OurCrowd

# AI Race to the Edge: The Next Investment Frontier

June 2024

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## Takeaway Points

- "The Edge" is a big place and describes distributed devices like cars, cameras, and cellphones, among many others, where AI-based computing is performed.
- Large industries will see growth driven by AI-edge chip adoption and upgrading including automotive, cameras (e.g., in smart cities), and internet of things (IoT) devices (e.g., in smart homes). Projected high compound annual growth rates (CAGR) are expected in these industries affecting both public and private company financial performance.
- Edge devices collect, process, and transmit data from an endpoint of a network across multiple sectors including consumer, finance, defense, government, and manufacturing. AI enables edge devices to become more intelligent entities with real-time processing and autonomous capabilities.
- AI functionality in edge devices is limited by constraints of size, processing, energy consumption, latency, memory, and cost – especially in the consumer market.
- Recent innovations in AI chip technology are enabling energy efficient, low latency, cost effective integration into edge devices.
- Investment in global edge computing semiconductors rose an estimated 500% between 2022 and 2023.[1]
- Multiple vulnerabilities in the supply chain from critical materials to cyber threats, as well as talent shortages, scaling complexities, ad hoc regulatory change, and IP threats can pose significant risks to AI semiconductor manufacturers.
- AI capabilities "on the edge" will be the catalyst for a new generation of edge devices, presenting investment opportunities not only in further chip advances, but also in the redesign and creation of innovative devices.

## Revolution on the Edge

In September 2023, the Financial Times reported that OpenAI was in discussions with SoftBank for a $1B investment to build OpenAI's first consumer device - an edge device described as the "**iPhone of artificial intelligence**."[2] According to the FT, OpenAI hired Apple's original designer, Jony Ive, to design the transformative device.

The gauntlet was thrown in the race to dominate the edge sector and shortly thereafter it was reported that Apple would be investing $1B per year to integrate generative AI (GenAI) across its product lines, and that it was talking to both Google and China's Baidu to bring their AI models to the next iPhone.[3] If Apple manages to pull this off successfully, the only painful news for Apple fans will be that the entwined lines witnessed around Apple's flagship Manhattan store for the first pre-orders of the iPhone 15 will be even longer with the release of their first fully AI-enabled device.

## Age of Operating on the Edge

We are all operating on the edge. Our smartphones, tablets, wearables and medical monitoring equipment, autonomous vehicles, and everything connected to the internet of things (IOT) are

[1] Source: Pitchbook data
[2] https://www.ft.com/content/4c64ffc1-f57b-4e22-a4a5-f9f90a7419b7
[3] https://www.firstpost.com/vantage/big-tech-launches-a-war-to-dominate-artificial-intelligence-space-vd7164/

edge devices – endpoints or nodes in a network which serve as intermediaries between the physical world and centralized computing resources, continually logging and communicating information to data centers. AI can empower edge devices to perform autonomous and more highly complex tasks locally such as object detection and recognition, anomaly detection, natural language processing, health monitoring and diagnosis, autonomous navigation, and deployment of custom machine learning models without having to communicate with a data center or cloud server. Moreover, with the emergence of GenAI, a move from cloud to edge applications has the potential to bring the power of large language models (LLMs) and other generative applications as close to the user as possible, enabling them to run independently of network connectivity while maintaining privacy and securing people's personal information.

Hyperscalers[4] (e.g., AWS, Google, Microsoft, and Meta) and semiconductor manufacturers are increasing investments in AI on the edge, bringing GenAI, inferencing, and other unique AI features closer to the end users on edge devices. Hyperscalers have been heavily investing in edge AI technologies to extend their cloud services to the edge, enhance IoT capabilities, and support edge computing across diverse applications and industries, with use cases including autonomous vehicles, smart cities, and industrial automation. In addition to acquiring and investing in multiple edge computing startups, these tech giants are themselves developing edge AI platforms, specialized AI accelerators, and system-on-chips (SoCs) optimized for edge deployment. They are also partnering with hardware manufacturers, establishing partnerships with telcos on 5G edge infrastructure, and embedding their platforms into operators' infrastructure.

