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Asia Emerging Robotics

Humanoid Robotics: The True Moats


Dien Wang, Ph.D.
+852 2123 2622
dien.wang@bernsteinsg.com


Stacy A. Rasgon, Ph.D.
+1 213 559 5917
stacy.rasgon@bernsteinsg.com


Robin Zhu
+852 2123 2659
robin.zhu@bernsteinsg.com


David Dai, CFA
+852 2918 5704
david.dai@bernsteinsg.com


Laurent Yoon
+1 917 344 8502
laurent.yoon@bernsteinsg.com


Min-Joo Kang
+852 2123 2644
minjoo.kang@bernsteinsg.com


Jay Huang, Ph.D.
+852 2123 2631
jay.huang@bernsteinsg.com


Weibin Liang, Ph.D.
+852 2123 2666
weibin.liang@bernsteinsg.com


Hyrum Caesar
+81 3 6777 6979
hyrum.caesar@bernsteinsg.com


Jack Lin
+852 2123 2683
jack.lin@bernsteinsg.com


Carmine Milano, CFA
+44 20 7762 1857
carmine.milano@bernsteinsg.com


Andrew Chung
+1 917 344 8302
andrew.chung@bernsteinsg.com


Alrick Shaw
+1 917 344 8454
alrick.shaw@bernsteinsg.com

In our initiation (here), we believed that it was still too early to identify the ultimate winners in humanoid robotics. We continue to see meaningful **second-mover advantages** in this space (Exhibit 1), particularly as first-movers have yet to establish durable moats. Therefore, we would like to assess what will ultimately emerge as the industry's true moats.

Technology can confer an advantage, but not a moat. In China, tech leads are short-lived (with a typical lead window of 1~2 years) and quickly eroded without sustained innovation, particularly when companies misjudge technology paths or hit innovation ceilings. This pattern, seen in solar and new energy vehicles, is now emerging in humanoid robotics: strong locomotion capability has rapidly shifted from a differentiator to a baseline, with late entrants even overtaking first movers (here).

Moats for humanoid robot OEMs are likely to rest on four pillars: **high-value data**, **ecosystem**, **IP & brand**, and **cost leadership**. 1) High-value data (Exhibit 9), e.g. corner-cases, is key to pushing robotic performance from 95% toward near-perfect reliability, which in turn enables broader robotic deployment. 2) Ecosystem is a classic moat, with self-reinforcing loop driving user growth and retention (Exhibit 11). However, it remains unclear whether it will be led by humanoid pure-plays or by incumbents integrating robots into their existing ecosystems. 3) IP & brand (e.g. **Tesla**, **Sony**, **Nintendo**, **Disney**, **Hybe**) will become increasingly important differentiators when robots enter consumer markets (Exhibit 16 to Exhibit 20). 4) Cost leadership will remain critical for mass adoption and competitive advantage (Exhibit 15). So far, however, no company appears to have built a truly defensible moat in humanoid robotics.

Component suppliers have a clearer path to building moats. The advantages that drove success in their existing end-markets are likely to carry over into humanoid robotics. We see three core moats: superior **quality control** in mass production, **cost leadership**, and **rapid-response R&D**. While best-in-class quality and cost control remain traditional lean manufacturing advantages, rapid-response R&D is increasingly important in meeting customers' evolving needs and deepening partnerships. **Shuanghuan**, the global leader in gears & reducers, stands out as a rare player that has built deep moats and continues to gain share across multiple verticals. Among semi components suppliers, **Infineon** and **Renesas** are key beneficiaries given their established industry leadership and broad product portfolios spanning power semiconductors, analog, sensing, connectivity, etc.

Compute and software platform providers also have a clear path to building moats with **NVDA** and **QCOM** at the forefront of developing processors that function as the "brain" of the robot, allowing it to process sensor data, reason, plan, and execute actions quickly. These are highly complicated system solutions that are difficult develop without expertise in semiconductor design and deep engagements with developers and customers, something both NVDA and QCOM have cultivated over the years. Furthermore, NVDA offers full-stack robotics, with an ecosystem spanning across training, models, simulation and on-robot inference, which further ensures continued engagement, design wins and deployment. Though not quite as extensive as NVIDIA's ecosystem, QCOM's workflow is also end-to-end, with the company building hardware, generating data and models, and deploying into customer environments, also ensuring continued customer engagement.

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DETAILS

HUMANOID ROBOT OEMS

Humanoid robotics, an industry with second-mover advantages. To date, the primary technological bottlenecks have shifted: hardware and motion control, once the key constraints, are no longer the limiting factors. Instead, the core challenge lies in robotic intelligence, or the "brain," which ultimately defines the pace and scope of commercialization. As a result, real-world deployment of humanoid robots remains limited. While several leading players have emerged, no company has secured a dominant position or built a durable moat across consumer, commercial, or industrial applications. This creates a compelling opportunity for well-established incumbents from various industries to avoid much of the costly trial-and-error faced by first-movers, and accelerate along a clearer technological path (Exhibit 1).

Technology can confer an advantage, but not a moat. In China, a single technological innovation typically provides only a 1-to-2-year lead, which requires continuous innovation to sustain. However, misjudging the technological path (especially without real customer feedback) or facing diminishing innovation headroom can quickly erode this lead as followers catch up rapidly. This dynamic has been evident in industries such as solar and new energy vehicles over the past five years and is now emerging in humanoid robotics. In 2024, only a few companies' robots demonstrated strong locomotion capability. Today, this has rapidly become a baseline feature rather than a differentiator. Moreover, late entrants can even surpass first movers. For example, Honor, the Chinese smartphone maker, developed a robot in less than a year that outperformed all competitors at the 2026 Humanoid Robot Half-Marathon and swept the top six places (here).

We believe the long-term moats in humanoid robotics will come from: **high-value data, ecosystem, IP & brand,** and **cost leadership.**

- **High-value data**. With the robotic "brain" still immature (Exhibit 2), industry debate remains centered on the feasibility and potential of different technical paths, such as VLA models vs. World models (Exhibit 3 to Exhibit 5), and on which data collection approaches (Exhibit 7, Exhibit 8) can scale and meaningfully improve robotic performance. We see growing evidence that scaling laws also apply to robotics (Exhibit 6), pointing to the increasing importance of data assets. At some point in the future, when technical paths converge, sustaining differentiated competition will become difficult, because core algorithmic ideas can be derived from academic research, experience spread quickly through talent mobility, and large volumes of general data can be available from the market. By contrast, the asset difficult to replicate is real-world operational data collected during robot deployment (Exhibit 9), which we define as high-value data. This type of data captures rare objects, complex environments, specialized instructions, and corner cases that are critical to improving robotic performance from ~95% to near-perfect reliability, and are not easily accessible to competitors. Some startups, such as Galbot, have already recognized its importance and placed it at the top of their data pyramid. An analogy can be drawn to human learning: teenage drivers may complete substantial general training, yet still face much higher accident rates because they lack real-world driving experience (Exhibit 10). The same logic applies to robots, and we see the high-value data may power data flywheel to deepen the moat: more high-value data improves robotic performance, better performance enables broader robotic deployment, and more robots in turn generate more high-value data.

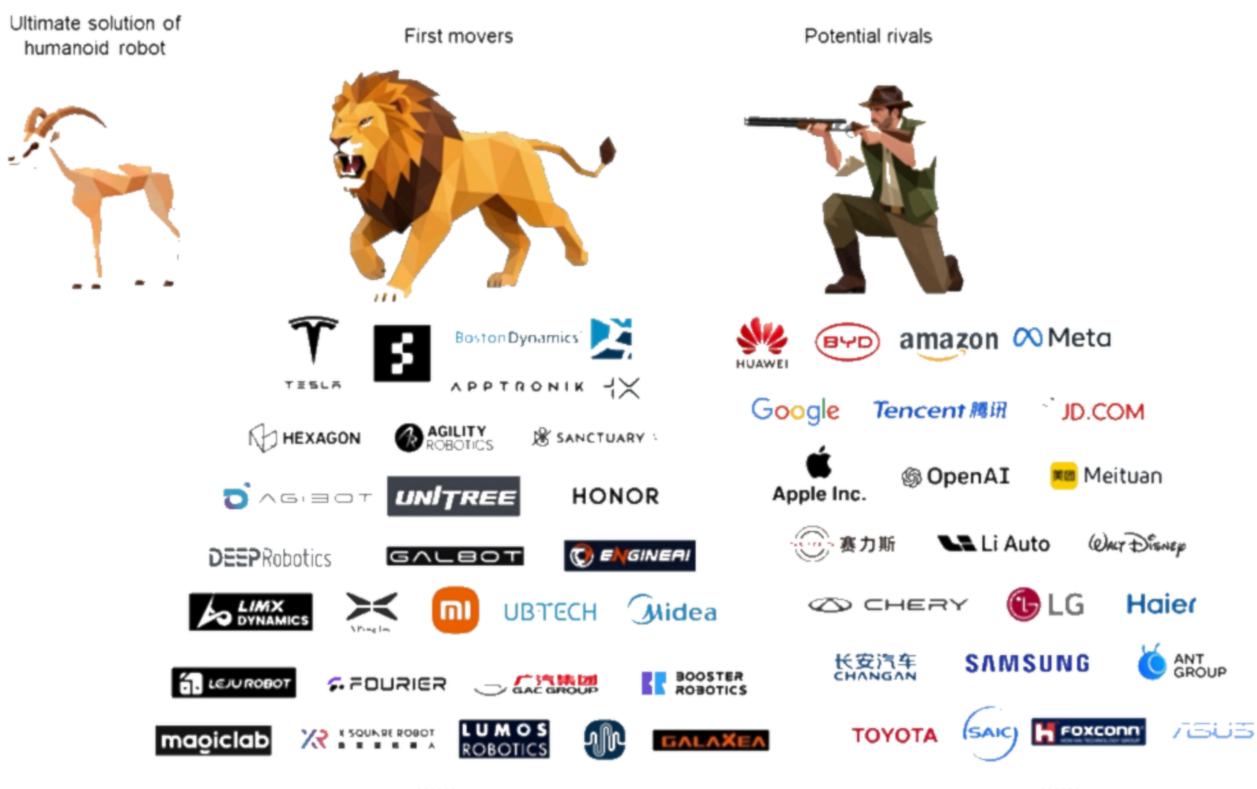
- **Ecosystem**. Ecosystems are among the most powerful moats because they create self-reinforcing loops that drive user growth and retention (Exhibit 11). The key uncertainty is whether humanoid robot pure-plays can build a new standalone ecosystem or whether incumbents integrate robots into their existing ecosystems, such as those developed by Apple and Huawei (Exhibit 12). This is why we believe the expansion potential of industry incumbents in this field should not be underestimated.

- **IP & brand**. When humanoid robots move into consumer markets, IP (Intellectual Property) and brand will become increasingly important. In early stages, when functionality remains limited, they can improve user tolerance for imperfect performance. As capabilities mature, they will become key sources of differentiation. Many companies are already exploring emotional engagement as part of their offering, e.g. Disney has developed robotic Olaf (Exhibit 16). The players that leverage strong IP and brand to unlock the consumer market early are more likely to activate the data flywheel sooner, and even potentially build ecosystem moat.

- **Cost leadership**. Falling costs improve the ROI of humanoid robots (Exhibit 13 and Exhibit 14) and make them affordable to a broader consumer base. Companies that achieve mass-market price points earlier are better positioned to unlock demand ahead of competitors. In addition, cost and pricing will remain critical competitive factors, as demonstrated by the clear cost advantages of Chinese new energy vehicles in the global market (Exhibit 15).

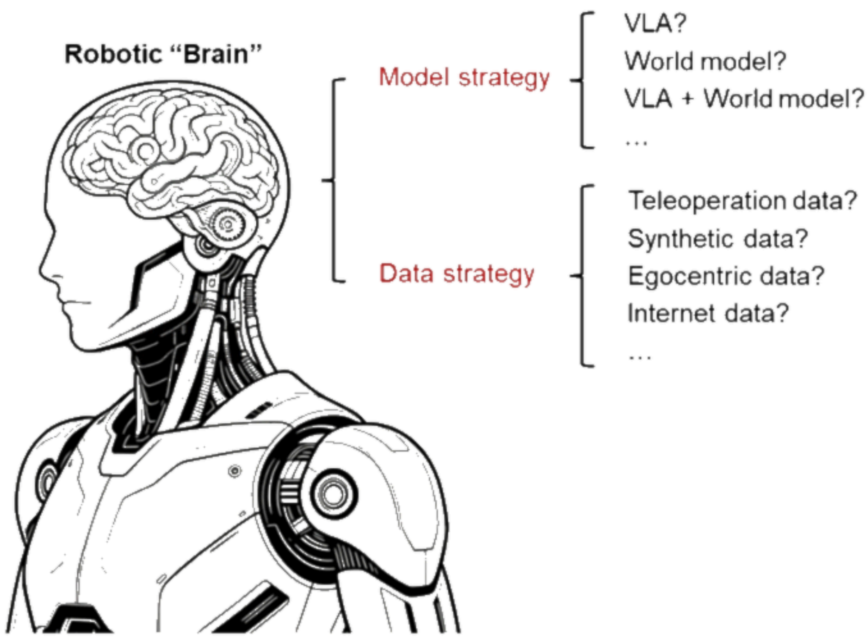
Overall, we have not seen which company has established a truly durable moat in humanoid robotics. However, established incumbents from various industries have the potential to transfer their existing strengths (e.g. experience, resource, talent pool) into humanoid robotics and take the lead in building barriers in specific areas.

