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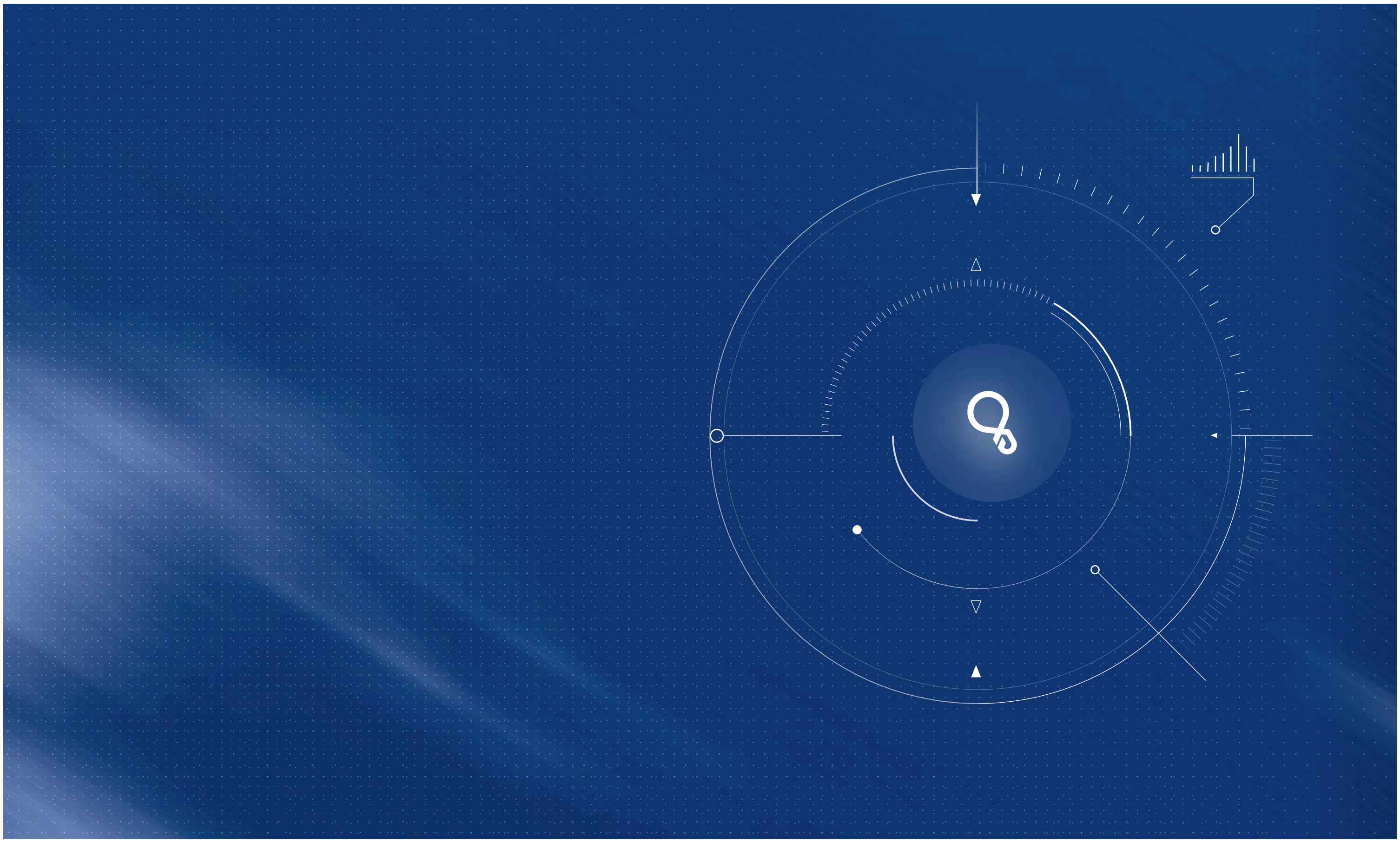

RESEARCH BRIEF

Ecosystem & Value Chain Map of the Industrial Robotics & Autonomous Manufacturing Sector

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Executive Summary

Industrial robotics and autonomous manufacturing encompass the hardware, software, and services used to automate factory and warehouse work using robots paired with the controls, safety, and integration layers required for reliable production operation. Consistent with widely used standards, the International Federation of Robotics (IFR) defines an industrial robot as an "*automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes , which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment*".

This ecosystem and value chain map demonstrates how the subsector is structurally organized and describes how value and technical dependencies flow through the value chain. The analysis focuses on several dynamics that shape participants' roles and value capture:

- hardware-software co-dependency, including the growing operational role of simulation, artificial intelligence (AI), and digital twins in deployment readiness;
- integration as a key leverage point (for multi-vendor architectures, systems integrators and automation engineering teams often become the central decision-makers shaping vendor selection, system design, and deployment execution); and
- the tradeoff between modular ecosystems and vertical integration, including how standards and integrator ecosystems aim to reduce friction in heterogeneous factories.