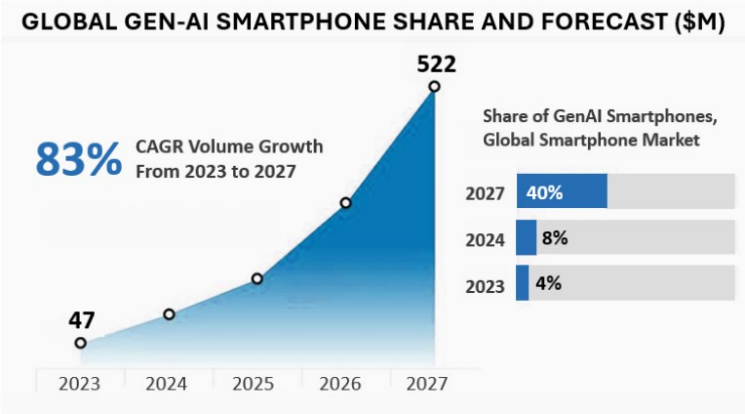
The ability to efficiently incorporate and operate AI chips in edge devices also opens new opportunities for innovation in edge equipment. AI integration in edge computing will be the catalyst for new generations of edge devices in use cases ranging from the transformation of the mobile phone presaged by the investment in OpenAI's new mobile phone venture, to a new generation of IoT devices, autonomous vehicles, and Industry 5.0. The **synergies between new AI hardware features and these new edge devices will create significant investment opportunities** for both emerging chip developers and device manufacturers.

A small sampling of the market use cases where AI will be the catalyst for redesigning and introduction of new edge devices include:

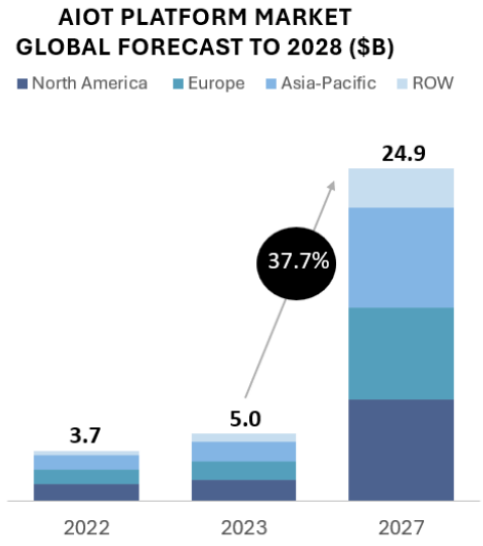
- Smartphones and tablets
- AI internet of things (AIoT) including smart homes, transportation, healthcare, and manufacturing (Industry 5.0)
- Autonomous vehicles (AVs)
- Smart cameras and surveillance systems
- Wearable devices
- Retail and point-of-sale systems
- Environmental monitoring systems
- Surgical and other hospital applications
- Online gaming

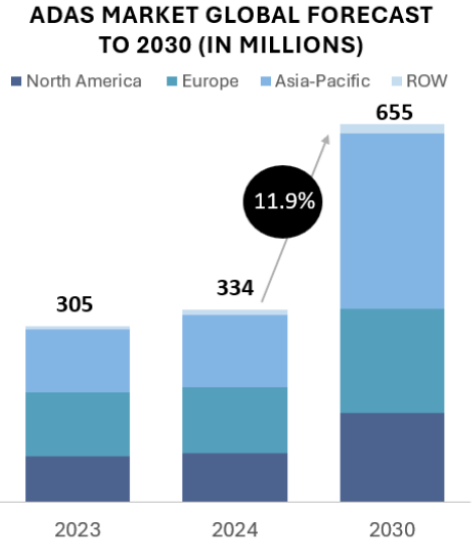
[4] Large cloud service providers

The potential for new innovative devices on the market is evident in the impact of AI on mobile phones, AIoT, and AVs. Counterpoint Research projects that sales of next generation AI-enabled smartphones will jump from 47M units (4% of total units) in 2023 to 522M units (40% of total units) in 2027 at a compound annual growth rate (CAGR) of over 80%.[5]




For AIoT devices, MarketsandMarkets forecasts that advances in edge computing will be a major catalyst in the growth of AIoT deployment which it projects will increase from $5B sales in 2023 to $25B in 2028, at a CAGR of almost 38%.[6]