EXHIBIT 1: **Humanoid robot players: Competition to intensify due to second-mover advantages**



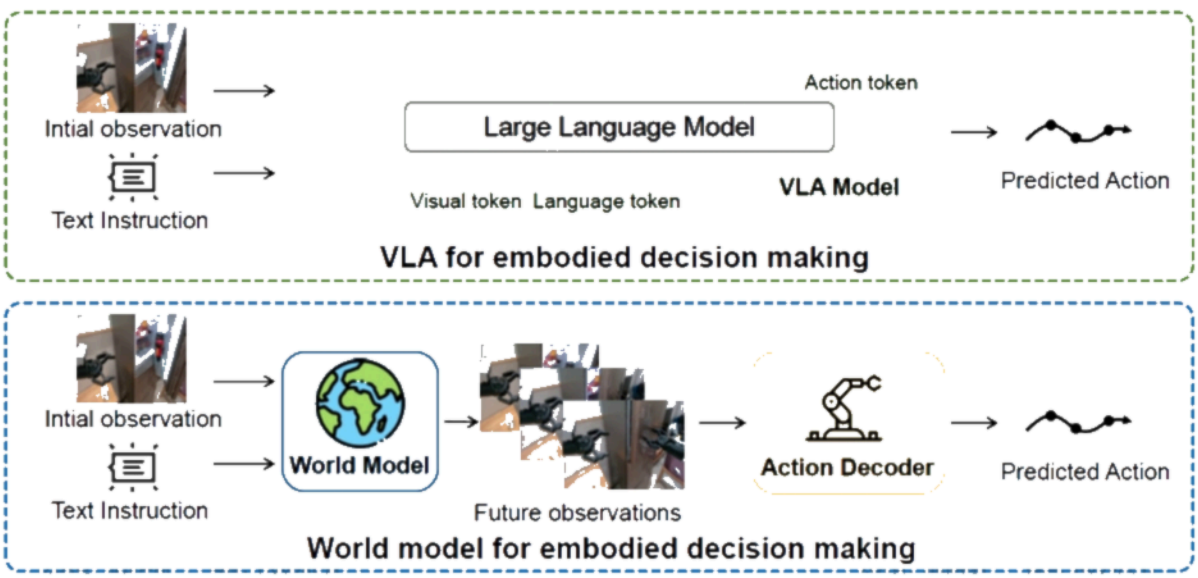
Note: BYD, Xiaomi, XPeng, Li Auto, SAIC and GAC Group are covered by Bernstein Asian Autos team. Samsung is covered by Bernstein Global Memory team. Apple is covered by Bernstein U.S. IT Hardware team. Meta, Google and Amazon are covered by Bernstein U.S. Internet team. Hexagon is covered by Bernstein European Capital Goods team. Tencent, JD.com and Meituan are covered by Bernstein China Internet team. Walt Disney is covered by Bernstein US Media & Telecom team. Toyota is covered by Bernstein Japan Autos & Auto Parts team. Others are not listed or covered by Bernstein.
Source: Company websites, Wiki Commons, Doubao (for creating images), Bernstein analysis and estimates

EXHIBIT 2: **The technical challenges of humanoid robots: The "brain"**



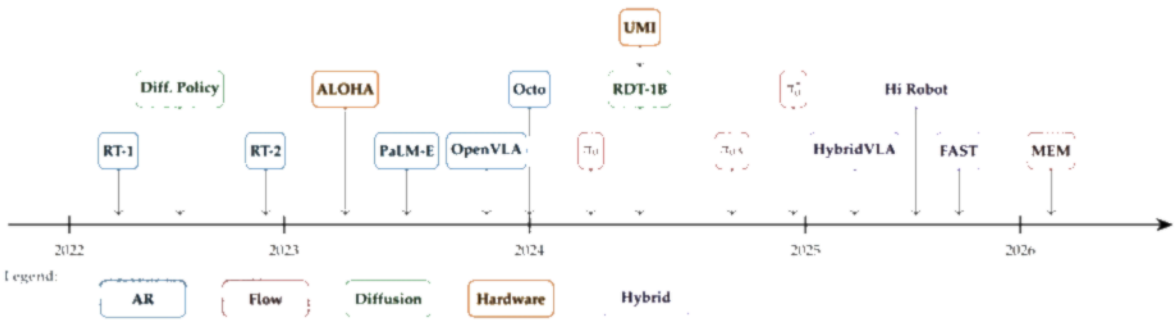
Source: NVIDIA, industry channel check, Bernstein analysis

EXHIBIT 3: **VLA (Vision-Language-Action) models and world models are two commonly used approaches to building the "brain" of humanoid robots**



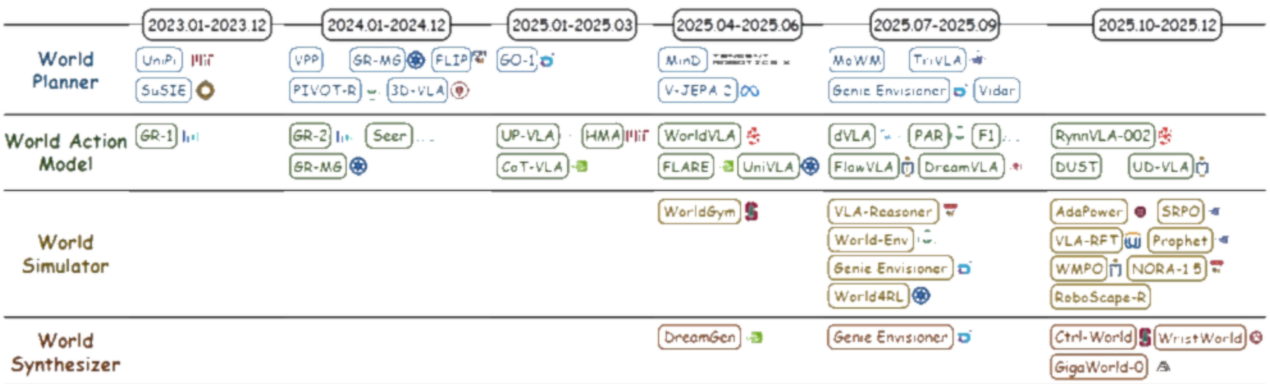
Source: "A Survey of Embodied World Models", Bernstein analysis

EXHIBIT 4: **VLA models have been evolving rapidly over the past few years**



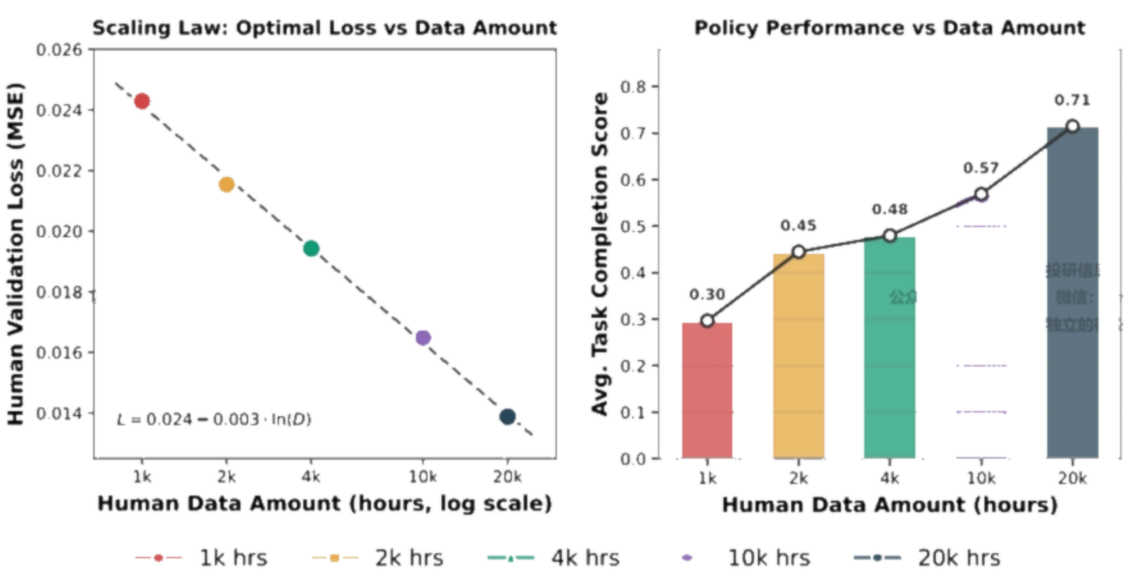
Note: Colors indicate the architectural family: autoregressive (blue), flow-based (red), diffusion-based (green), hardware platforms (orange), and hybrid/efficient methods (purple)
Source: "Vision-Language-Action (VLA) Models for Unmanned Aerial Robotics and Bimanual Manipulation: A Review", Bernstein analysis

EXHIBIT 5: **World models have also evolved rapidly, but have yet to converge**



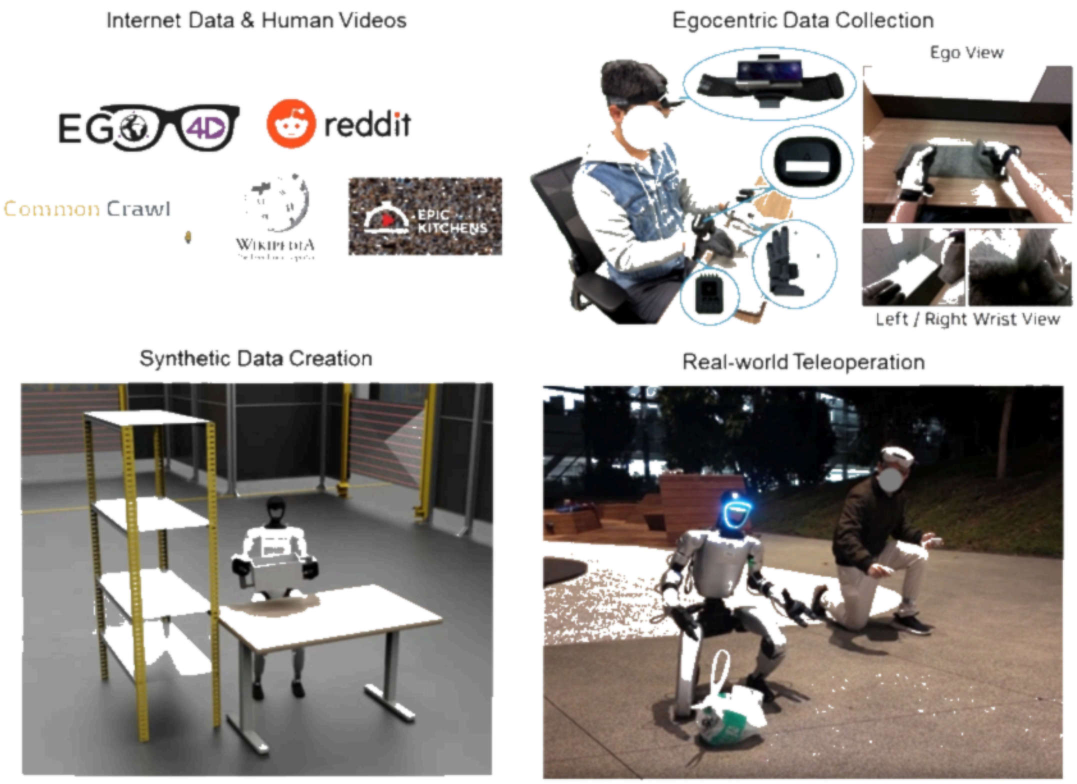
Source: "Towards Generalist Embodied AI: A Survey on World Models for VLA Agents", Bernstein analysis

EXHIBIT 6: **Scaling law for humanoid robots: Data scale vs. Validation loss**



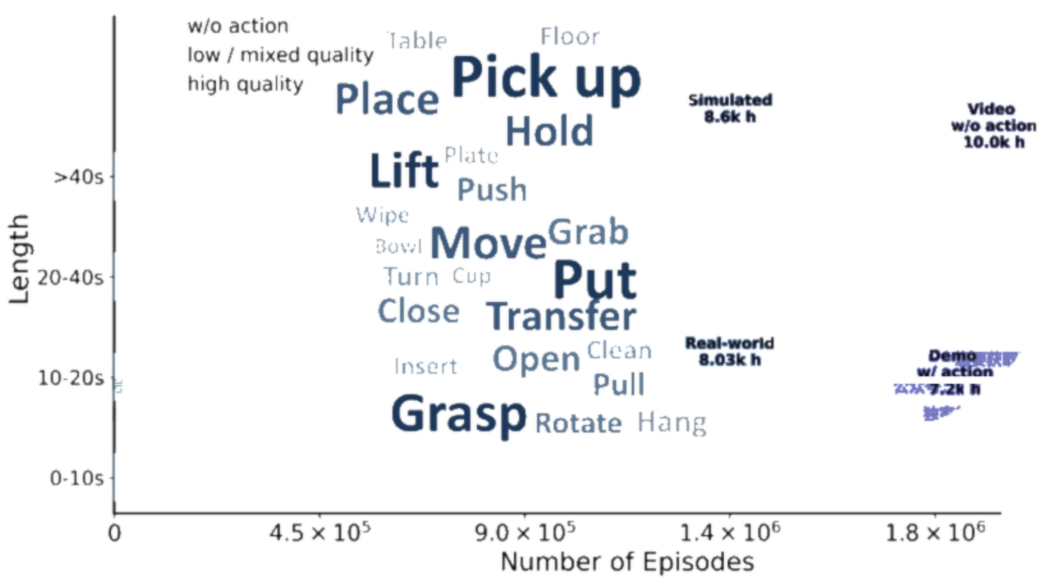
Source: "EgoScale: Scaling Dexterous Manipulation with Diverse Egocentric Human Data", Bernstein analysis