Industrial robots enable scalable gains in throughput, quality consistency, and workplace safety across factories and logistics operations as automation adoption in manufacturing expands globally. In 2024, the IFR reported 542,076 new industrial robots installed and a 9% increase in the operational stock of industrial robots from the previous year.[1] These metrics indicate the pace at which robotics is becoming a baseline capability in industrial competitiveness. The insights provide an evidence-based understanding of roles and dynamics within the ecosystem, where dependencies and boundary shifts are occurring, and how value is created and transferred across the industrial robotics stack.

Analyst Opinion

This ecosystem and value chain remains structurally fragmented, but the practical constraint is not a shortage of capable robots. Instead, the primary challenge is often the cost and complexity of integrating heterogeneous hardware, software, safety, and plant-control environments into a dependable production system. Most deployments behave more like integration programs that must reconcile workflow design, controls engineering, commissioning, validation, and lifecycle support. In that context, the most persistent bottleneck and durable source of influence is the ability to reduce integration friction and repeatably deliver time-to-value across sites.

The center of gravity for value capture also seems to be shifting upward toward a software control plane that sits above individual robot stacks. As perception, simulation/virtual commissioning, orchestration, and monitoring mature, software increasingly determines how multi-vendor systems behave as a coherent production asset and where learning loops form over time. This does not erase OEM differentiation in reliability, safety-rated controls, and service networks, but it changes the basis of advantage. Participants that can abstract hardware variability, standardize

[1] "World Robotics 2025," IFR International Federation of Robotics, 2025.

deployment workflows, and close the loop between operational data and continuous improvement gain more leverage over system architecture and vendor selection.

Commercial models reinforce these technical dynamics. Service-led procurement and managed-operations constructs, often framed as Robotics-as-a-Service (RaaS), shift emphasis from one-time delivery to sustained uptime, maintenance, monitoring, and refresh cycles, compressing traditional handoffs between OEMs, integrators, and operators. In parallel, interoperability and integration approaches can increase substitutability of platforms and raise the strategic importance of interfaces, tooling, and commissioning automation. The net effect is an ecosystem pulled simultaneously toward modularity through standardization and toward bundling through outcome accountability. As a result, the most consequential players are increasingly defined by who can deliver integrated performance and “own” the operating loop rather than by who supplies any single component.

Subsector Definition & Segment Breakdown

Industrial robotics and autonomous manufacturing comprise a layered ecosystem of hardware, software, and services that together enable automated production and material-handling workflows. This breakdown reveals how this subsector is organized and distinguishes the major participant categories involved from upstream component suppliers and robot OEM platforms to software and controls vendors, systems integrators, RaaS providers, and end-market adopters. Each of these categories contains meaningful subsegments (e.g., different robot architectures, specialized software layers, and critical components) that shape how capabilities are developed, combined, and deployed across industrial environments. This structural framing provides context to examine roles, dependencies, and value creation across the broader ecosystem.

Component Suppliers

Component suppliers form the upstream enabling layer of the industrial robotics ecosystem, providing the specialized hardware that underpins robot performance, precision, safety, and adaptability. This segment includes:

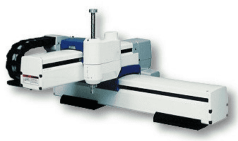
- **motion components** such as motors, actuators, drives, reducers, and bearings that determine payload, speed, and accuracy;
- **sensing and perception hardware** like encoders, force/torque sensors, machine vision, and safety scanners that enable feedback, inspection, and safe operation;
- **control and safety systems** including robot controllers, programmable logic controllers (PLCs), and safety-rated input/output (I/O) systems for real-time motion and compliance;
- and **end-of-arm tooling (EOAT) or end effectors** such as grippers, welding torches, and tool changers that tailor robots to specific tasks.

Many of these components are highly specialized for robotics use cases. For example, cycloidal and strain-wave (harmonic) gearboxes are optimized for compactness and low backlash. This makes OEMs and integrators dependent on a relatively concentrated set of precision suppliers. As a result, component suppliers can exert outsized influence on cost, capability ceilings, and innovation pace across the broader robotics value chain.

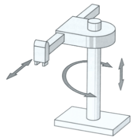
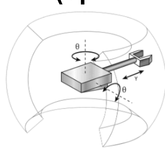
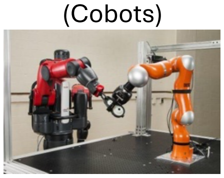
Robot Manufacturers (OEMs)

Robot manufacturers (OEMs) occupy a central position in the industrial robotics ecosystem as the designers, manufacturers, and long-term stewards of robot platforms. Their offerings are typically organized around core mechanical architectures optimized for different industrial use cases, such as articulated robots for flexible multi-axis tasks, SCARA robots for high-speed planar assembly, delta robots for rapid pick-and-place, and collaborative robots designed to operate alongside humans under defined safety standards (**Table 1**).[2, 3] Beyond the physical robot, OEMs define much of the downstream technical stack by supplying controllers, teach pendants, safety-rated features, and native software tools that shape how robots are programmed, integrated, and maintained. As a result, robot OEMs act as both hardware suppliers and platform owners whose design choices influence system integration complexity, software interoperability, service models, and the overall structure of value creation across the automation value chain.

