deployments and assess whether robotic systems can be trusted at scale.

The value of a common framework is making capability claims meaningful in the context of a specific use case, operating environment, supervision model and assurance expectation. Common language is therefore a precondition for market confidence.

Why a common language matters to the ecosystem

A common language for intelligent robotics should help describe:

- What a robotic system can do;
- How sophisticated its behavior is;
- What assumptions it depends on; and
- What expectations should apply in a given use case and operating context.

It should make robotic capability easier to understand, compare, procure, assure and trust while preserving freedom of innovation and implementation.

The architectural need is for a stable reference layer between broad market claims and detailed implementation choices. Robotics Capability Framework is Arm's proposed contribution to that reference layer. It combines two complementary views:

1) A set of levels describing how robotic systems progress from reactive behavior toward deliberative, adaptive, contextual, cognitive and self-improving intelligence.
2) A capability view describing where that intelligence is expressed across the system, including areas such as perception, localization, motion, manipulation, decision-making, learning, interaction, safety, security, lifecycle management, interoperability and ecosystem integration.

Together, these views avoid reducing robotics intelligence to a single marketing label. This allows any differences to be described as a capability profile linked to the use case, operating context, human role and assurance expectations. For example:

- A fixed industrial system may be most valuable when it is predictable and tightly bounded;
- A robot operating near people in a changing environment may require stronger contextual awareness, richer interaction and more sophisticated fallback behavior;
- A fleet of robots operating across multiple sites may need stronger lifecycle management, update governance and shared learning; and
- A public-safety robot may require particularly clear expectations for supervision, resilience, security, fallback behavior and accountability.

Moreover, the role of a common framework extends beyond clarifying claims It should also help the industry describe where intelligent robotics is heading, what future systems may need to do, and what expectations should apply as robots become more adaptive, collaborative, and trusted in real-world environments. Robotics will not converge on one hardware architecture, one AI model, one sensor configuration, one safety architecture, one software stack, one deployment pattern or one cloud-edge relationship. Different systems will make different trade-offs. Some will optimize for latency. Others for safety, cost, energy, scalability, lifecycle support, explainability, fleet learning or user experience.

REGULATORY PERSPECTIVE

"Robotic systems cannot be compared solely to technical specifications. The industry needs a shared language for classification and baseline requirements for testing, and certification by an independent third-party because the value functionality and safety of a robot depend on the task it is intended to perform, the risks associated with its use, and the environment in which it operates. Without a common reference point, every jurisdiction keeps reinventing its own taxonomy, and manufacturers are left translating compliance instead of building it."

Rubén Lirio, Global Cybersecurity Director DEKRA

In practice, Robotics Capability Framework helps turn use cases, workloads, stakeholder expectations and assurance needs into clearer capability objectives.

Those objectives can then support architecture decisions, technology roadmaps, product planning, procurement language, deployment assurance and ecosystem collaboration. The framework is intended to be stable in a fast-moving industry that needs shared language, and flexible where the industry needs innovation.

Ultimately, Robotics Capability Framework is intended to reduce friction across the robotics ecosystem.

For customers, it makes systems easier to compare. For manufacturers, it provides a consistent way to communicate capability. For integrators, it supports clearer deployment planning. For regulators and insurers, it offers neutral terminology for assurance and risk assessment. And for investors and analysts, it provides greater confidence that capability claims reflect meaningful technical maturity.

Success should not be measured by whether every robot looks the same, but by whether capability becomes easier to understand, systems become easier to deploy, and trust becomes easier to build.

The guiding principles

These guiding principles are proposed as a starting point for discussion with the robotics ecosystem. They reflect the characteristics of a common reference framework that can evolve alongside the industry and are designed to be refined through collaboration with robotics companies, customers, integrators, regulators, insurers, researchers, standards bodies and technology partners.

Build trust through clarity

Robotic capabilities should be described in a way that is consistent, understandable and meaningful for the context in which they operate. Clear capability descriptions are the foundation for trust.

Describe capability, not implementation

A common framework should explain what a robotic system can do, the conditions under which it can do it and the level of supervision or assurance it requires, without prescribing how those capabilities are implemented.

Preserve innovation and differentiation

A common framework should enable comparison and confidence, while allowing vendors to continue differentiating through architecture, AI models, software, safety approaches, performance, efficiency and user experience.

Reflect the diversity of robotics

Robotics spans manufacturing, healthcare, logistics, agriculture, public services and many other domains. A useful framework must support this diversity rather than assuming a single operating environment, embodiment or deployment model.

Evolve with the industry

Robotics will continue to advance through new AI models, sensors, compute architectures, safety approaches and operating models. Therefore, any common framework must be stable enough to build trust today while remaining flexible enough to adapt as the industry evolves.

Build together

A common framework will only succeed if it is shaped by the broader robotics ecosystem.

Robotics Capability Framework is intended as a practical starting point, with its long-term value depending on open collaboration across industry, academia and standards organizations.

We're proud to be supported by:

An invitation to build a shared foundation

Arm is inviting robotics companies, customers, integrators, silicon and software partners, regulators, insurers, safety experts, investors, researchers, defense and public-sector stakeholders, and open bodies to help shape this common framework into a practical, trusted and future-proof foundation for intelligent robotics.

To register interest, contribute feedback or participate in future collaboration, visit: www.arm.com/company/contact-us/robotics-capability-framework or email the team at roboticsframework@arm.com.

Robotics Capability Framework documentation is available at: www.arm.com/markets/robotics/robotics-capability-framework.

The industry is still taking shape. Now is the moment to build the shared foundations that will allow intelligent robotics to scale with confidence.