EXHIBIT 7: **Four mainstream data collection approaches**



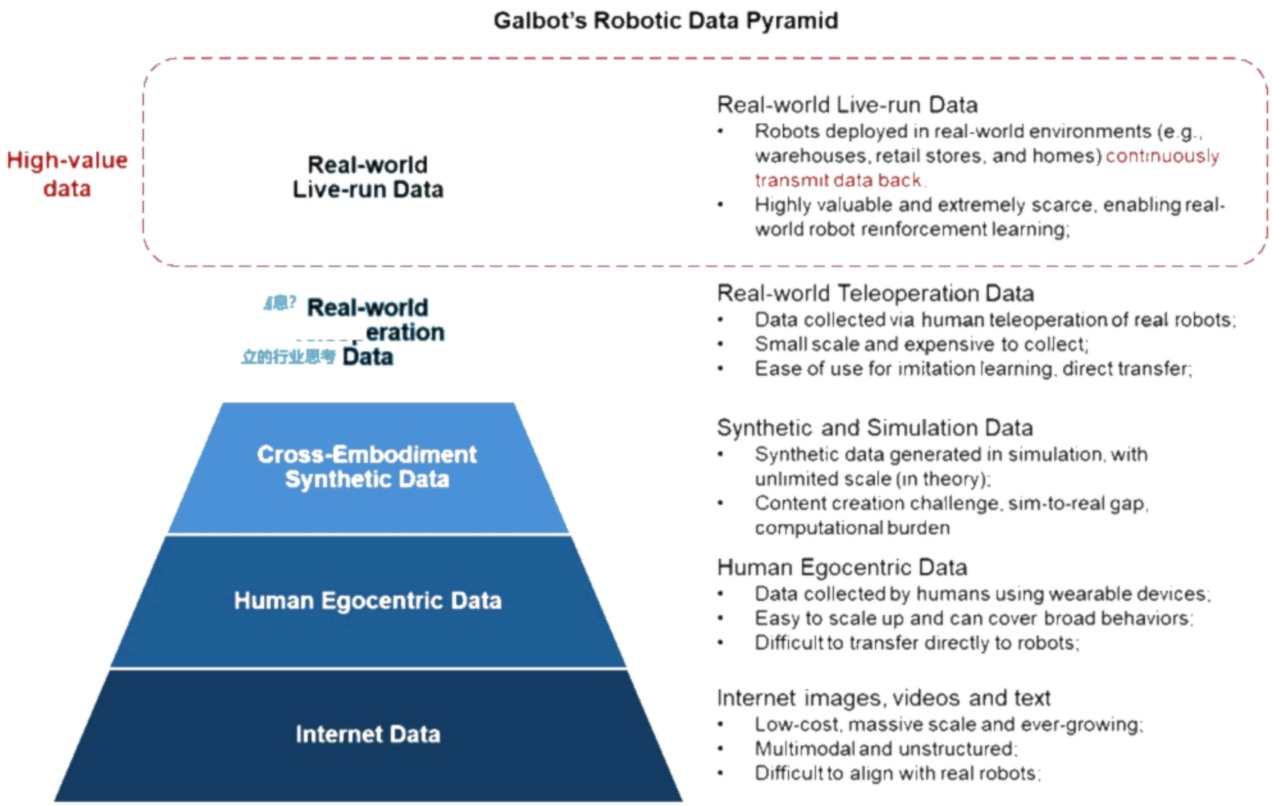
Note: The images were from "EgoScale: Scaling Dexterous Manipulation with Diverse Egocentric Human Data", "SONIC: Supersizing Motion Tracking for Natural Humanoid Whole-Body Control", "HumanoidMimicGen: Data Generation for Loco-Manipulation via Whole-Body Planning", and "GR00T N1: An Open Foundation Model for Generalist Humanoid Robots"
Source: NVIDIA, Bernstein analysis

EXHIBIT 8: **Mixed training data (e.g., simulation, real-world teleoperation, human videos, etc.) has become a major trend**



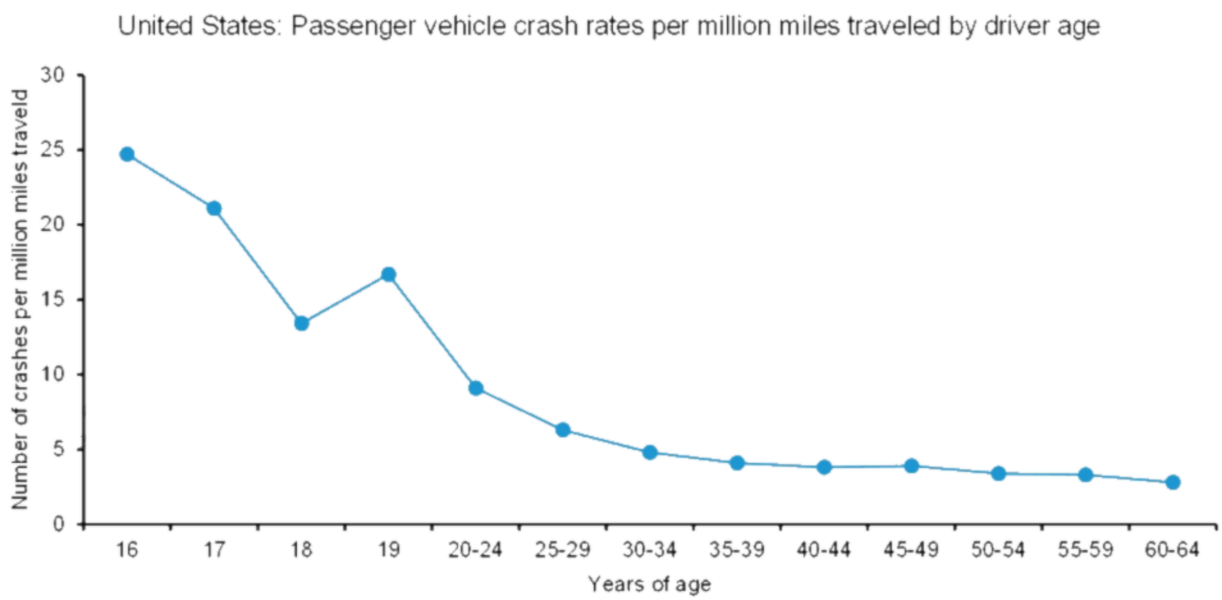
Source: "LDA-1B: Scaling Latent Dynamics Action Model via Universal Embodied Data Ingestion", Bernstein analysis

EXHIBIT 9: **Data pyramid proposed by Galbot: Real-world live-run data will be the most valuable**



Source: Galbot, Bernstein analysis

EXHIBIT 10: **New drivers have significantly higher crash rates, mainly due to a lack of real-world driving experience (similar to robots' lack of real-world live-run data)**

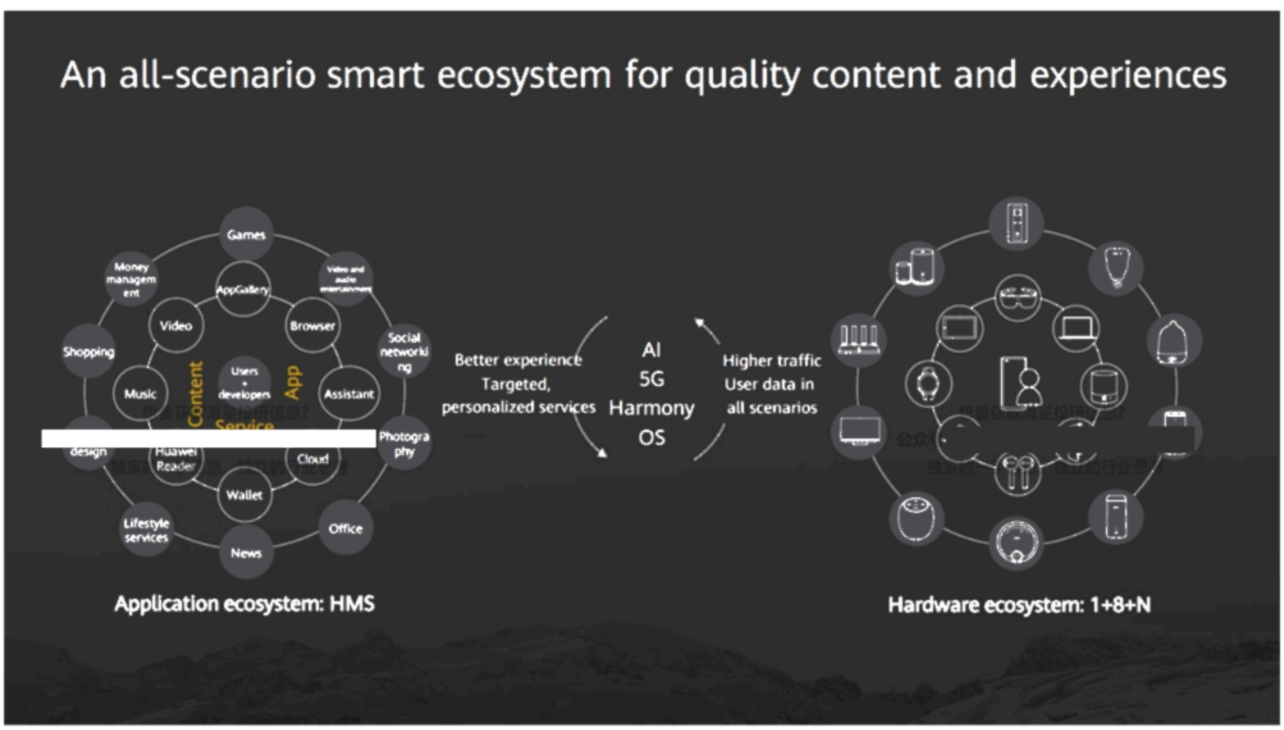


Source: U.S. Insurance Institute for Highway Safety (IIHS) and Highway Loss Data Institute (HLDI), Bernstein analysis

EXHIBIT 11: **An ecosystem creates a self-reinforcing loop that drives both user growth and retention**

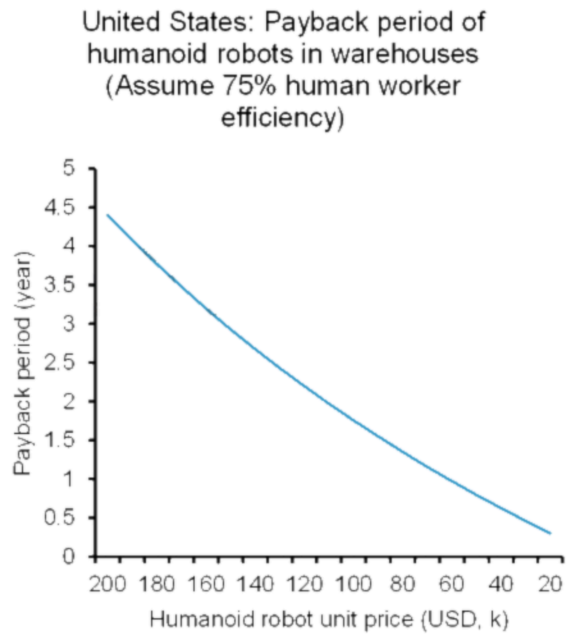
Source: Bernstein analysis

EXHIBIT 12: **Huawei has built an all-scenario HMS (Huawei Mobile Services) ecosystem with a comprehensive portfolio of hardware and applications**



Source: Huawei, Bernstein analysis

EXHIBIT 13: **The U.S.: Humanoid robot price vs. Payback period**

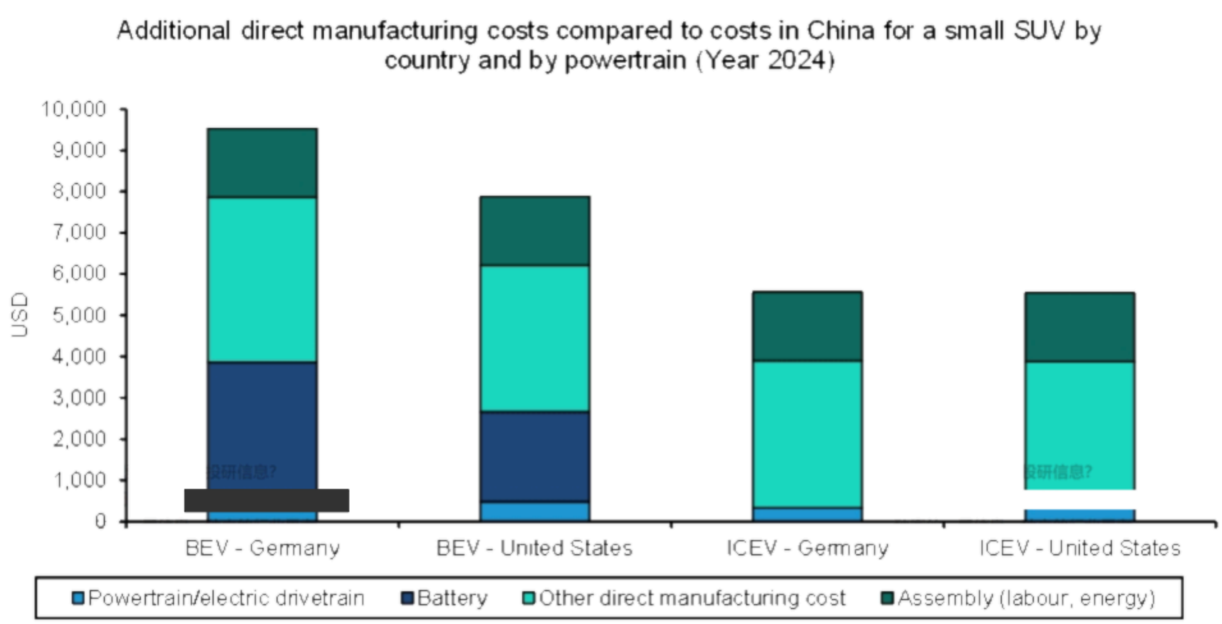


Source: US Bureau of Labor Statistics (BLS), Robozaps, Bernstein analysis and estimates

EXHIBIT 14: **China: Humanoid robot price vs. Payback period**

Source: China National Bureau of Statistics, Robozaps, Bernstein analysis and estimates

EXHIBIT 15: **Cost as a key moat: An example from the global automotive industry**



Source: IEA, Bernstein analysis

IP AND BRAND

Humanoid robots hold enormous promise for the consumer market, but adoption in the home may not be as straightforward as the technology roadmap suggests. Imagine walking into your home and being greeted not by a pet or a familiar voice assistant, but by a humanoid-shaped machine—a "hunk of metal" with human proportions, yet fundamentally unfamiliar. Despite its utility, such a presence could feel alien, even unsettling, to many households.