Table 1: Industrial Robot Types - Mechanical Structure and Typical Use Cases [4, 5, 6, 7]

Industrial Robot Type	Mechanical Structure	Typical Use Cases
Cartesian/Gantry 	Linear movement along three perpendicular axes (X, Y, Z); mechanically simple and highly precise	Well suited for large work envelopes such as CNC loading, palletizing, and gantry-based material handling
SCARA (Selective Compliance Articulated Robot Arm) 	Two parallel rotary joints that allow fast, compliant motion in a selected plane	Commonly used for high-speed assembly, pick-and-place, and electronics manufacturing
Articulated 	Three or more rotary joints, resembling a human arm; high flexibility and range of motion	Dominant platform for welding, painting, assembly, and general-purpose industrial automation
Parallel/Delta 	Multiple arms connected in a closed-loop structure to a common end effector; optimized for extremely fast, lightweight movements	Widely used in high-speed picking, sorting, and packaging applications

[2] "ISO/TS 15066:2016 Robots and Robotic Devices — Collaborative Robots," ISO, February 2016.
[3] "ISO 10218-1:2025 Robotics — Safety Requirements," ISO, February 2025.
[4] "Industrial Robots," IFR International Federation of Robotics.
[5] "What Are the Different Types of Industrial Robots and Their Applications?," Process Solutions, Inc., October 1, 2018.
[6] "What Are the Different Types of Collaborative Robots?," Process Solutions, Inc., October 2, 2018.
[7] "Performance of Collaborative Robot Systems," NIST, March 26, 2025.

Cylindrical 	Combines rotary and linear motion to operate within a cylindrical workspace	Less common, but still used for simple handling, assembly, and machine tending where reach around a central axis is beneficial
Polar (Spherical) 	Two rotary joints and one linear joint, creating a spherical work envelope	Historically important in early industrial automation, now largely replaced by articulated robots due to greater flexibility and simpler integration
Collaborative (Cobots) 	Designed to safely operate alongside human workers using built-in sensing and control features that limit force, speed, and power	Generally easier to program and redeploy than traditional industrial robots, enabling flexible automation in shared workspaces where full isolation or guarding is impractical

Software & Controls Vendors

Software and controls vendors sit adjacent to robot OEMs in the ecosystem and provide the software layers that translate production intent into safe, repeatable robotic work (e.g., planning motions, programming behaviors, coordinating multiple machines, and connecting robotic cells into broader factory execution systems). This segment spans:

- **robot programming and runtime environments** (including OEM toolchains and offline programming/code-generation),
- **motion and path-planning engines** (trajectory generation, collision checking, and multi-robot coordination),
- **perception and AI layers** (vision-based picking, pose estimation, inspection/anomaly detection, and learning-enabled manipulation), and
- **simulation/digital-twin tools** used for virtual commissioning, cell/line simulation, and "what-if" capacity and throughput analysis.

In practice, these vendors often act as the interoperability and optimization layer across heterogeneous hardware. This enables faster deployment and iterative improvement by reducing commissioning time, improving uptime and quality, and making robotic workflows easier to reconfigure as products, mixes, and layouts change.

System Integrators

Systems integrators are the deployment architects of the industrial robotics ecosystem, responsible for translating robot platforms, components, and software into fully operational automation solutions on the factory or warehouse floor. These engineering and service firms design robotic cells and production lines by combining multi-vendor hardware, such as robots, conveyors, safety systems, and end-of-arm tooling, with higher-level software integration across environments. Their role spans application engineering and process selection, safety architecture and standards-aligned risk assessment, electrical and controls integration, and on-site commissioning through ramp to production. Beyond initial deployment, systems integrators often provide operator training, maintenance support, and lifecycle services such as upgrades and retrofits, positioning them as a critical leverage point where technical feasibility, vendor interoperability, and end-user requirements are reconciled into reliable automation systems.

RaaS Providers

RaaS (Robotics-as-a-Service) providers are companies that deliver robotic automation through subscription or usage-based contracts rather than traditional capital equipment sales. These providers typically bundle robot hardware, integration, software, maintenance, monitoring, and ongoing support into a single service offering. RaaS models lower adoption barriers for manufacturers and logistics operators that may lack internal automation expertise or balance-sheet flexibility by reducing upfront capital expenditure requirements and shifting uptime, maintenance, and lifecycle risk from the customer to the provider. Structurally, RaaS providers often sit across multiple layers of the value chain, coordinating platforms, software stacks, and integration services into a recurring-revenue deployment model that emphasizes utilization, reliability, and rapid redeployment over asset ownership.

End-Market Adopters

End-market adopters represent the downstream users of the industrial robotics and autonomous manufacturing ecosystem, encompassing manufacturers and logistics operators that deploy robots to improve throughput, quality, consistency, safety, and operational flexibility across production and distribution environments. These organizations span sectors such as automotive, electronics, general manufacturing, logistics and warehousing, metals and machinery, food and beverage, and plastics and chemicals. They may purchase, lease, or consume robotic capability through direct ownership, integrator-led projects, or service-based models. Automotive and electronics have historically been the largest and most visible adopting industries, reflecting high volumes, repeatable processes, and mature automation strategies. However, a broad set of general industry segments collectively account for a significant and growing share of deployments as robots become more flexible and easier to integrate. End-market adopters ultimately anchor the value chain by translating robotic technologies into measurable operational outcomes, influencing requirements passed upstream to OEMs, software vendors, integrators, and service providers.