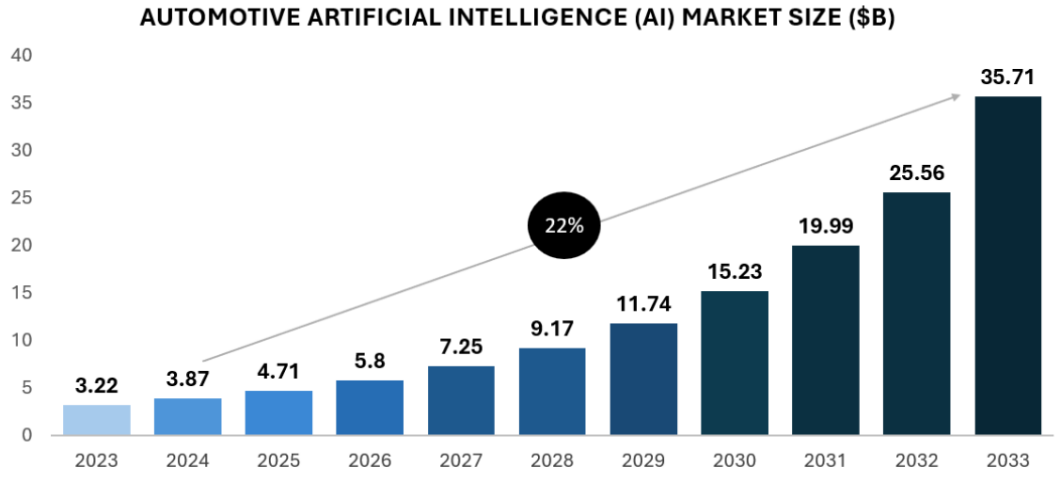



The technology of advanced driver-assistance systems (ADAS), which had its origins in the 1970s with the first anti-lock braking systems, has also been transformed by AI. Starting with companies like Mobileye (NASDAQ: MBLY), AI enabled ADAS systems to autonomously analyze data from multiple sensors in vehicles including cameras, LiDAR, and radar. Mobileye, which has an estimated 65-70% market share of the ADAS industry,[7] utilizes AI in conjunction with sophisticated algorithms and machine learning techniques to interpret visual data captured by cameras installed in vehicles. Mobileye was acquired by Intel for $15B in 2017. Prior to acquisition, Mobileye raised $600M from private equity funds.[8] The company was publicly listed on the NASDAQ in 2022 at a valuation of $17B and is currently valued at almost $26B. MarketsandMarkets projects that the ADAS market will grow from 334M units in 2024 to 655M units by 2030, at a CAGR of about 12%.[9]

[5] https://www.counterpointresearch.com/insights/over-1-billion-generative-ai-smartphones-to-be-shipped-cumulatively-during-cy-2024-2027/
[6] https://www.marketsandmarkets.com/Market-Reports/aiot-platform-market-4544896.html
[7] https://www.marketbeat.com/originals/mobileye-gets-poked-on-weak-forecasts-buying-opportunity/#:~:text=Mobileye%20has%20an%20estimated%2065,over%20125%20million%20vehicles%20worldwide
[8] Source: Pitchbook
[9] https://www.marketsandmarkets.com/Market-Reports/driver-assistance-systems-market-1201.html

Overall, the global automotive AI market size was estimated to be $3.2B in 2023. By 2033, the market is expected to reach around $36B, increasing at a CAGR of 22% between 2024-2033.[10]




## Challenges at the Edge

AI chips have been used by centralized enterprise computers since 2016 when Google launched its tensor processing unit (TPU) designed specifically for AI workloads. However, most edge devices do not have the processing power, memory, or energy resources to support the chips that enable enterprise AI functionality. Existing processors for automotive and other smart devices were not designed for deep-learning tasks. For smart homes and smart cities to operate effectively, IoT devices must process an enormous quantity of data while factoring in potential latency and speed issues. Autonomous vehicles (AVs) that are being tested on public roads currently require complex, expensive, bulky data centers in their trunks, with high energy requirements. A full high-definition real-time camera operating in the AV needs the full capacity of a data-center-scale graphics processing unit (GPU), consuming dozens of Watts and, as a result, also an active cooling system.