The challenge is not primarily technical—it is emotional and psychological. The value proposition of humanoid robots is clear: they could *eventually* handle household chores, serve as personalized entertainment or recommendation agents (*"What's everyone watching these days?"*), and act as a mobile embodiment of AI systems that already exists today. In fact, aspects like conversational intelligence or "mobile AGI" are arguably easier to deliver in the near-term than dexterous physical tasks like folding laundry or cooking. As a result, early consumer robots may be functionally limited—capable of moving around and interacting, but not yet fully replacing human labor in the home.

In this interim phase, when capabilities are still catching up to ambition, differentiation may matter less in what robots can do and more in how humans feel about them. This is where IPs could play an important role.

Familiar, beloved characters, such as Disney's Olaf (Exhibit 16) and Captain America, offer something that raw hardware cannot—instant emotional recognition, connection, and trust. A robot that looks and behaves like a known character can reduce the cognitive and emotional friction of introducing a new kind of "being" into the home. For children especially, interacting with a robot modeled after a friendly character could feel natural, even delightful, rather than awkward or intimidating.

In this case, IP acts as a bridge between cutting-edge technology and human acceptance. An Olaf-like robot does not just perform tasks—it embodies personality, narrative, and cultural familiarity. That familiarity can significantly increase users' tolerance for the robot's early limitations, whether those are functional constraints, occasional errors, or awkward movements.

Importantly, this suggests that the early competitive frontier in consumer humanoid robotics may not be defined solely by engineering prowess and supply chain advantage, but by ecosystem strategy. Companies that pair hardware and AI capabilities with strong IP could accelerate adoption curves by making robots feel less like tools and more like companions, perhaps even a family member.

Over time, as capabilities improve and robots become more seamless integrated into daily life, the importance of IP may diminish relative to utility. But in the early stages—when trust is fragile and expectations are still forming—recognition, familiarity, and emotional resonance may be an important adoption drivers.

In short, the difference between a "hunk of metal" and a character like Olaf is not just aesthetic—it could be the difference between hesitation and acceptance. And in a nascent market, that difference could shape the speed and trajectory of adoption.

EXHIBIT 16: **Disney has developed a robotic Olaf**

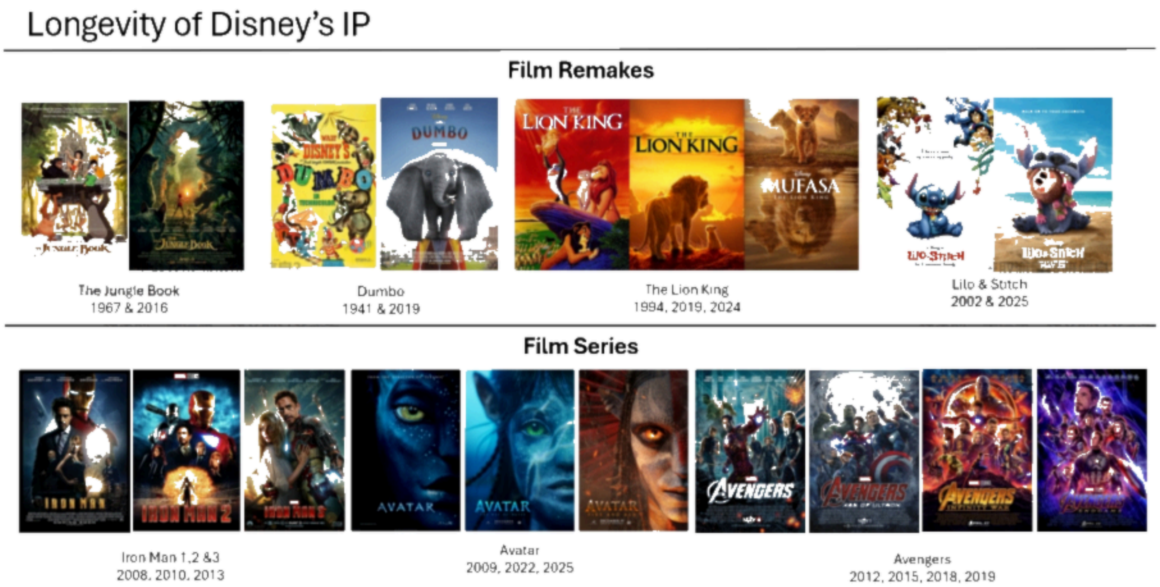
Olaf Robot

Source: "Olaf: Bringing an Animated Character to Life in the Physical World", Disney, Bernstein analysis

EXHIBIT 17: **Almost anything that creates popular recognition can technically be considered content IP… but only some content IPs evolve to become fashion; even fewer become evergreen in nature**

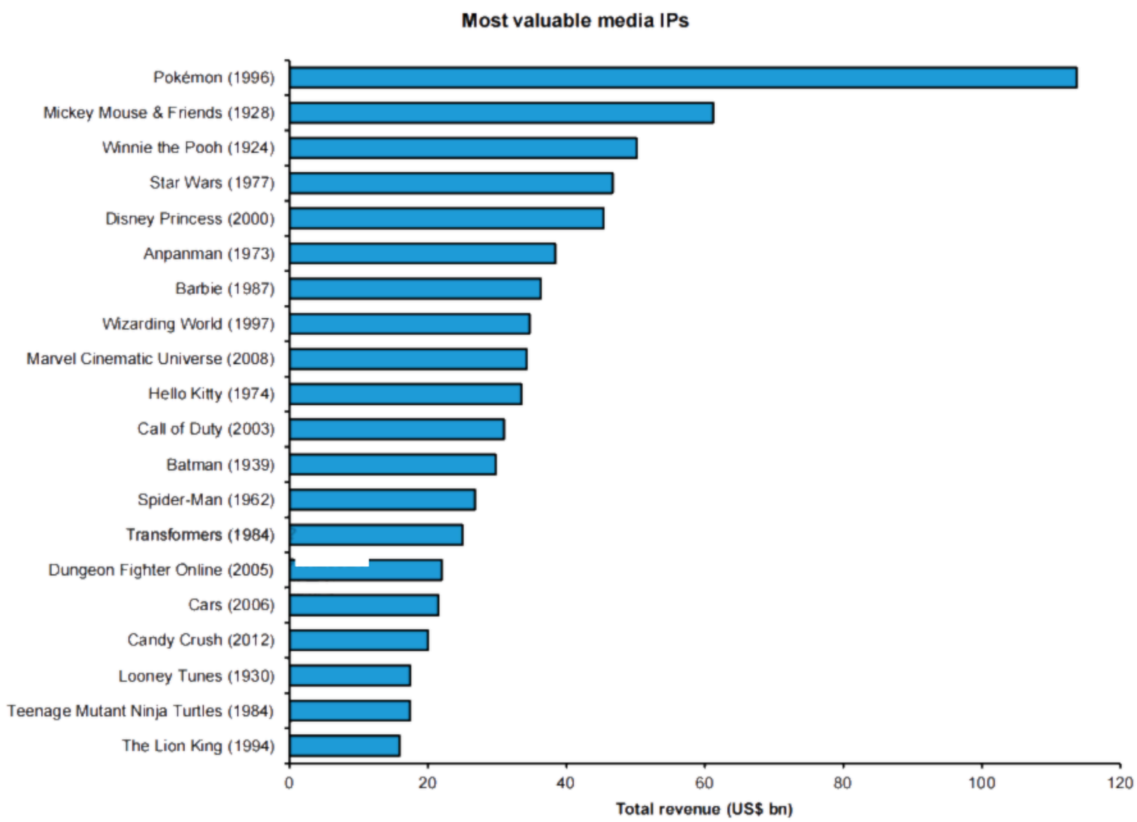
Source: Corporate reports, Wikimedia Commons, Twitter/X, and Bernstein analysis.

EXHIBIT 18: **Disney franchises and classics continue to generate value through remakes and sequels**



Source: Disney and Bernstein analysis.

EXHIBIT 19: **Creating new IP is difficult, but once established many top IPs have shown incredible longevity... the top 20 global IPs by revenue were created an average of 45 years ago**

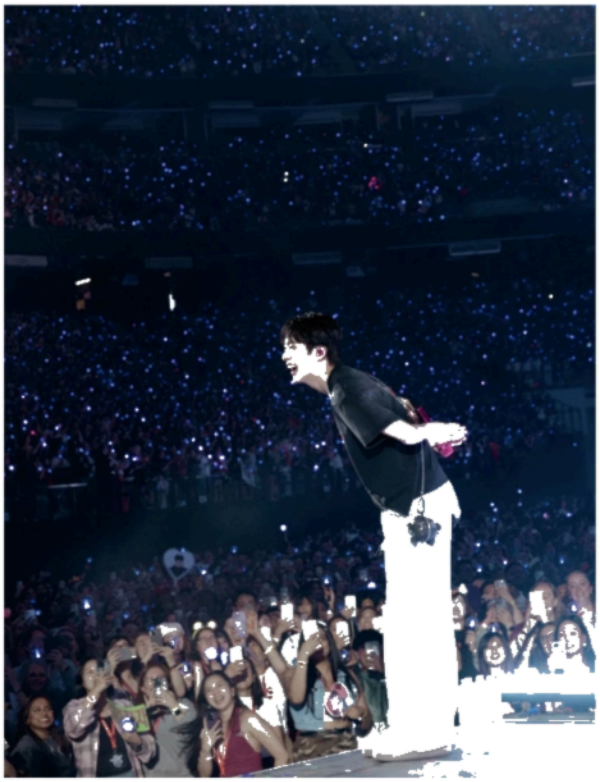


Source: Company websites, news, and Bernstein analysis.

FROM HUMAN SCARCITY TO SCALABLE PRESENCE...WHERE K-POP IP EXPANDS

K-pop IP has already crossed the threshold from artist-centric branding to globally scaled, fandom-driven platforms, where millions of highly engaged fans co-own the cultural relevance and continuously amplify demand. This creates a uniquely powerful launchpad for humanoid extension: a massive, emotionally invested installed base with proven high willingness-to-pay for access, intimacy, and status-driven experiences. In this context, humanoid embodiments are not speculative tech add-ons but a direct monetization lever - translating existing attachment into always-on interaction, deeper personalization, and new premium layers that can unlock incremental demand (Exhibit 20). The question is not whether the audience exists, but whether a model historically built on human scarcity can successfully evolve when that scarcity is no longer the binding constraint?

EXHIBIT 20: **K-pop IP is anchored in humans - and the scarcity of artist time is its core value. Humanoids based on K-pop IP could be a way to tap into a globally sticky fandom base. But here's the question: do fans pay to laugh and cry live with their bias, or for a robot that simply looks like them?**



Disclaimer: The following image was generated using AI (Copilot) based on a prompt to depict a humanoid-style representation inspired by BTS Jin, and does not reflect any real individual, endorsement, or official likeness.
Source: Instagram, Bernstein analysis.

COMPONENTS SUPPLIERS

Compared with humanoid robot OEMs, component suppliers have a clearer and more certain path to building moats. The approaches they have used to establish moats in their existing markets (e.g. automotive, consumer electronics, industrial) are likely to carry over into humanoid robotics. In addition, component suppliers typically have longer track records, making their competitiveness, corporate governance, and decision-making capabilities easier to assess and validate.

We believe the moats of component suppliers in humanoid robotics mainly come from three areas:

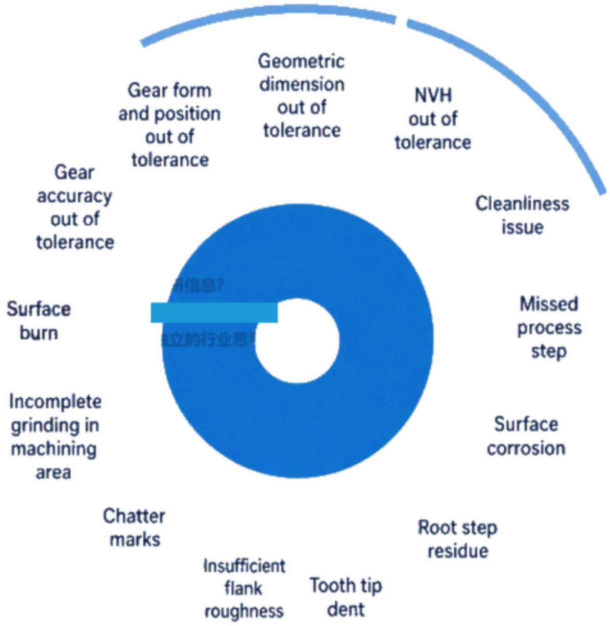
- **Superior quality control in mass production**. While many humanoid robot OEMs showcase in-house components, this does not imply readiness for true mass production. As output rises from small batches to millions of units, maintaining high quality becomes exponentially difficult, as any minor variations in materials, equipment, environment, or execution can lead to defects (Exhibit 21, Exhibit 22). Only companies that can rigorously control process variation end-to-end are able to deliver both high quality and high consistency at scale. In the automotive industry, for example, components suppliers are typically required to limit defect rates to as low as 50–80 parts per million units, while leading players even perform better, reflecting deep and hard-earned expertise in scalable quality control (Exhibit 23).

- **Cost leadership**. In China, technical complexity does not necessarily deter new entrants, but poor commercial viability often does. When component suppliers push manufacturing process control to the limit, leverage scale advantages, and earn only reasonable margins, low cost becomes the natural outcome of the system-level optimization, forming a sustainable competitive moat.

- **Rapid-response R&D**. Quality and cost control remain within the realm of traditional lean manufacturing capabilities. However, accelerated downstream iteration raises the bar for component suppliers: they must have strong rapid-response R&D capability to support customers' fast-evolving product development needs. This capability is essential for strengthening downstream partnerships and differentiating from other component suppliers. For example, Shuanghuan has gained share rapidly by co-developing customized actuators with robotic vacuum OEMs (Exhibit 24 and Exhibit 25); Tuopu has positioned itself as a Tier 0.5 supplier, engaging deeply in R&D with automotive OEMs.