Supporting Ecosystem

The supporting ecosystem strengthens industrial robotics and autonomous manufacturing by supplying the shared knowledge base, technical guardrails, and collaboration infrastructure that make multi-vendor automation scalable and safe. Leading academic labs advance core capabilities in perception, manipulation, planning, and learning that often migrate into commercial robot platforms and autonomy stacks via research publications, open-source frameworks, and spinout companies. Standards bodies and regulators define interoperability expectations, performance and test methods, and safety frameworks that shape how robots are designed, validated, and deployed on factory floors. Finally, consortia and institutes coordinate pre-competitive development, reference architectures, training, and best-practice transfer to reduce integration friction and accelerate adoption across the value chain.

Value Chain Architecture

The industrial robotics and autonomous manufacturing value chain is best understood as an interdependent stack rather than a simple handoff from “parts” to “robots” to “deployment” (**Figure 1**). Upstream components constrain robot platform performance and reliability, while controllers and base software define the interfaces through which higher-level motion, perception, and orchestration layers can add capability. Systems integrators and service organizations often become the practical leverage point in this architecture by translating heterogeneous hardware and software into production-ready cells, managing safety and connectivity, and sustaining uptime through commissioning, maintenance, upgrades, and redeployment. Emerging technologies, especially AI-driven controls, learning-based perception, and autonomy stacks, are shifting where differentiation lives. This moves functionality “up” into software layers that can abstract underlying hardware, change interface requirements for OEMs and component suppliers, and enable more repeatable, service-led deployment models (including RaaS) that blur traditional boundaries between product delivery and ongoing operations.

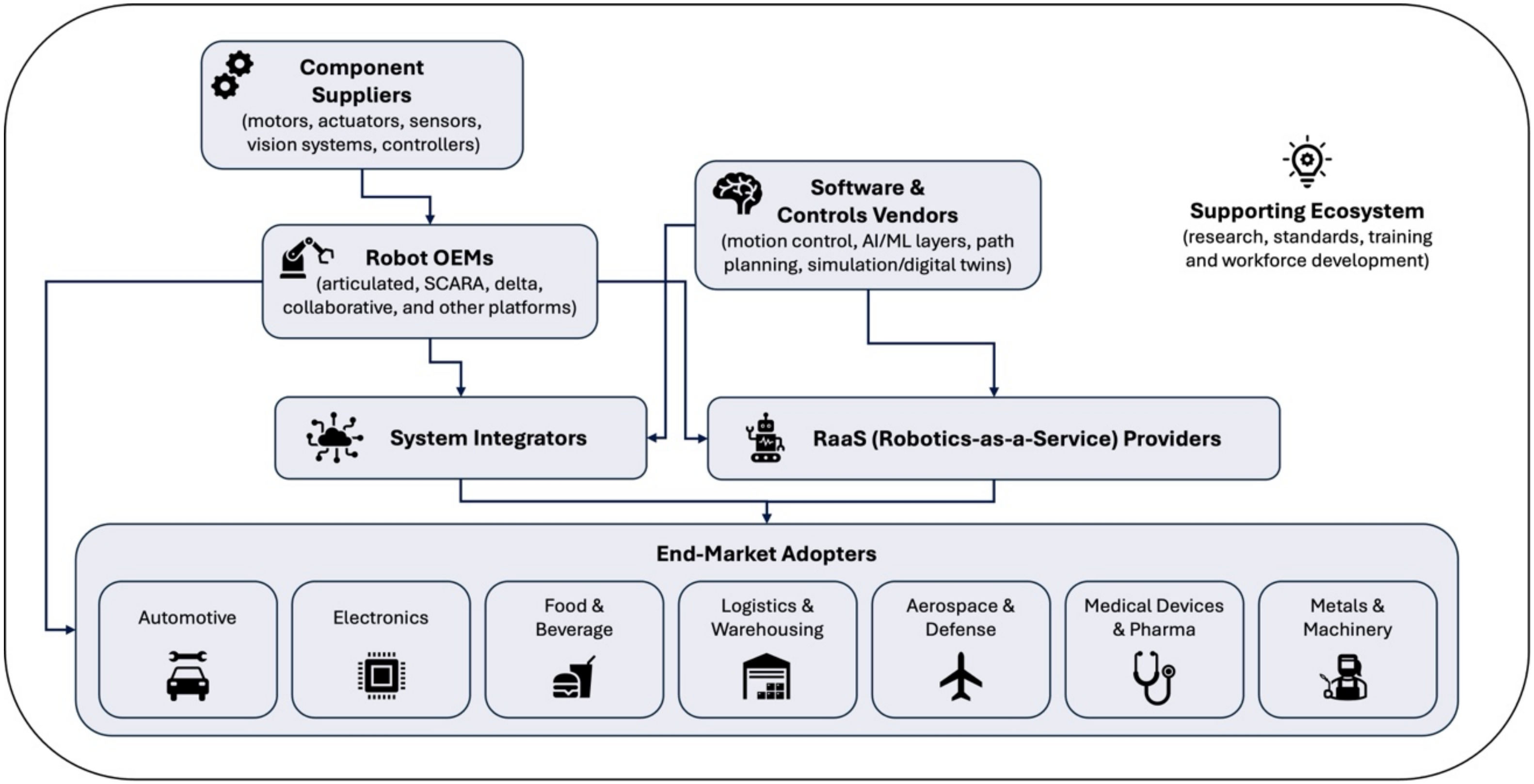


Figure 1: Industrial Robotics and Autonomous Manufacturing Value Chain & Ecosystem