Growing demand for high functioning edge devices is pushing innovation in chip architecture, as well as supporting integration infrastructure. New developments in AI processing chips are making the integration of AI into edge devices possible. Architectural innovations enabling significant size reduction and lower energy requirements are enabling companies to develop advanced processors dedicated to AI tasks on edge devices in a wide variety of applications. For example, the use of dataflow-based processing, rather than flow-control architectures used by traditional computer processing units (CPUs), holds great promise for efficiency, performance, power consumption, and memory access in significantly smaller chips.[11] The features of these new chips will enable integration of more powerful AI processors into edge devices opening the floodgates for the creation of new edge devices across sectors including consumer, retail, industrial, governmental, medical, and defense.

## Growing Corporate investment in AI chips

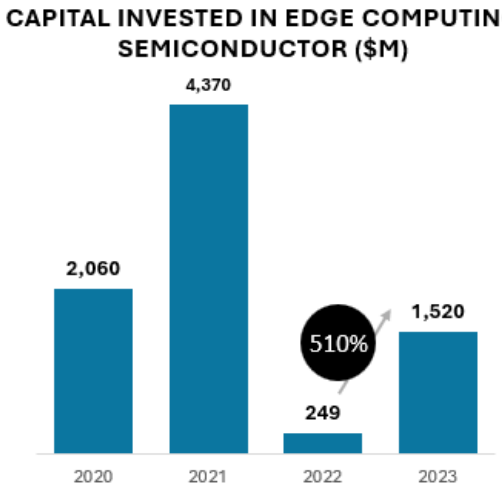
Recognizing the need for specialized AI accelerators and system-on-chips (SoCs) optimized for edge deployment, the major global chip manufacturers are investing in R&D and acquisitions in chip technology. Intel offers its Movidius line of vision processing units (VPUs) and FPGA-based accelerators catering to edge AI applications. The NVDIA Jetson platform of AI-enabled modules and developer kits are designed for edge devices and enable tasks such as computer vision,

[10] https://www.precedenceresearch.com/automotive-artificial-intelligence-market
[11] https://hailo.ai/products/hailo-software/hailo-ai-software-suite/#sw-dc

robotics, and autonomous systems. Qualcomm's Snapdragon platforms offer integrated AI capabilities for various edge devices including smartphones, IoT devices, and AV.[12]

In 2022, Advanced Micro Devices (NASDAQ: AMD) paid $35B,[13] for the acquisition of specialty chip maker, Xilinx, which among its portfolio of chips features the Versal™ AI Edge series. The Versal AI Edge is a chip designed for a broad range of edge applications which, the company reports, delivers high performance, low latency AI inference for intelligence in automated driving, predictive factory and healthcare systems, multi-mission payloads in aerospace & defense, and a wide range of other applications.[14]

According to estimates derived from Pitchbook, there was a 510% increase in capital invested in private edge computing semiconductor companies from 2022 to 2023. The investment level in 2023 demonstrated a strong recovery in investment after the sharp retraction in 2022 which had followed the investment spike in 2021.




In addition to internal R&D investment and large acquisitions, corporates are doubling down on investments in innovative startups developing new architectures for edge AI. Among these disruptors are companies such as:

**OurCrowd portfolio companies**

- Hailo: An Israeli startup developing breakthrough AI chip technology and vision processors uniquely designed to accelerate embedded deep learning applications on edge devices with the mission to make high-performance AI available at scale outside the realm of data centers.[15] Hailo's proprietary chip is 15X smaller and consumes almost 20X less power than NVIDIA's Xavier at 10% of the price. In early April 2024, the company completed a $120M extension to its Series C-2 fundraising round; to date the company has raised more than $340M. Hailo is valued at $1.2B[16] and has strategic investors which include ABB and NEC.[17]
- NeuReality: An Israeli startup that enables AI inference by lowering the cost, complexity, and power consumption with a new category of network addressable processing units (NAPU) and AI-centric architecture specifically optimized for AI workloads, offering up to 10X improvement in cost and energy efficiency compared with current CPU-centric architectures. NeuReality has established close collaborations with leading AI ecosystem partners and customers such as IBM, AMD, and Lenovo. The company's strategic investors include Samsung Ventures.[18] The company has raised total funds of $70M to date.[19]