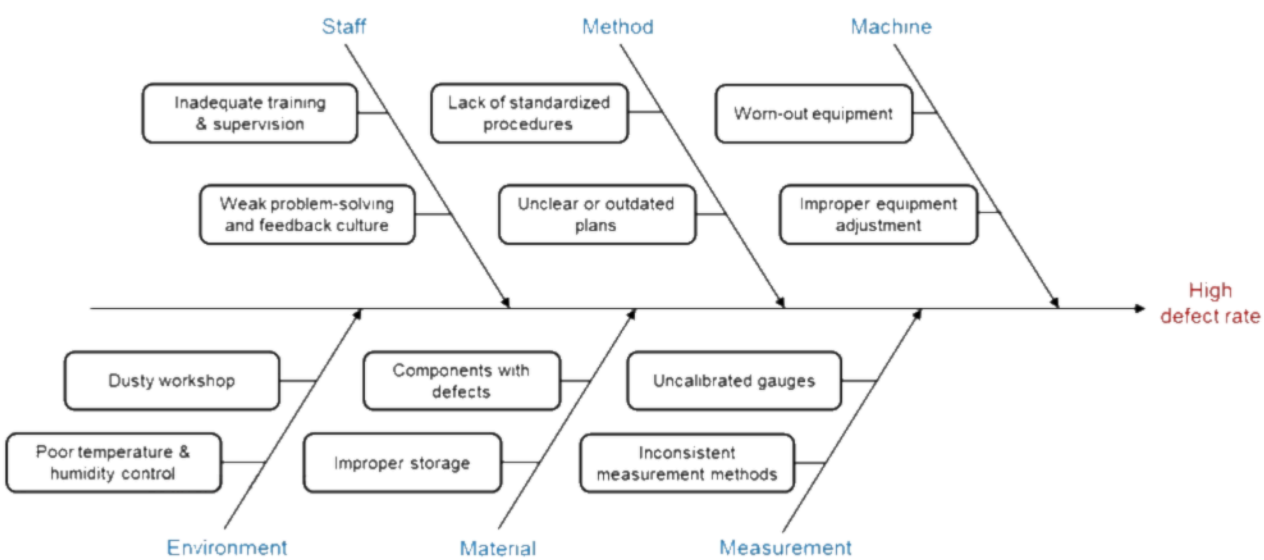
Among component suppliers, **Shuanghuan**, the global leader in gears & reducers, stands out as a rare player that has consistently gained market share across multiple verticals (Exhibit 26 to Exhibit 28), which we view as strong evidence that its competitive moat is already taking shape. In humanoid robotics, Shuanghuan has successfully penetrated Honor, a leading smartphone maker and a rising star in humanoid robotics. The company has also maintained partnerships with the leading robotic player in North America. We believe Shuanghuan's established capabilities and entry barriers position it well to expand further along the emerging robotics value chain, beyond the humanoids.

EXHIBIT 21: **Potential product quality issues in mass production of gears**



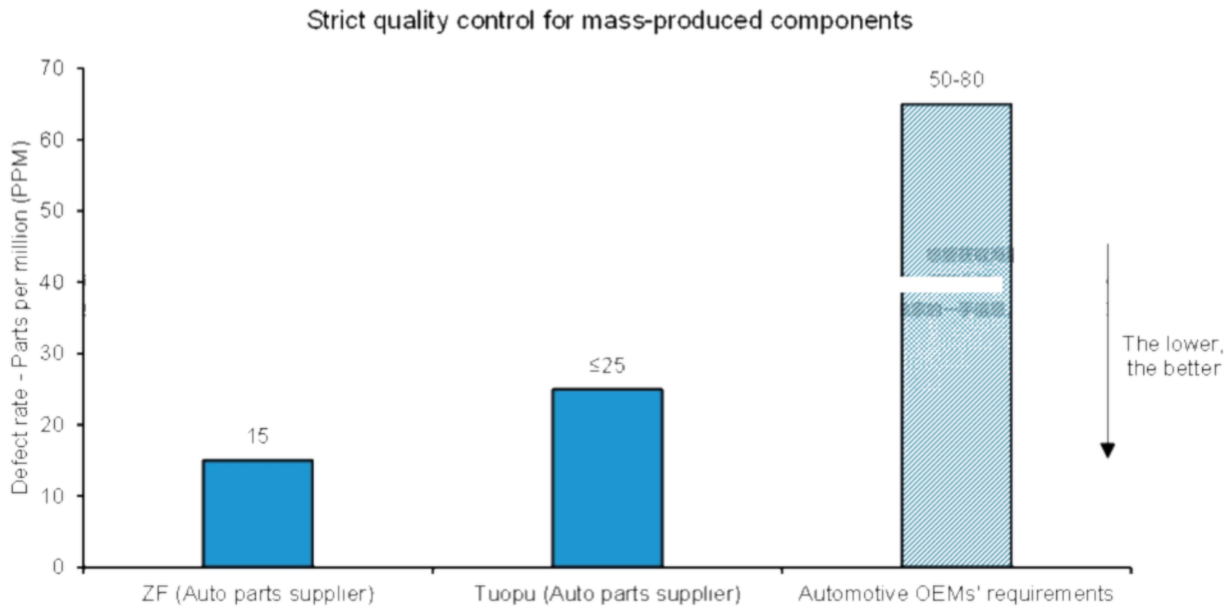
Source: Shuanghuan, Bernstein analysis

EXHIBIT 22: **Challenges of lean manufacturing: Any minor errors in management or execution can result in product quality issues**



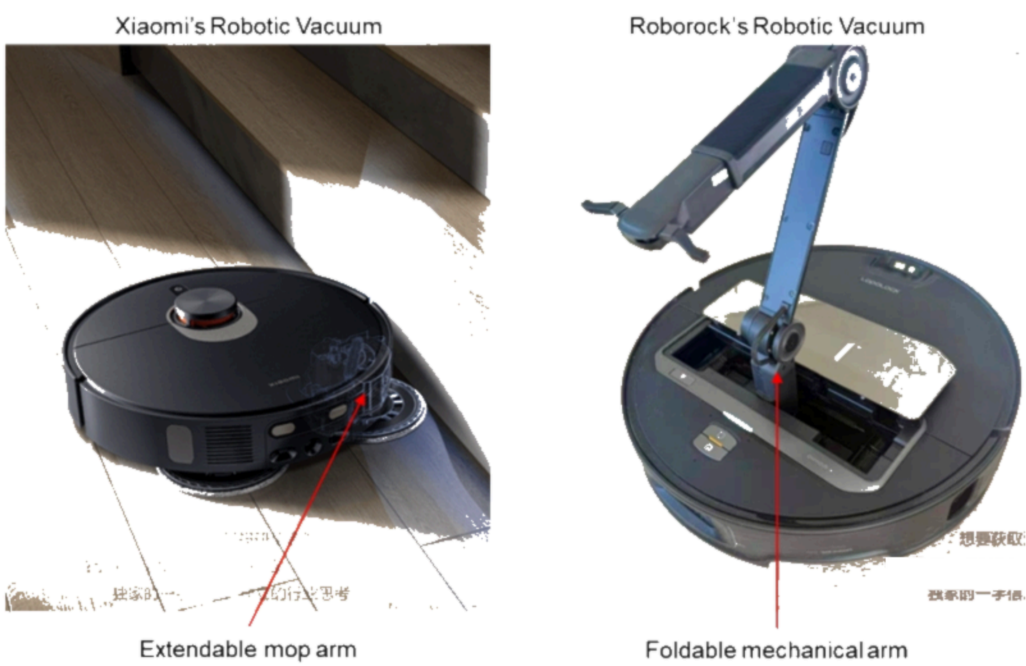
Source: "An application of Six Sigma to PPM reduction in the relationship with the external customer", Bernstein analysis

EXHIBIT 23: **Leading auto parts suppliers have extensive experience in mass-producing high-quality components with consistency**



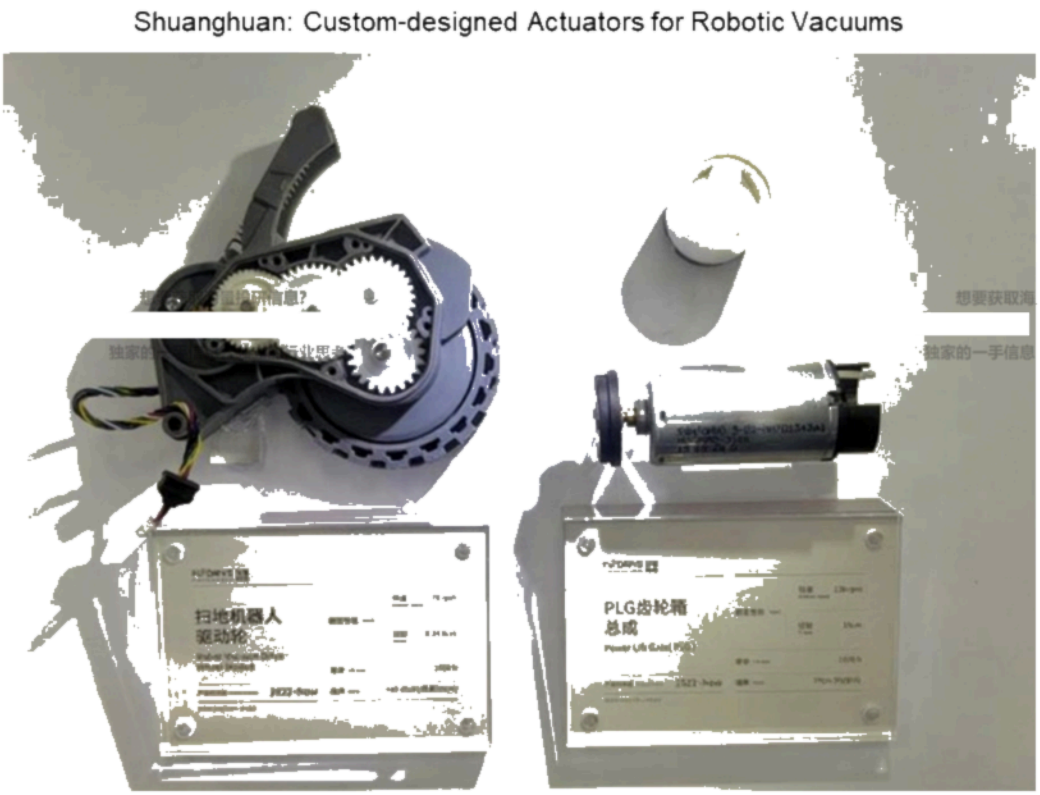
Note: Parts Per Million (PPM) is a quality metric used to quantify the number of defective units out of one million manufactured parts.
Source: ZF, Tuopu, XZB, Bernstein analysis

EXHIBIT 24: **Innovation in robotic vacuums requires rapid R&D support from component suppliers**



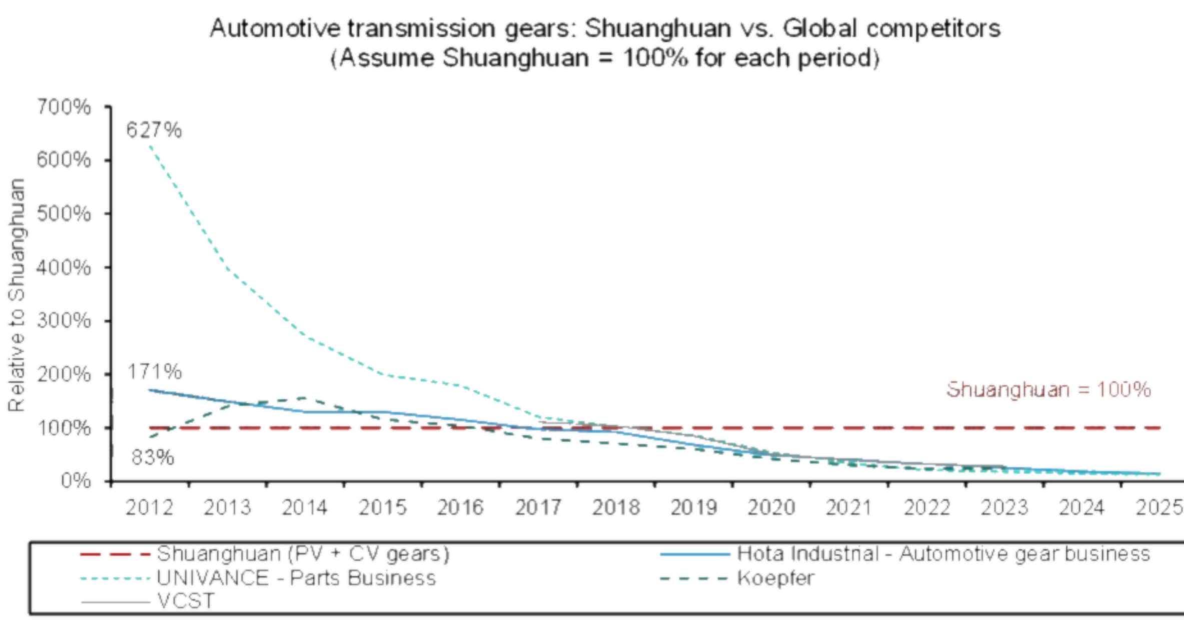
Source: Roborock, Xiaomi, Bernstein analysis

EXHIBIT 25: **Shuanghuan penetrated key robotic vacuum makers by offering rapid R&D support**



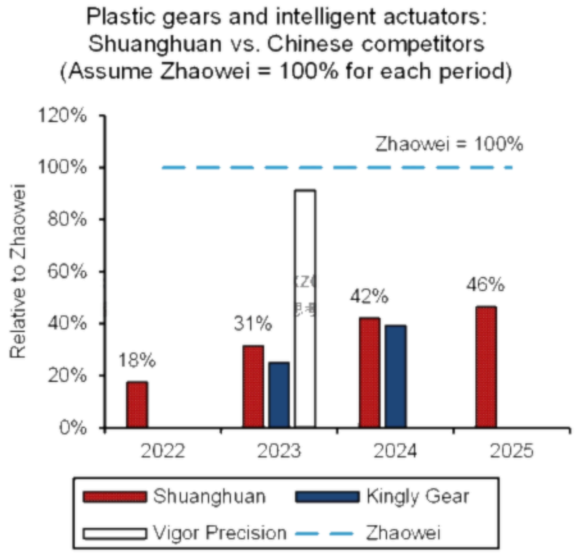
Source: Shuanghuan, Bernstein analysis

EXHIBIT 26: **Shuanghuan: Winning head-to-head competition with global competitors in automotive transmissiongears**