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Player Landscape Map

The player landscape map translates the segment definitions into a single visual snapshot of the ecosystem, showing how established incumbents and emerging entrants cluster across the stack. Each entity is placed according to its primary function in the value chain, demonstrating who owns platform leverage, who provides enabling subsystems, who supplies orchestration and autonomy software, and who delivers deployment and lifecycle operations in real-world installations. The companies shown are illustrative examples rather than an exhaustive count, intended to highlight representative incumbents and emerging players in each segment and outline the overall structure of the ecosystem (**Figure 2**).

Figure 2: Industrial Robotics and Autonomous Manufacturing Player Landscape Map

Role-by-Role Summary of Each Category

This section provides a role-by-role view of the industrial robotics and autonomous manufacturing ecosystem, clarifying what each participant category contributes to the creation, deployment, and operation of robotic systems. The summary focuses on functional responsibilities, core capabilities, and points of interaction across robot OEMs, component suppliers, software and AI vendors, systems integrators, RaaS providers, and end-market adopters, highlighting how value is created, transferred, and coordinated across the value chain.

Component Suppliers

Primary Role: Provide the specialized subsystems that determine key aspects of robot performance, robustness, and compliance, including motion components, sensing and perception hardware, and safety and control elements. Their primary role is to deliver precision parts and modules that meet stringent industrial requirements for repeatability, duty cycle, and safety certifications, while sustaining quality at high manufacturing volumes.
Distinct Capabilities: Advanced precision manufacturing, sensor performance and calibration expertise, compliance documentation for regulated safety components, and cost-reduction discipline achieved through scale, process control, and supply-chain optimization

Robot Manufacturers (OEMs)

Primary Role: Design, industrialize, and support standardized robotic platforms intended for repeatable deployment across many applications and customer sites. Responsibilities span mechanical and mechatronic design, embedded control and safety functionality, reliability engineering, and the creation of a product and service architecture that can be manufactured, installed, and maintained at scale.
Distinct Capabilities: Safety-rated control features, lifecycle validation and testing, global field-service networks, and proprietary programming environments and application libraries that accelerate deployment and preserve platform consistency over time

Software & Controls Vendors

Primary Role: Supply the higher-level software layers that make robots easier to program, more capable in unstructured tasks, and more efficient to deploy and operate across complex production environments. Their responsibilities can include motion and task planning, perception and localization, simulation and virtual commissioning, fleet or cell orchestration, and the tooling needed to integrate robotic behavior with broader factory systems.
Distinct Capabilities: Algorithm development (planning, optimization, and control), trained perception models, integration APIs and middleware, and developer tooling that reduces engineering time from prototype to production

System Integrators

Primary Role: Translate robotic platforms and components into functioning production cells and lines, tailoring hardware, safety, controls, and process workflows to the realities of a specific facility and use case. Their primary role is to engineer the end-to-end deployment (cell design, safety architecture, electrical and controls integration, commissioning, and ramp to stable operations) while ensuring the solution interfaces correctly with plant systems.

Distinct Capabilities: Process and application engineering, safety risk assessment and compliance implementation, multi-vendor controls integration, commissioning speed, and lifecycle support for upgrades, changeovers, troubleshooting, and performance optimization

RaaS Providers

Primary Role: Reduce adoption friction by packaging robotic capability into operating-expense contracts, typically bundling equipment, deployment, maintenance, and monitoring under subscription or usage-based pricing. Their responsibilities extend beyond technical deployment to include commercial structuring (financing, contracting, and service-level commitments), ongoing operational support, and accountability for uptime and performance outcomes.
Distinct Capabilities: Standardized deployment plans, remote monitoring and support operations, asset management across distributed fleets, and the operational discipline required to meet contractual service levels while keeping deployments repeatable and economically viable

End-Market Adopters

Primary Role: Define the operational requirements that robotic systems must satisfy and ultimately realize value through day-to-day use in production. They select use cases, specify performance and quality metrics, integrate robotics into standard operating procedures, and sustain performance through maintenance, training, and continuous improvement.
Distinct Capabilities: Deep process ownership and domain knowledge, disciplined engineering change management, mature maintenance and reliability practices, workforce training and safety culture, and the organizational capacity to redeploy or scale automation as product mixes, volumes, and facility constraints evolve

Supporting Ecosystem

Primary Role: Create shared foundations that reduce uncertainty and friction across the sector by generating credible knowledge, translating it into common rules and practices, and providing neutral venues for coordination.
Distinct Capabilities: Neutrality and convening power for pre-competitive collaboration, authority to produce trusted guidance, benchmarking capacity (labs, testbeds, protocols, datasets), cross-domain translation ability, workforce development and knowledge diffusion

Emerging vs. Established Players

Industrial robotics includes a mix of long-standing incumbents and a fast-growing set of newer entrants changing how robotic capability is built, integrated, and delivered. This analysis contrasts emerging versus established players by evaluating their place in the value chain and differentiation strategies or optimization focus (**Table 2**). This helps to frame how competitive advantage and partnering dynamics may evolve across the ecosystem.