[12] https://www.qualcomm.com/products/technology/artificial-intelligence/edge-ai-box
[13] Source: Pitchbook
[14] https://www.amd.com/en/products/adaptive-socs-and-fpgas/versal/ai-edge-series.html
[15] Hailo lands $120 million to keep battling Nvidia as most AI chip startups struggle | TechCrunch
[16] https://www.reuters.com/technology/chipmaker-hailo-raises-120-million-riding-ai-boom-2024-04-02/
[17] https://www.prnewswire.com/il/news-releases/ai-chipmaker-hailo-raises-60-million-in-series-b-funding-301015609.html
[18] https://www.neureality.ai/pressrelease/israeli-ai-startup-neureality-raises-35m-series-a-to-bring-its-novel-inferencing-chip-to-the-market
[19] https://www.calcalistech.com/ctechnews/article/skmfqepca

**Others notable players**

- Axelera AI: Netherland-based AI chip manufacturer specializing in edge AI solutions to create AI hardware and software platforms for edge computing.[20] The company's Series A round of $50M in early 2023 was oversubscribed and included investors such as CDP Venture Capital, Verve Ventures, and Fractionelera.[21]
- Blaize: California-based startup developing efficient full-stack programable processor architecture and low-code/no-code software platform systems. The company has raised over $295M to date including investments from Denso, Mercedes Benz, Magna, and Samsung.[22]
- Cerebras: US-based cloud-focused AI chip manufacturer building wafer-scale processors. Cerebras has raised ~$720M to date at a valuation of over $4B.[23]
- DeepX: South Korea-based company developing next-generation neural networks designed to assist AI silicon in deep learning operations. News was leaked in February 2024 that the company is close to raising a $90M round led by Skylake Equity Partners and Timefolio Asset Management.[24]
- Groq: US-based company providing high-performance, energy-efficient AI inference services via the cloud, powered by its proprietary ASIC hardware architecture. The company has raised over $360M, backed by Social Capital, Cleo Capital, NJF Capital, and Ascolta Ventures.[25]
- Horizon Robotics: Chinese AI processor architecture startup focusing on the development of the core technologies for assisted and autonomous driving. The company has raised ~$2.2B to date, backed by notable investors Intel, Sequoia Capital, SK Hynix, and SK China.[26]
- Rebellions: South Korea-based AI chip vendor. In January 2024, the company announced that it raised a $124M Series B round led by Korean telecom giant KT with participation from leading regional and global investors including Temasek.[27]
- Sima.ai: Silicon Valley-based startup (founded by Xilinx alumni) focusing on edge AI chips with a new methodology for embedded ML development across sectors including government, healthcare, AVs, drones, robotics, industry 4.0, and smart vision. The company has raised ~$200M to date.[28]
- Tenstorrent: Canada-based AI platform startup focusing on cloud, automotive, and chiplet-based designs. The company has raised over $334M backed by Fidelity Management, as well as Eclipse Ventures, Epic CG, and Moore Capital.[29]

## AI Chips and the Emerging Risks Quandary

The semiconductor industry remains highly concentrated and competitive with mega-producers such as Intel, Taiwan Semiconductors (now TSMC), Nvidia and AMD, often in a winner-takes-most environment. The semiconductor industry is traditionally also considered highly cyclical with periods of high demand followed by oversupply leading to significant price fluctuations; yet cyclical concerns for the rapidly emerging AI-semiconductor sub-sector is less of an immediate risk given the seemingly skyrocketing demand for computational power to support the surge in adoption of GenAI applications across industry verticals. However, significant 'single point of failure' risks exist in the AI chips sector which could result in significant limitations imposed on development, production, and deployment of cutting-edge AI applications including

[20] Axelera AI - Crunchbase Company Profile & Funding
[21] https://pulse2.com/axelera-ai-50-million-series-a-funding/
[22] Source: Pitchbook
[23] https://www.reuters.com/technology/ai-chip-startup-cerebras-systems-raises-250-million-funding-2021-11-10/
[24] https://www.bloomberg.com/news/articles/2024-02-26/ai-chip-startup-deepx-is-close-to-raising-90-million-in-funding
[25] Source: Pitchbook
[26] Source: Pitchbook
[27] https://www.axios.com/2024/01/30/rebellions-ai-chips-kt-nvidia
[28] Source: Pitchbook
[29] Source: Pitchbook