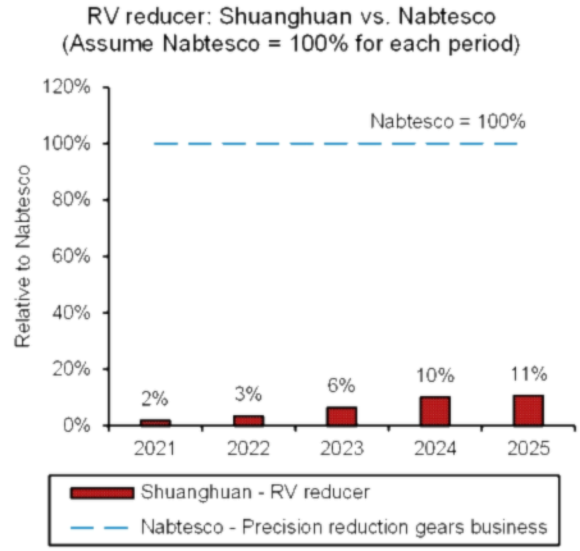
Note: PV refers to passenger vehicles; CV refers to commercial vehicles; We only adopt transmission gear related businesses in the comparison, instead of total revenue from the companies
Source: Company websites, company annual reports, Bernstein analysis and estimates

EXHIBIT 27: **Shuanghuan: Gaining share in non-metallic gears and intelligent actuators vs. Chinese competitors**



Source: Company websites, company annual reports, Bernstein analysis

EXHIBIT 28: **Shuanghuan: Gaining share in industrial robot RV reducers from global leader Nabtesco**



Source: Company websites, company annual reports, Bernstein analysis

INFINEON/RENESAS ARE SET TO CAPITALIZE ON ROBOTICS SURGE

Infineon is a key beneficiary

Infineon is well positioned to become a key semiconductor beneficiary of humanoid robotics, as the category brings together several of the company's strongest franchises: power, sensing, analog, MCUs, connectivity, security and memory. Management's latest divisional realignment is particularly relevant, as Infineon will restructure into three divisions, with the new Edge Systems division encompassing robotics as one of its key end applications.

Infineon's indicate an addressable content opportunity of around US$500 per humanoid robot, covering a broad range of functionalities such as processing, power, analog, storage, sensing, and connectivity. This includes microcontrollers, motor control ICs, and security ICs that enable local control and safety features. It also spans power components such as silicon and GaN-based switches, DC-DC conversion, and voltage regulators that support distributed power architectures. In addition, the content covers gate drivers, analog amplifiers, and data converters used for actuation and signal conditioning. Embedded storage is addressed through NOR flash and SRAM, while connectivity is enabled through technologies including Wi-Fi, Bluetooth, NFC, Ethernet, and EZ-USB (Exhibit 29).

The company also highlights a very broad sensor portfolio for humanoids, addressing around 200 sensors per robot, including environmental sensors such as pressure, vibration, SiMiC, ToF and radar, capacitive sensing for dexterous hands, more than 100 position sensors for joints, and current sensors for battery management. This is complemented by current sensors, pressure sensors, radar systems, microphones, 3D time-of-flight sensors, 3D sensors, angle sensors, linear sensors. This very broad sensor range is strengthened by the acquisition of ams OSRAM's analog mixed-signal sensor business, which adds complementary technologies (Exhibit 30).

The key advantage for Infineon is its breadth combined with system know-how. Management repeatedly highlights that customers value a "one-stop shop" that can cover silicon, SiC, GaN, analog and packaging, as well as system-level design. This is particularly relevant in humanoids, where power efficiency, thermal management and reliability are critical across many small subsystems. Infineon can supply the sensing layer, the control layer and the power layer, rather than just individual components

The growth opportunity is also supported by manufacturing and investment. Infineon is expanding capacity for power and analog technologies, including the Dresden facility. This fab targets advanced power and mixed-signal products and is designed to support high-growth markets such as AI, automotive and robotics.

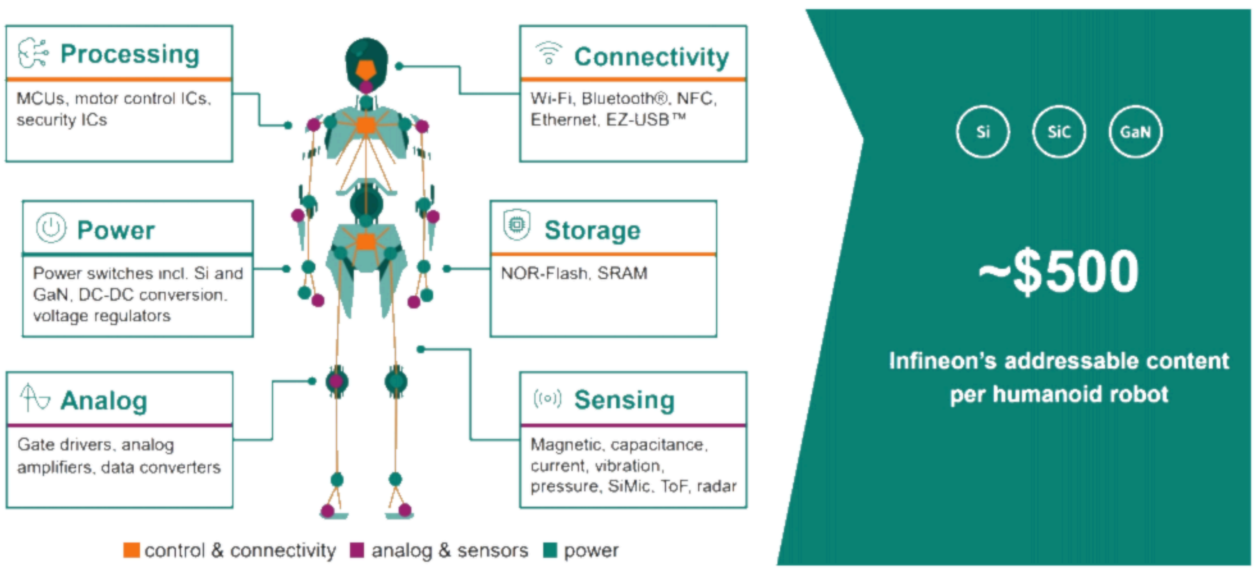
In summary, humanoid robotics represents a natural extension of Infineon's strategy. The company has exposure across most of the BOM, from sensors to power and control. Its portfolio is unusually broad, which allows it to address system-level needs rather than single components. As the humanoid market scales, this positioning should translate into meaningful content per unit and a long-term growth driver for the group.

Renesas: Another Key Beneficiary in Power Semiconductors

Similar to Infineon, Renesas is also well positioned to be a key semiconductor beneficiary of humanoid robotics, as the category converges across several of the company's core strengths, including power, analog, connectivity, sensors, MCUs, MPUs, and SoCs.

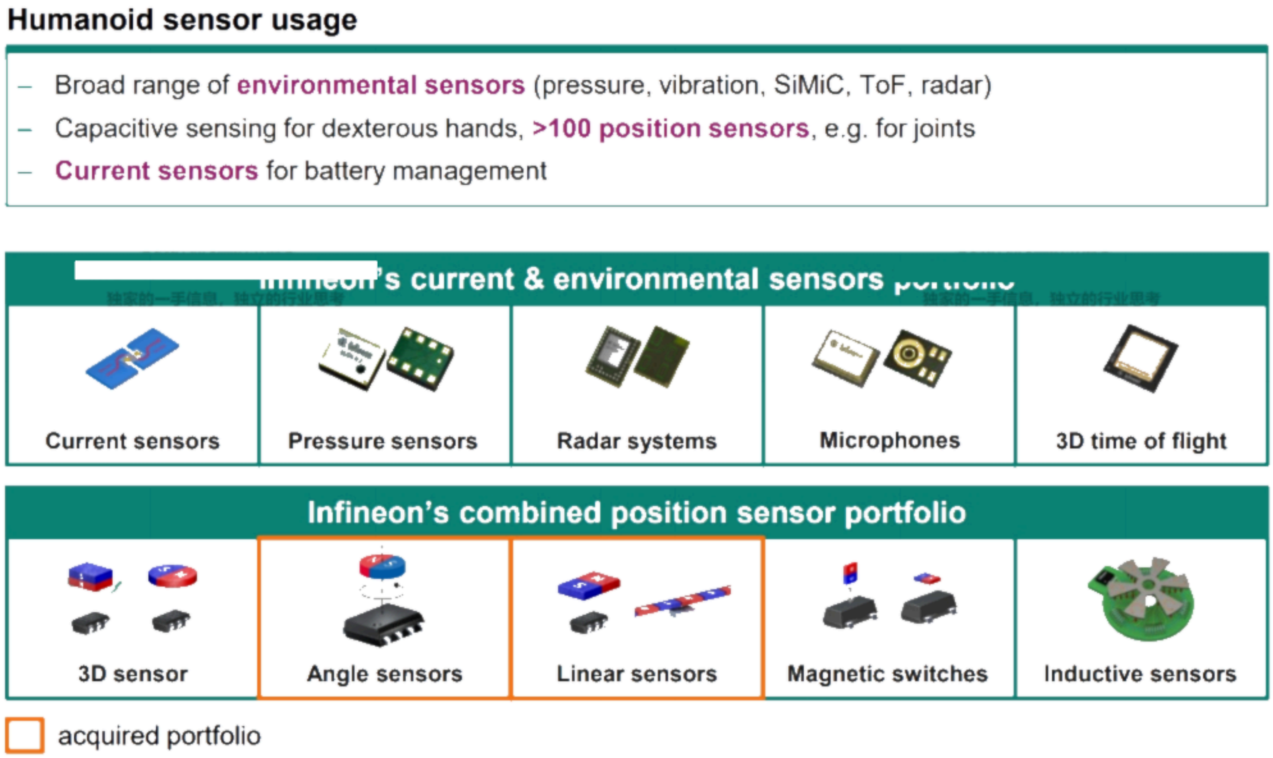
At Renesas' Capital Market Day (CMD) on 25th June 2026 (refer to [Renesas CMD 2026: AI infra to drive revenue doubling]), the company identified humanoid robotics as a key long-term growth driver. The company expects its edge and Physical AI businesses to outgrow the broader market, supported by rising penetration in high-growth segments, with humanoids representing the fastest-growing opportunity over the long term (Exhibit 31). Management also expects its SAM in humanoids to expand ~2.3x to ~70% of semiconductor BOM coverage by 2035 (vs. ~30% in 2025), while the robotics market is projected to grow at a 40% CAGR over 2035-40 (Exhibit 32, Exhibit 33).

EXHIBIT 29: **Infineon's broad portfolio enables ~$500 content per humanoid, spanning power, sensing, processing and connectivity, and covering Si, SiC and GaN technologies across the full system stack.**



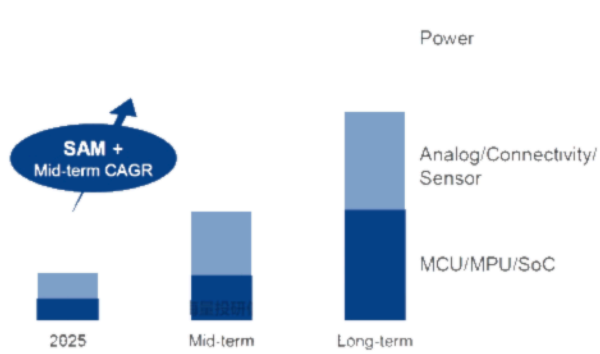
Source: Infineon

EXHIBIT 30: **Infineon's broad sensor portfolio addresses ~200 sensing points per humanoid, spanning environmental, position and current sensing, enabling precise motion control, perception and safe battery management across complex robotic systems**



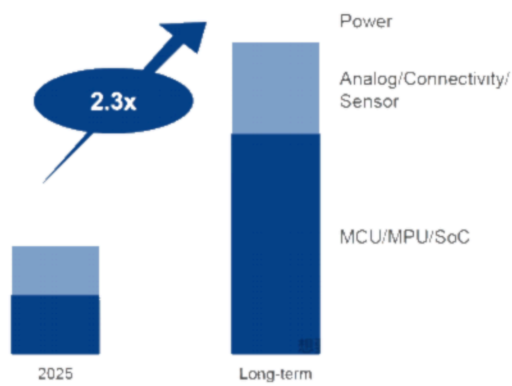
Source: Infineon

EXHIBIT 31: **Renesas' Edge/Physical AI - Mid-to-Long Revenue Target**



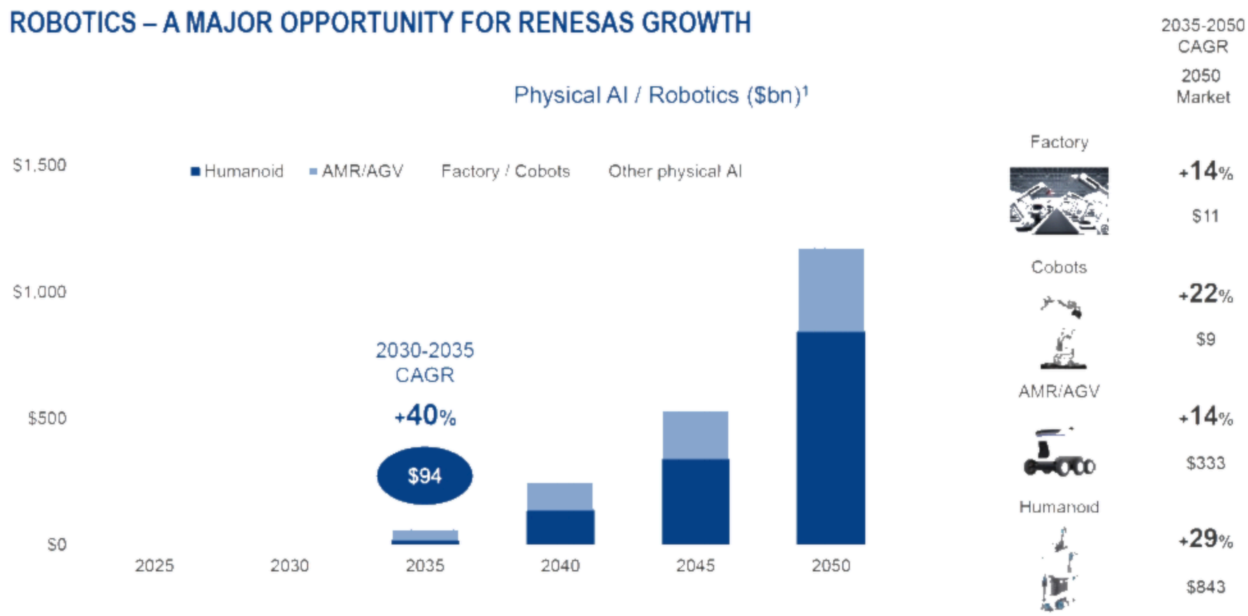
Source: Renesas

EXHIBIT 32: **Within Edge/Physical AI, Renesas' Targeted SAM for Humanoid**



Source: Renesas

EXHIBIT 33: **Physical AI and Robotics as Another Growth Driver in the Long Term**