Table 2: Comparative Strategies Across the Industrial Robotics Value Chain

Dimension	Established Incumbents	Emerging Entrants & Innovators
Competitive Strengths	Large installed base of robot platforms and controllers with reliability and global support	Software and control layers, data/learning loops, and packaged applications that can sit above multiple hardware stacks
Differentiation Emphasis	Deterministic performance, safety certification, lifecycle durability, channel/service scale; incremental platform evolution	AI-first perception/control, abstraction layers that reduce programming burden, faster iteration cadence, and modular architectures that enable quicker redeployments across sites
Integration Posture	Often optimized around OEM toolchains and preferred component ecosystems; integration frequently mediated by partners (integrators, automation vendors)	"Hardware-agnostic" positioning is more common; they compete by plugging into heterogeneous fleets, standard interfaces, and workflow software rather than replacing the robot OEM outright
Go-to-Market (GTM) Strategy	Distributor/integrator channels; large enterprise sales; long qualification cycles and standardized offerings	Land-and-expand via a narrow, high-ROI use case (e.g., picking, depalletizing, kitting) or via a developer platform; heavier emphasis on pilots and iterative deployment
Commercial Model	CapEx-heavy equipment sales and service contracts	Greater share of OpEx-friendly models such as subscription software, outcome/usage-based pricing, or RaaS-style packaging
Defensibility	Manufacturing scale, IP in mechanics/controls, safety and reliability reputation, global service networks	Data advantage, model performance, workflow-level integrations, and repeatable deployment playbooks
Typical Constraints	Slower changes due to certification, installed-base compatibility, and channel complexity	Harder to prove industrial reliability at scale; dependency on integration partners or incumbent hardware; performance generalization and uptime guarantees become the proving ground
Illustrative Examples	ABB, FANUC, Yaskawa, KUKA	Intrinsic, Covariant, Dexterity, JAKA, Pickle Robot

In practice, emerging automation companies tend to stand out through a small set of recurring approaches that shift differentiation toward software, integration speed, and lifecycle economics:

- **AI-first controls and perception as the product** that positions robots as deployable compute and data systems rather than fixed-function machines;[8]

[8] "AI at Its Best: A Closer Look at the Covariant Brain," Covariant, September 28, 2023.

- **abstraction and developer tooling that lowers integration friction** (wrapping heterogeneous hardware in more uniform programming, simulation, and deployment workflows);[9]
- **modular, workflow-centric architectures** that emphasize quick commissioning, reconfiguration, and reuse across sites;
- **flexible deployment and procurement models**, especially subscription/usage constructs that shift projects from occasional CapEx buys to continuous operational scaling.[10]

Overall, ecosystem dynamics increasingly revolve around who controls deployment speed and lifecycle outcomes where incumbents remain structurally advantaged in certified platforms and long-term support and emerging players aim to capture influence by determining which hardware or software is selected, how quickly it is integrated, and how performance improves over time.

Ecosystem Trends & Structural Forces

The industrial robotics and autonomous manufacturing ecosystem has continued to evolve and is shaped by a set of structural forces that determine where differentiation concentrates, how solutions are assembled, and which participants capture value over the lifecycle. These forces include shifts in architecture, the rise of software as the coordination layer, evolving commercial models, the growing importance of interoperability in heterogeneous factory stacks, regional clustering of deployment, and more. Each of these trends and forces may effectively redraw boundaries in the value chain and alter control points in the ecosystem map.

Vertical Integration vs. Modular Architectures

Industrial robotics is shaped by a recurring tradeoff between vertical integration and modular, ecosystem-driven architectures. Integrated approaches align hardware, software, and services under one owner to improve performance control, roadmap coordination, and margin capture, but they raise complexity and capital requirements by forcing firms to sustain capabilities across multiple value-chain layers. Modular approaches instead depend on interoperable components linked by systems integrators and common interfaces, spreading innovation across the ecosystem while increasing reliance on integrator skill and the maturity of standards. Corporate actions can significantly alter the balance between these models. For example, in April 2025, ABB announced plans to spin off its robotics division, followed later by reporting on a planned SoftBank acquisition of the same division in October 2025. This illustrates how ownership changes can reshape platform control, partner relationships, and ecosystem dynamics. For ecosystem mapping, this reiterates that corporate structure is not static and shifts in ownership can redefine who controls platforms, channels, and adjacent service layers.