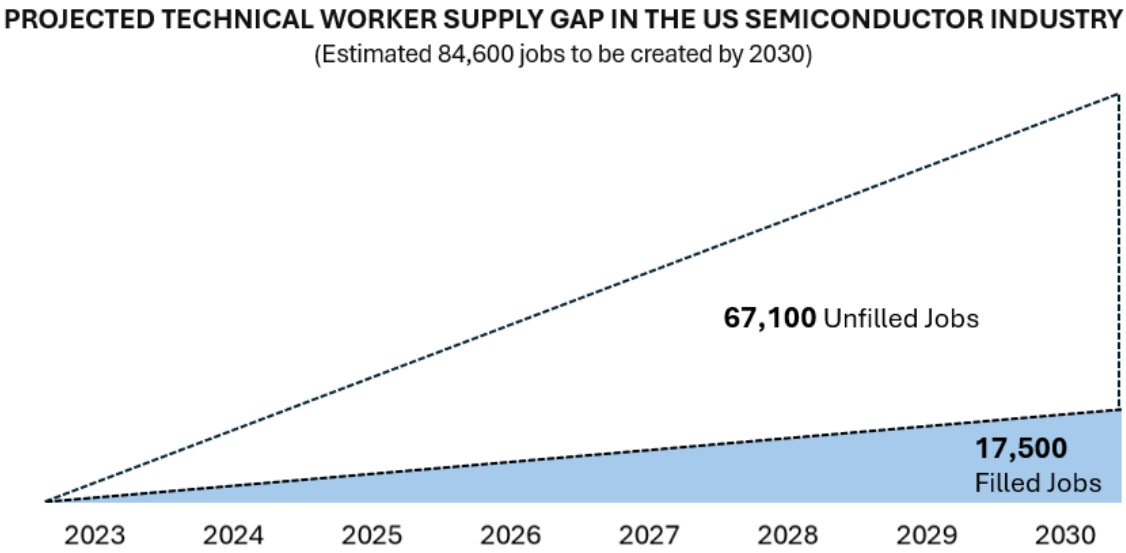
technological risks such as obsolescence, supply-chain disruptions, talent shortages, ad hoc regulatory changes, and IP threats.

**Technological Risks**

Technological risks linked to the semiconductor industry primarily relate to issues of obsolescence (given the break-neck pace of advancements in AI technologies as well as semiconductors design and manufacturing process) and AI implementation challenges. As discussed in a McKinsey report on scaling in the AI industry, many developments are still in the pilot phase with AI/ML, and scaling these technologies can be challenging and costly.[30] In addition, the industry needs to find ways to circumvent the limitations of Moore's law to provide smaller, more powerful chips. As transistors approach atomic dimensions, they become exceedingly costly to develop and produce, while power, cooling, memory bandwidth, capacity, and reliability all become more complex.[31]

**Talent Risk**

The incessant requirements for greater AI chip functionality and performance are resulting in semiconductor companies facing higher development costs to remain competitive through constant R&D, and manufacturing in the industry is characterized by increasingly high-precision processes. The fabrication of semiconductors involves several intricate steps including photolithography, etching, and doping. Each requires a high level of accuracy with minute margins for error in each step. As demand for more advanced chips continues to rise, the industry requires a substantial increase in skilled labor to meet these needs. Companies will face severe constraints if they cannot hire either the talent to continually innovate and develop AI-specialized chips or the skilled talent for manufacturing. The Semiconductor Industry Association estimated that by 2030 there will be a shortage of 67,000 technicians, computer scientists, and engineers in the US,[32] while a Deloitte report estimates that there will be a shortage of one million skilled workers in the semiconductor industry worldwide.[33]




[30] https://www.mckinsey.com/industries/semiconductors/our-insights/scaling-ai-in-the-sector-that-enables-it-lessons-for-semiconductor-devices
[31] https://aibusiness.com/verticals/moore-s-law-lives-on-and-ai-chips-prove-it#close-modal
[32] https://www.semiconductors.org/america-faces-significant-shortage-of-tech-workers-in-semiconductor-industry-and-throughout-u-s-economy/
[33] www2.deloitte.com/us/en/pages/technology/articles/global-semiconductor-talent-shortage.html