Autonomous Vehicle is excluded. AMR (Autonomous Mobile Robot) / AGV (Automated Guided Vehicle) includes Drones. Classified industrial robots into "factory robots" and "cobots".
Source: Renesas

COMPUTE AND SOFTWARE PLATFORM PROVIDERS

NVIDIA

NVIDA's long-standing technology leadership in AI hardware extends into physical AI, under which robotics is a key focus area. They have meticulously cultivated an ecosystem where developers are able to build effective physical AI systems across many industries with a three computer approach. 1) NVIDIA DGX AI platform for training, 2) NVIDIA Omniverse, Cosmos, and Issac on RTX Pro servers for simulation, and 3) NVIDIA Jetson AGX Thor for on-robot inference.

NVIDIA DGX AI platform is an industry-leading AI infrastructure system solution, featuring compute, storage, networking and infrastructure management that are co-optimized to maximize performance. While there are many different configurations, the largest offering is the DGX Vera Rubin NVL72, a rack-scale solution with 72 Rubin GPUs and 36 Vera CPUs offering up to 3,600 PFLOPS of performance. Developers are able to pre-train their own robotics foundation models on the platform, but can also use NVIDIA's Cosmos foundation models or Isaac GROOT humanoid robot foundation models as base models for post-training.

NVIDIA Omniverse is the company's collection of libraries and services for physical AI simulation. The company has made notable progress developing the ecosystem to train and validate robots in physically accurate digital twins prior to real-world deployment. Recently, they launched Cosmos 3, an open world foundation model that unifies synthetic world generation, vision reasoning, and action prediction. NVIDIA Isaac is built on Omniverse libraries, and is a development platform that has simulation and robot learning frameworks essential to the creation of autonomous mobile robots, robot arms and humanoid robots (Exhibit 34). Unlike large language models, which primarily depend on text data, robotic training and validation rely heavily on simulation (Exhibit 35). This requires not only high-fidelity visual rendering (e.g., illumination, surface reflectance, and texture), but also robust physics engines capable of accurately modeling real-world dynamics (e.g., collisions, friction, joint constraints, fluid behavior, soft-body deformation). Despite continued advancements, a meaningful gap between simulation and reality still persists (Exhibit 36), impacting real-world robotic performance. As a result, scale matters and creates a powerful flywheel: NVIDIA's large user base generates continuous feedback and validation data. These inputs continuously help improve simulation fidelity and narrow the sim-to-real gap. In turn, a more accurate and reliable simulation stack becomes increasingly attractive to customers.

NVIDIA Jetson AGX Thor is the runtime computer for these physical AI systems that enables real-time autonomous robot functionality as robots need to process sensor data, reason and plan, and execute actions quickly. This on-robot inference requires multimodal AI reason models, Jetson AGX Thor is a compact solution with the performance needed to run those models as the hardware itself contains a 14-core Arm-based CPU, 2560-core Blackwell GPU and offers up to 2070 TFLOPS of AI performance (Exhibit 37).

QUALCOMM

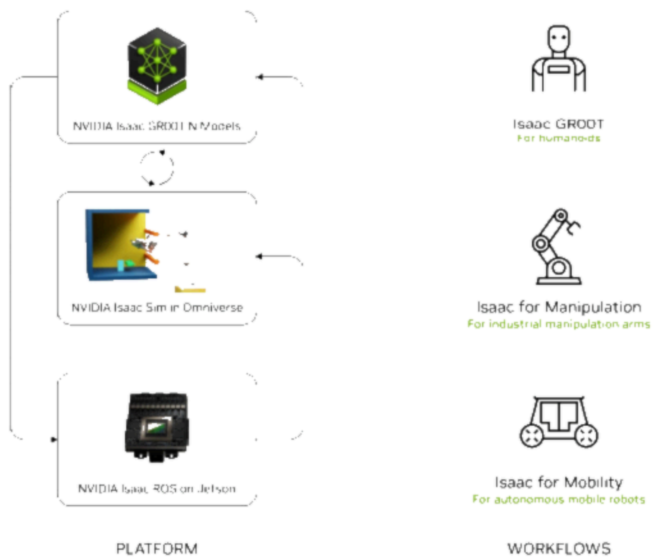
Qualcomm's broad semiconductor product portfolio also spans across the robotics space, with the company offering a full-stack solution that integrates hardware, software and compound AI. Their latest offering for instance, the Dragonwing IQ10 SoC recently announced in June, is targeted for the premium-tier and features an 18-core Oryon CPU, Adreno GPU, a dedicated NPU with up to 700 TOPS of performance, 20+ camera sensors, supports multi-OS and SDKs, and has built-in functional safety. This solution is intended to support the most advanced AMRs, humanoid robots, and other general-purpose robots and features a compact reference design (Exhibit 38). This functions of as the brain of the robot and contains perception IP for visualization, motion control IP for trajectory and balance, actuation and control IP for motor control, and wireless/wired IP for time-sensitive networking. Though the brain controller system is important and is where Qualcomm specializes now, they view humanoid robots as a decentralized system with three differ systems at the same time, the brain controller system, the body controller system, and an execution system. And the company intends to build embodiment across all these different systems (Exhibit 39). The Dragonwing IQ10 is shipping today and is designed into NEURA robots. The company aims to continue to garner design wins given their end-to-end solution stack as they build the hardware, generate the data and models, and deploy into customer environments.

Their portfolio ranges from high-end solutions like the Dragon 1Q10 series to simpler embodiments like the IQ9 still provides high AI performance, reliability, a compact form factor, and long-life support and is designed into cu products. The Dragonwing IQ-9075 SoC for instance, was built for the most demanding industrial-grade, compu edge AI devices in extreme temperatures. Their IQ-9075 module integrates the SoC, PMICs, and LPDDR5 memo compact, power-efficient, fanless designs (Exhibit 40).

At the low-end, they also offer the Dragonwing QRB2210, a cost-effective low-power processor for robotics and IoT applications. This features a quad-core Kyro CPU, Adreno 702 GPU, dual image signal sensors a dedicated DSP, and comprehensive connectivity options (Exhibit 41), offering power-efficient performance and optimized for thermally constrained, battery-powered, and space-limited devices.

Qualcomm has sized the 2035 Physical AI TAM at $1T, including Robotics, Automotive and Industrial IoT, and they believe that 1M+ robots will be deployed globally by 2035, from cobots, to mobile manipulators (AMMRs) to humanoids.

EXHIBIT 34: **The NVIDIA Isaac platform features simulation and learning frameworks for physical AI, including humanoid robots**



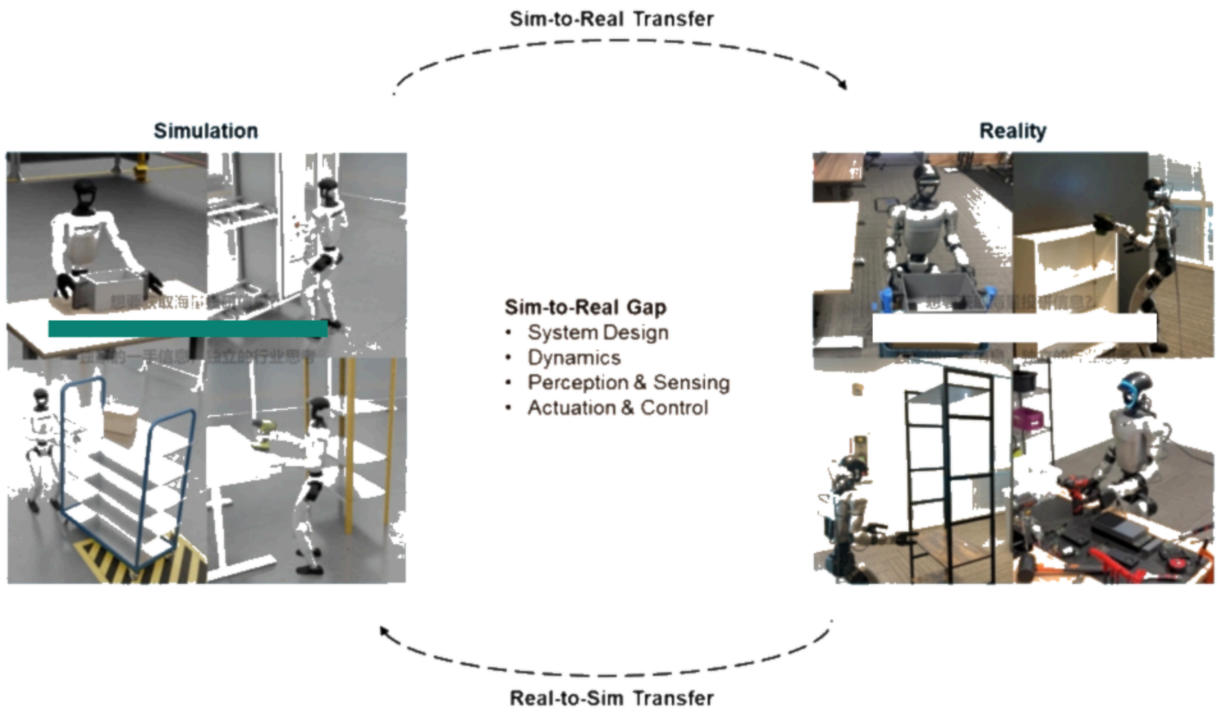
Source: NVIDIA, Bernstein analysis

EXHIBIT 35: **Major suppliers of robotic simulators**

Company	Region	Simulation environment	Physics engines	GPU-accelerated simulation?	Open source?
NVIDIA	USA	NVIDIA Isaac Sim	PhysX; Newton;	✓	✗
Google DeepMind	USA	MuJoCo (Acquired by DeepMind in 2021)	MuJoCo	✓	✓
Gazebo	USA	Gazebo	Bullet; ODE; DART; Simbody	✗	✓
Coppelia Robotics	Switzerland	CoppeliaSim	MuJoCo; Bullet; ODE; Newton; Vortex	✗	✓
Bullet Physics	USA	PyBullet	Bullet	✗	✓

Note: NVIDIA is covered by Bernstein U.S. Semiconductors team. Google is covered by Bernstein U.S. Internet. Others are not listed or covered by Bernstein.
Source: Simulately, SimBenchmark, company websites, Bernstein analysis

EXHIBIT 36: **Simulation is critical for robotic training, yet the sim-to-real gap remains a big hurdle**



Source: "HumanoidMimicGen: Data Generation for Loco-Manipulation via Whole-Body Planning", Bernstein analysis

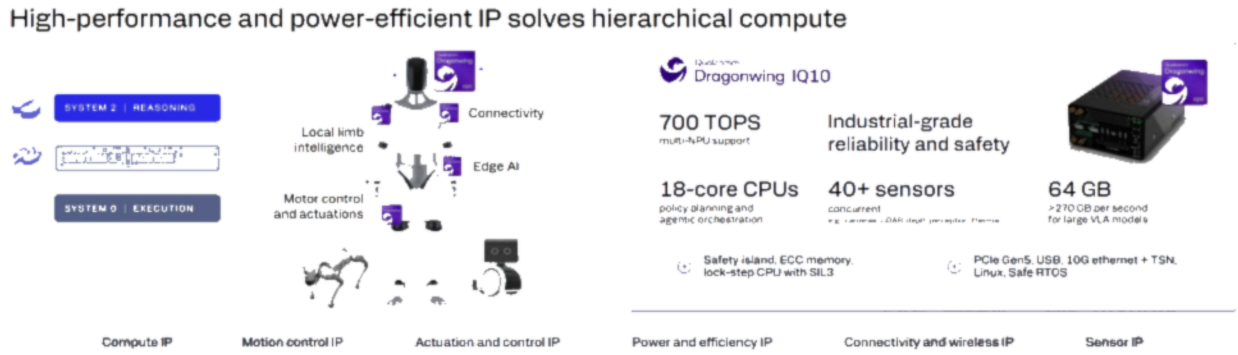
EXHIBIT 37: **NVIDIA Jetson AGX Thor specifications**