Increasing Software Centrality

Software is becoming an increasingly central point of differentiation and value capture within the robotics ecosystem. Recently, AI-enabled perception, manipulation, and task planning capabilities are being bundled into higher-level platforms and developer environments, **positioning software providers as system orchestrators rather than peripheral tool vendors**. For example, Intrinsic explicitly positions itself as an AI and software robotics company, highlighting a broader trend toward abstraction layers that decouple application logic from underlying hardware. In parallel,

[9] "Intrinsic's Flowstate Seeks to Simplify Industrial Robotics," IEEE Spectrum, May 15, 2023.
[10] "Robots-as-a-Service: The Flexible Automation Solution," Locus Robotics.

simulation and digital twin technologies are gaining prominence as core infrastructure rather than optional engineering tools.[11] Vendors such as Siemens position digital twins as enablers of virtual commissioning, allowing manufacturers to simulate, test, and optimize robotic systems before physical deployment. This **shortens iteration cycles, reduces commissioning risk, and shifts more value creation upstream** into the design and software phases of automation projects.

Growth of RaaS & Service-Led Deployment Models

RaaS is gaining traction as a default "go-to-market" option in segments where uptime, rapid deployment, and flexible capacity are decisive because it aligns buying behavior with operating budgets and shortens the decision cycle.[12] **As RaaS scales, it reshapes how value and power distribute across the ecosystem.** Providers must build capabilities that look more like fleet operators including remote monitoring, predictive maintenance, spares logistics, and continuous software improvement. These become central differentiators alongside data/telemetry platforms that gain leverage because they enable outcome-based guarantees and multi-site operations. This also changes partner dynamics as integrators are pulled toward managed services and recurring revenue, OEMs face pressure to package standardized cells that can be deployed repeatedly, and interoperability becomes more economically important because providers want to utilize tooling and support across varied customer environments rather than re-engineer each deployment.

Convergence of Ecosystem Roles

Traditional boundaries between robot OEMs, software vendors, and systems integrators are increasingly blurred. As deployments shift from isolated cells to networked workflows, **players that can bundle hardware, software, deployment engineering, and lifecycle operations into turnkey offerings seem to capture more value**, especially as software becomes the control plane for configuring and running robotic work cells. Current commercial models reinforce this convergence. RaaS commonly packages equipment access with monitoring, maintenance, and uptime commitments under a single contract. Interoperability and PLC-centric initiatives reduce integration friction and help integrators "productize" repeatable solutions across mixed robot fleets. Overall, control points shift toward actors best positioned to deliver integrated, lifecycle-managed solutions rather than discrete components or individual projects.

Regional Clustering & Deployment Concentration

Geography remains a significant structural dimension of the robotics ecosystem. According to the IFR, **Asia accounted for approximately 70% of global industrial robot installations** in 2023 with 382,073 new units deployed (**Figure 3**). The IFR also reports that **78% of global deployments in 2023 spanned installations in only five countries** including China, Japan, the United States, the Republic of Korea, and Germany.[13] This concentration highlights the continued dominance of a small number of manufacturing hubs in driving global robotics demand. Separately, robot density is another key comparative indicator across countries, with a **global average density of 162 units per 10,000 employees** reported in 2023 (**Figure 4**).[14] Variations in density reflect differences in

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[11] Mohsen Soori et al., "Digital Twin for Smart Manufacturing, A Review," *Sustainable Manufacturing and Service Economics* 2 (April 2023): 100017.
[12] Tanya M. Anandan, "Robots for Rent – Why RaaS Works," Automate, December 20, 2018.
[13] "World Robotics 2024 – Industrial Robots," IFR International Federation of Robotics, 2024.
[14] "Global Robot Density in Factories Doubled in Seven Years," IFR International Federation of Robotics, November 20, 2024.

industrial structure, labor economics, and automation maturity, reinforcing the importance of regional context when assessing adoption patterns and ecosystem development.

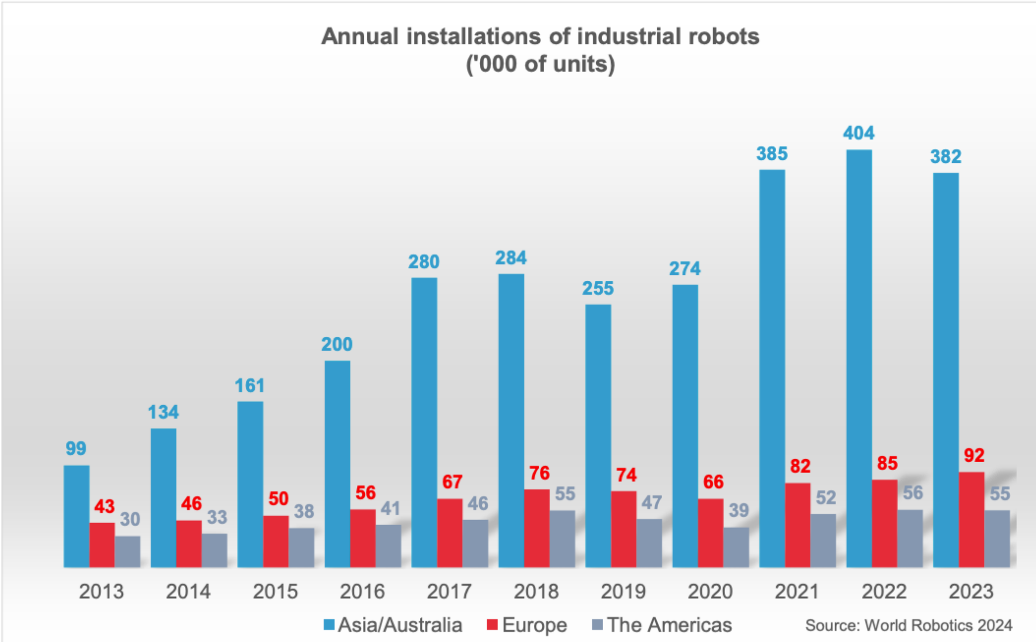

Figure 3: Annual Installations of Industrial Robots (Source: IFR)