**Supply Chain Risk**

The semiconductor industry relies on globalized supply chains with multiple choke points and any disruptions can lead to sudden shortages of chips. The Russian invasion of Ukraine severely impacted the supply of noble gases critical to semiconductor industry. Ukraine supplies approximately 70-80% of the world's neon gas and some 40% of the krypton supply, and Russia contributes 35-45% of the world palladium supply.[34] On the manufacturing side, China, S. Korea, and Taiwan account for an estimated 90% of global semiconductor foundry revenue, with Taiwan producing more than 60%.[35] Political instability in the region and/or an outright Chinese invasion of Taiwan would severely impact the sector, as would climate change – a recent drought forced Taiwanese fabs to truck in water.[36] In addition, the industry is susceptible to cyber risks ranging from hardware vulnerabilities at the design process level to security-related vulnerabilities, such as the 2023 cyberattack on TSMC demanding $70M ransom.[37] In a 2023 survey of senior managers in the semiconductor industry, some 43% identified continuing shortages of raw materials as the most likely to have the greatest impact on business in next two years, followed by 40% of respondents which expressed concerns for energy resources and other service interruptions.[38]

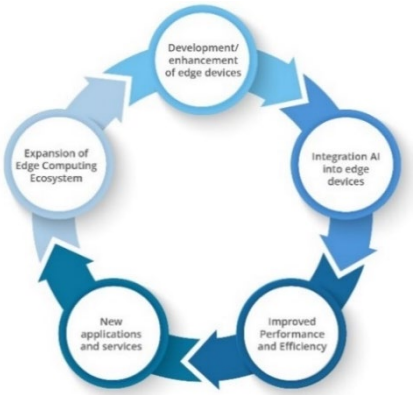
**Regulatory/IP Risk**

Governmental agencies are scrambling to keep pace with the technology and its impact on data privacy, security, and antitrust concerns. Any ad-hoc changes to regulations (e.g., controls over compute power) could present operational challenges resulting in additional costs as well as lower profits for companies.

Given the fierce competition in this industry, protecting patents and trade secrets against IP theft or litigation is also a crucial challenge facing companies trying to protect their competitive edge and grow their market share. Tougher regulatory scrutiny is primarily driven by competition, national security, and industrial policy concerns.

## Virtuous Edge AI Innovation Cycle: Attractive Investment Opportunities

The circular chart summarizes how recent innovations in AI chip technology, enabling the integration of AI chips into edge devices, are creating the environment for a feedback loop of AI and hardware innovation, redesign, and creation. While the advent of edge devices marked a shift towards decentralized computing, these devices which excel at data collection and transmission tasks were not able to jump on the AI bandwagon due to multiple constraints, particularly on processing power and energy resources. Recent innovations in AI chip technology are enabling AI chips to be adapted to run efficiently on edge hardware, enabling the devices to perform complex data analysis, pattern recognition, and decision-making tasks locally. As edge devices become more intelligent, they will spur the development of new applications and services that were previously not feasible which, in turn, will drive demand for new edge devices. This virtual cycle opens investment opportunities for companies developing semiconductor hardware enabling deep learning, processing, and inference capabilities of edge devices, as well as new disruptive edge devices.




[34] https://kpmg.com/ua/en/home/insights/2022/05/russia-ukraine-war-impact-semiconductor-industry.html
[35] https://www.statista.com/topics/11501/semiconductor-industry-in-the-asia-pacific-region/#topicOverview
[36] https://www.channelnewsasia.com/commentary/climate-change-semiconductor-water-shortage-risks-manufacturing
[37] https://www.securityweek.com/tsmc-says-supplier-hacked-after-ransomware-group-claims-attack-on-chip-giant/
[38] https://www.wtwco.com/en-gb/insights/2023/05/2023-semiconductor-supply-chain-risk-report

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PLEASE BE AWARE THAT INVESTMENTS IN EARLY-STAGE COMPANIES OR IN VENTURE CAPITAL FUNDS CONTAIN A HIGH LEVEL OF RISK AND YOU SHOULD CONSIDER THIS PRIOR TO MAKING ANY INVESTMENT DECISIONS. PAST PERFORMANCE IS NOT INDICATIVE OF FUTURE RESULTS.

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IN RESPECT OF HONG KONG RESIDENTS, THIS COMMUNICATION HAS BEEN REVIEWED AND APPROVED BY OURCROWD CAPITAL (HK) LIMITED (“OCHK”) FOR DISTRIBUTION TO CLIENTS OF OCHK THAT MEET ITS SUITABILITY REQUIREMENTS. OCHK IS LICENSED WITH THE SECURITIES AND FUTURES COMMISSION OF HONG KONG FOR TYPE 1 (DEALING IN SECURITIES) AND TYPE 4 (ADVISING ON SECURITIES) REGULATED ACTIVITIES.