NVIDIA Jetson Thor Series

	Jetson AGX Thor Developer Kit	Jetson T5000	Jetson T4000
AI Performance	2070 TFLOPS (FP4—Sparse)		1200 TFLOPS (FP4—Sparse)
GPU	2560-core NVIDIA Blackwell architecture GPU with fifth-gen Tensor Cores Multi-Instance GPU (MIG) with 10 TPCs		1536-core NVIDIA Blackwell architecture GPU with fifth-gen Tensor Cores Multi-Instance GPU (MIG) with six TPCs
GPU Max Frequency	1.57 GHz		1.53 GHz
CPU	14-core Arm® Neoverse®-V3AE 64-bit CPU 1 MB L2 cache per core 16 MB shared system L3 cache		12-core Arm® Neoverse®-V3AE 64-bit CPU 1 MB L2 cache per core 16 MB shared system L3 cache

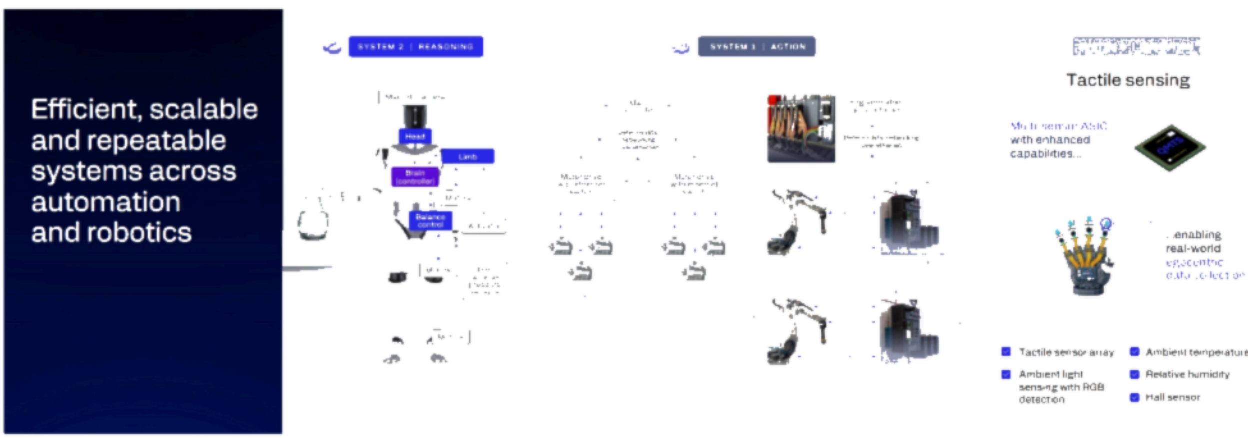
Source: NVIDIA, Bernstein analysis

EXHIBIT 38: **Qualcomm's Dragonwing 1Q10 is a central compute SoC for robotics applications**



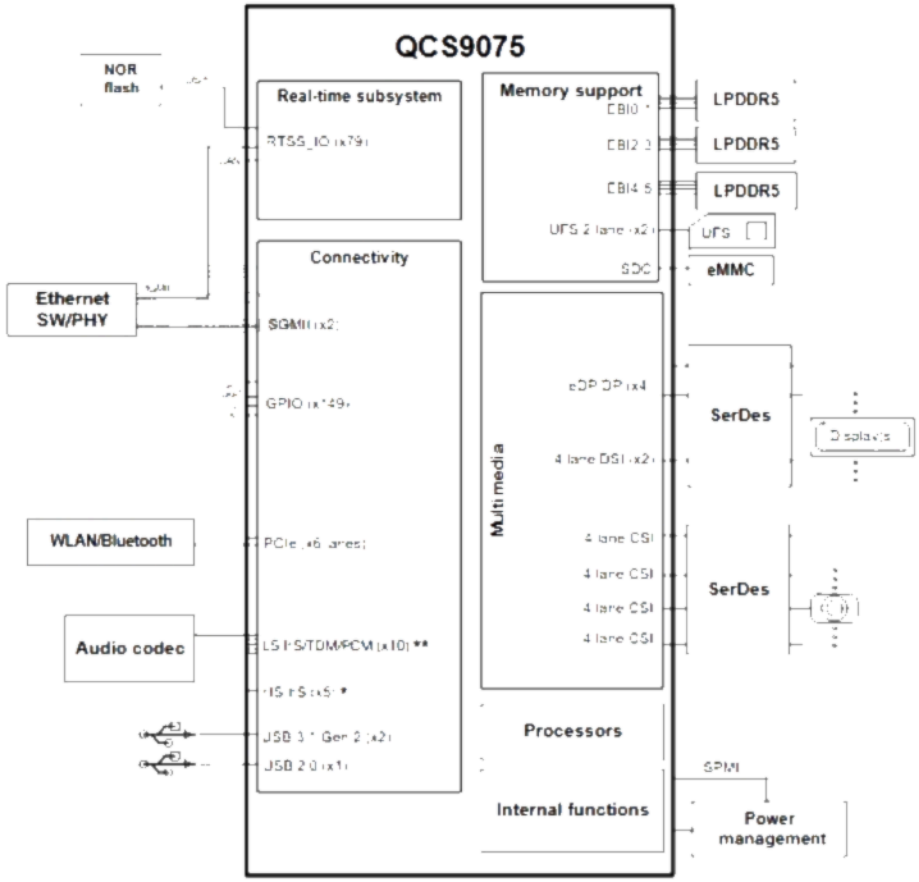
Source: Qualcomm, Bernstein analysis

EXHIBIT 39: **Qualcomm believes robotics systems will require decentralized solutions, containing a brain controller system, body controller system and execution system**



Source: Qualcomm, Bernstein analysis

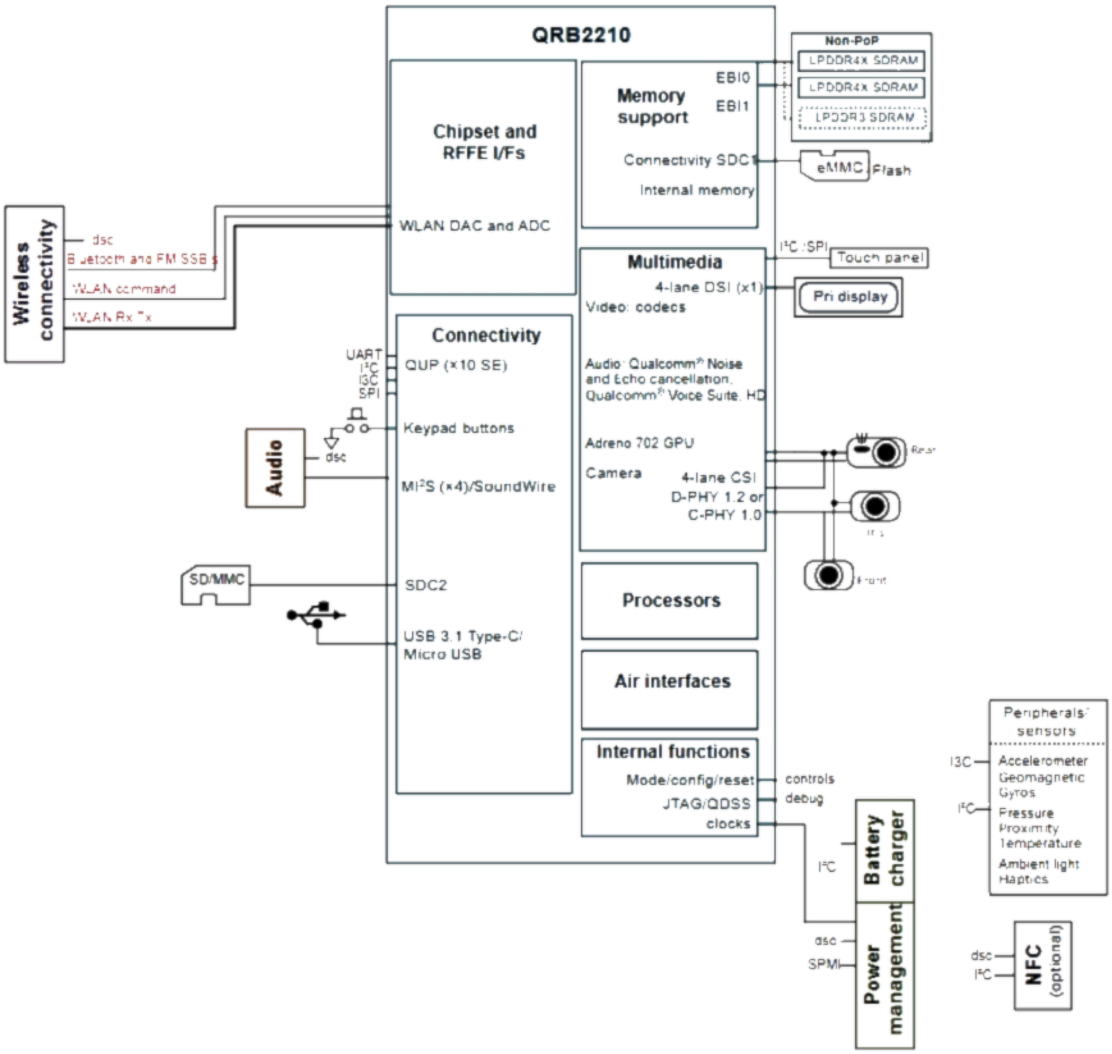
EXHIBIT 40: **High-level block diagram of the Dragonwing IQ-9075 Module**



* 2 of the 5 HS-I^{2}S interfaces are muxed behind I^{2}S interfaces
** 10 LS I^{2}S interfaces include 7 dedicated LS I^{2}S and 3 dedicated HS I^{2}S reconfigured as LS I^{2}S interfaces

Source: Qualcomm, Bernstein analysis

EXHIBIT 41: **High-level block diagram of the QRB2210 SoC**



Source: Qualcomm, Bernstein analysis

INVESTMENT IMPLICATIONS

We rate **Shuanghuan**, **Hesai**, **Tuopu**, **Nintendo**, **Tencent**, **Hybe**, **HDSI**, and **Inovance** Outperform, **Sanhua** Market-Perform, and **Leader Drive** Underperform.

We rate **Sony Market-Perform** with PT = **¥3,500.00**.

We rate **Infineon Outperform** with PT = **€102.00**.

We rate **Renesas Outperform** with PT = **¥6,300.00**.

We rate **Disney Outperform** with PT = **$129.**

QCOM (Market-Perform, $235.00): Memory headwinds appear likely to pressure smartphone builds and numbers still appear high though the datacenter narrative sounds promising.

NVDA (Outperform, $315.00): The datacenter opportunity is enormous, and still early, with material upside still possible.

BERNSTEIN TICKER TABLE

			25 Jun 2026		TTM	Reported EPS				Reported P/E (x)		
			Closing	Price	Rel.							
Ticker	Rating	Cur	Price	Target	Perf.	Cur	2025A	2026E	2027E	2025A	2026E	2027E
HSAI.US (Hesai)	O	USD	15.02	30.00	(71.7)%	CNY	2.92	3.31	5.27	35.0	30.9	19.4
2525.HK (Hesai)	O	HKD	114.30	238.00	NA	CNY	2.92	3.31	5.27	33.9	30.0	18.8
688017.CH (Leader Drive)	U	CNY	369.46	115.00	160.9%	CNY	0.69	0.83	0.96	533.6	442.9	384.2
601689.CH (Tuopu)	O	CNY	52.75	75.00	(24.6)%	CNY	1.61	1.81	2.36	32.8	29.2	22.4
2050.HK (Sanhua)	M	HKD	24.36	27.00	(39.3)%	CNY	1.03	0.97	1.11	20.5	21.7	19.1
002050.CH (Sanhua)	M	CNY	41.50	39.00	22.1%	CNY	1.03	0.97	1.11	40.3	42.7	37.5
002472.CH (Shuanghuan)	O	CNY	37.15	60.00	(20.0)%	CNY	1.50	1.70	2.00	24.8	21.8	18.6
352820.KS (Hybe)	O	KRW	188,200	400,000	(78.5)%	KRW	(5,713.11)	10,055	10,175	(32.9)	18.7	18.5
7974.JP (Nintendo)	O	JPY	6,589.00	10,300	(93.1)%	JPY	364.51	350.74	423.85	18.1	18.8	15.5
6758.JP (Sony)	M	JPY	3,199.00	3,500.00	(52.1)%	JPY	171.30	198.75	207.66	18.7	16.1	15.4
SONY (Sony)	M	USD	19.32	22.00	(42.2)%	USD	1.08	1.25	1.30	18.0	15.5	14.8
700.HK (Tencent)	O	HKD	413.20	780.00	(56.2)%	CNY	28.09	30.00	34.91	12.8	11.9	10.3
IFX.GR (Infineon)	O	EUR	82.01	102.00	106.4%	EUR	1.38	1.74	2.94	59.3	47.1	27.9
6723.JP (Renesas)	O	JPY	4,800.00	6,300.00	134.4%	JPY	181.61	244.76	298.54	26.4	19.6	16.1
DIS (Disney)	O	USD	98.05	129.00	(39.0)%	USD	5.93	6.85	7.37	16.5	14.3	13.3
NVDA (NVIDIA)	O	USD	195.74	315.00	6.5%	USD	4.77	9.19	12.52	41.0	21.3	15.6
QCOM (Qualcomm)	M	USD	204.90	235.00	9.8%	USD	12.03	10.64	10.16	17.0	19.3	20.2
300124.CH (Inovance)	O	CNY	63.28	82.00	(38.3)%	CNY	1.87	2.19	2.65	33.8	28.9	23.9
6324.JP (HDSI)	O	JPY	7,100.00	7,800.00	105.9%	JPY	16.99	57.37	79.51	417.9	123.8	89.3
ASIAX			1,963.59									
JPL			2,600.90									
SPX			7,354.02									
EDME			1,580.77									

O - Outperform, M - Market-Perform, U - Underperform, NR - Not Rated, CS - Coverage Suspended

352820.KS, 700.HK, IFX.GR, 6723.JP, DIS, NVDA, QCOM estimate is Adjusted EPS; 352820.KS, 700.HK, IFX.GR, 6723.JP, DIS, NVDA, QCOM valuation is Adjusted P/E (x); 7974.JP, NVDA base year is 2026;

Source: Bloomberg, Bernstein estimates and analysis.