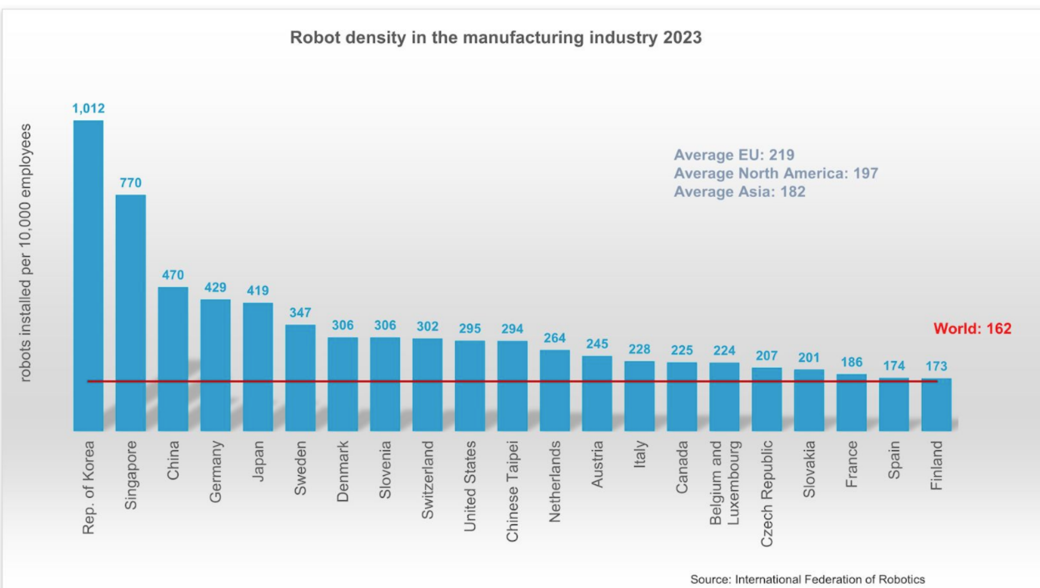

Figure 4: Robot Density in the Manufacturing Industry 2023 (Source: IFR)

Mobile Robots & Fleet Deployments

Mobile robots are becoming more tightly coupled with industrial automation requirements, shifting more robotics value creation toward material-flow workflows like internal transport, kitting, and warehouse operations. These can be deployed first as a practical on-ramp before manufacturers attempt higher-complexity manipulation and work cell automation. IFR's World Robotics 2025: Service Robots results point to **transportation/logistics as a major driver of professional service robot sales and cite staff shortages as an important demand signal**. These dynamics have potential to reshape where integration effort and differentiation sit, highlighting shifts toward fleet deployment, orchestration, uptime support, and cross-system connectivity.

Open-Source Industrialization

Another structural force is the increasing role of open-source stacks as enabling infrastructure and ecosystem coordination mechanisms. For instance, ROS-Industrial explicitly positions itself as extending ROS (Robot Operating System) into manufacturing applications, supported by regional consortia, and its stewardship model functions as an ecosystem coordination layer rather than a single vendor product. **High-quality open-source robotics software has also been characterized as a competitive factor**, **demonstrating that "platform gravity" can form outside OEM-controlled software environments.**[15] Open-source consortia and reference stacks can shape interoperability, talent pipelines, and integration economics.

Humanoid Robot Development

Humanoid robots and other "general-purpose" form factors represent an adjacent competitive arena for industrial robotics. Even if most deployments over the next several years remain task-specific, **successful humanoid commercialization could reshape upstream supplier relationships, influence which software stacks become foundational for deployment, and shift go-to-market narratives toward more flexible, cross-task automation**. Humanoid robots are gaining momentum supported by rising investment and experimentation, however, practical limitations remain that constrain near-term substitution for purpose-built industrial systems.[16] Recent reporting highlights accelerating funding and early commercialization pushes aimed at warehouse and manufacturing use cases.[17, 18] In the current ecosystem, humanoids fit best within a watchlist overlay rather than a core node in the value chain. However, if they clear reliability and cost hurdles, they could considerably reshape supplier relationships, software leverage points, and go-to-market dynamics.

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[15] "#3 ROS-Industrial: Free Software Tools Drive Robotics Forward," Fraunhofer Institute for Manufacturing Engineering and Automation IPA.
[16] "Humanoid Robots: 'Vision and Reality' Paper Published by IFR," IFR International Federation of Robotics.
[17] "Hyundai Motor Group to Unveil AI Robotics Strategy at CES 2026," HYUNDAI MOTORS.
[18] "Apptronik Raises $350 Million in Series A Funding," Apptronik, February 13, 2025.