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# A Semiconductor Surge Will Soon Alter The World

## Organizations Must Ready Themselves For A Ubiquitous Compute Future

A FORRESTER CONSULTING THOUGHT LEADERSHIP PAPER COMMISSIONED BY INTEL, JULY 2023

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## Executive Summary

On the path to delivering long-held promises of a ubiquitous compute future, new opportunities abound as semiconductors are propelled to a prominence not seen since the emergence of personal computing. However, organizations face numerous challenges on this journey.

In December 2022, Intel commissioned Forrester Consulting to evaluate the state of computing technology in consumer electronics organizations and what the future of computing will hold. Forrester conducted an online survey with 641 respondents and 33 interviews with global technology decision-makers at consumer electronics organizations to explore this topic.

We found that connected devices and data are proliferating at an exponential rate and leaders are concerned that compute power will not be able to keep up. However, innovations in compute technology are just on the horizon, poised to disrupt the technology landscape entirely. To prepare themselves for a world where computing capabilities and connected devices are everywhere, organizations will need to embrace this technology as well as ensure they are able to source and deliver products seamlessly and sustainably — and secure their data wherever it may be.

In addition to answering questions about the future of compute technology, we created a straightforward, effective tool to measure organizational readiness to activate these findings: the Compute Ubiquity Readiness Index, a highlighted path toward a ubiquitous compute future.

## Key Findings

**Connected device volumes are surging to new heights, requiring compute to catch up.** Connected device volumes are expected to grow an estimated 15x from five years ago to five years from today. While compute demand is growing, though, compute power is lagging behind: 64% of respondents note that compute power is not currently as high as they need it to be and 76% say they are starting to see plateaus in computing power.

**AI is aggressively accelerating compute demand.** AI has been on the rise as more compute power enables machine learning (ML) and other concepts which were once not feasible. A sudden and irreversible surge in AI is poised to change everything. Firms don't have enough compute capacity to serve this demand yet, so future specialized semiconductor innovations will aim to fill this void.

**The Compute Ubiquity Readiness Index helps organizations traverse a ubiquitous compute world.** We developed a tool that measures organizational preparedness to navigate and compete in this world based on three key pillars: 1) future of compute readiness, 2) supply chain future readiness, and 3) data security future readiness. Overall scores of the respondents' firms evaluated in this study ranged from 2.5 to 7 out of 10, with an average of 4.7.

**Supply chain, sustainability, and data security maturity play key roles in a ubiquitous compute future.** Future preparation can't rely solely on the adoption of new computing innovations. Firms must prepare to source and distribute through seamless supply chains, secure their data, and manage their compute in a sustainable way.

## As Device Volumes Soar, The World Looks Toward The Next Compute Revolution

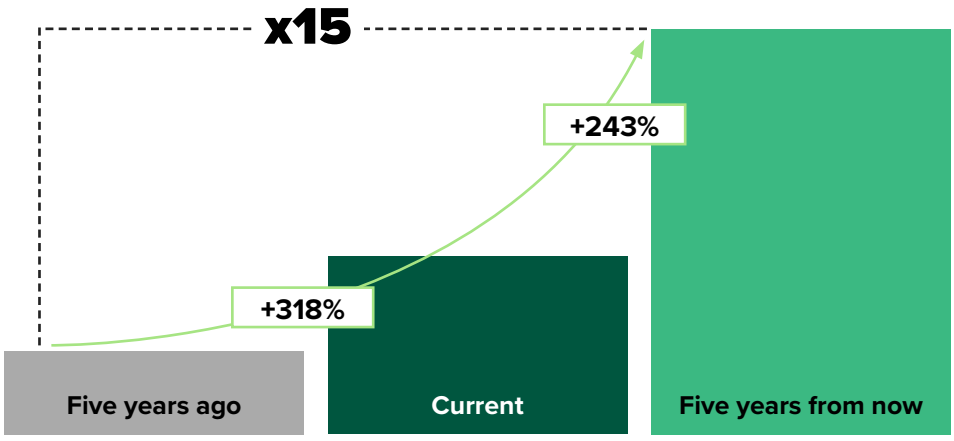
We are living in an age where many are worried that Moore's Law may become increasingly difficult to maintain. As the demand for connected devices increases and the physical and digital rapidly converge, many worry about compute power capabilities keeping up with these growing needs. However, there are significant landscape-shifting technologies just on the horizon that can revolutionize the way we think about computing limitations. Technology leaders are working to restructure their current strategies to allow for the agility needed to keep up with a new computing paradigm and a rapidly evolving technology landscape.

> "The emergence of a new computing paradigm upends our current view of the world. … We will need hardware accelerators that cater to [emerging] technology and the need for devices is expected to constantly increase."
>
> **Senior architect, computer hardware manufacturer**

- **Connected devices are exponentially growing**. As we sprint towards a truly connected world, organizations are navigating a 4x increase in the number of devices they are managing over the past five years. In the next five years, surveyed technology leaders expect that number of devices to more than triple again, which is more than 15x growth in a 10-year span (see Figure 1). Edge computing and an explosion of connected internet-of-things (IoT) devices in areas like medicine, energy, manufacturing, and transportation will represent the majority of this growth.

**Figure 1**

**Connected Devices Are Expected To Increase Over Next Five Years**




Base: 641 security decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

- **Organizations need to adapt to rapidly changing tech.** As connected devices continue to proliferate and increases in data and new technology disrupt industries, it can be challenging for organizations to keep up. Nearly half of technology decision-makers told us that the pace of technological changes over the next five years will require significant changes or a complete overhaul of their organization's strategy.

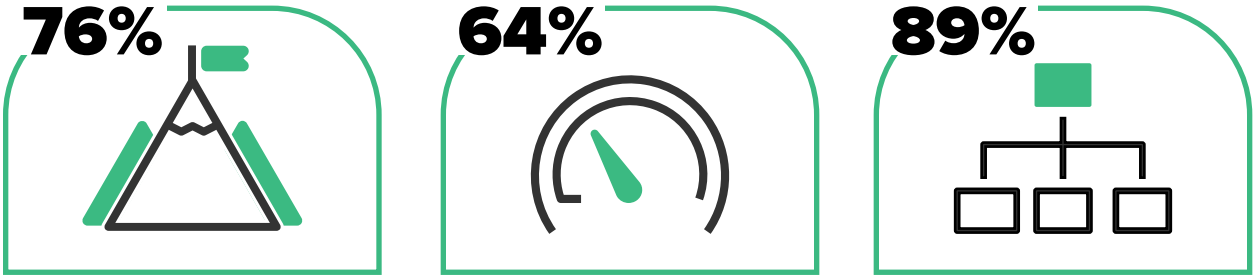
"I believe that we need to prepare for a big change in semiconductor capacity"

**Senior Mechanical Engineer, LED Technology Company**

- **Organizations seek increases in compute power.** Sixty-four percent of technology leaders feel that compute power is not as high as their organization needs it to be today and 76% say they are beginning to see plateaus in computing power (see Figure 2). As organizations are continuing to move data volumes into edge and IoT spaces, their leaders are realizing the pitfalls of their current infrastructure.

**Figure 2**

**Leaders Want Compute Power To Increase**




report they are beginning to see plateaus in compute power.

say that computer power is not as high as they need it to be.

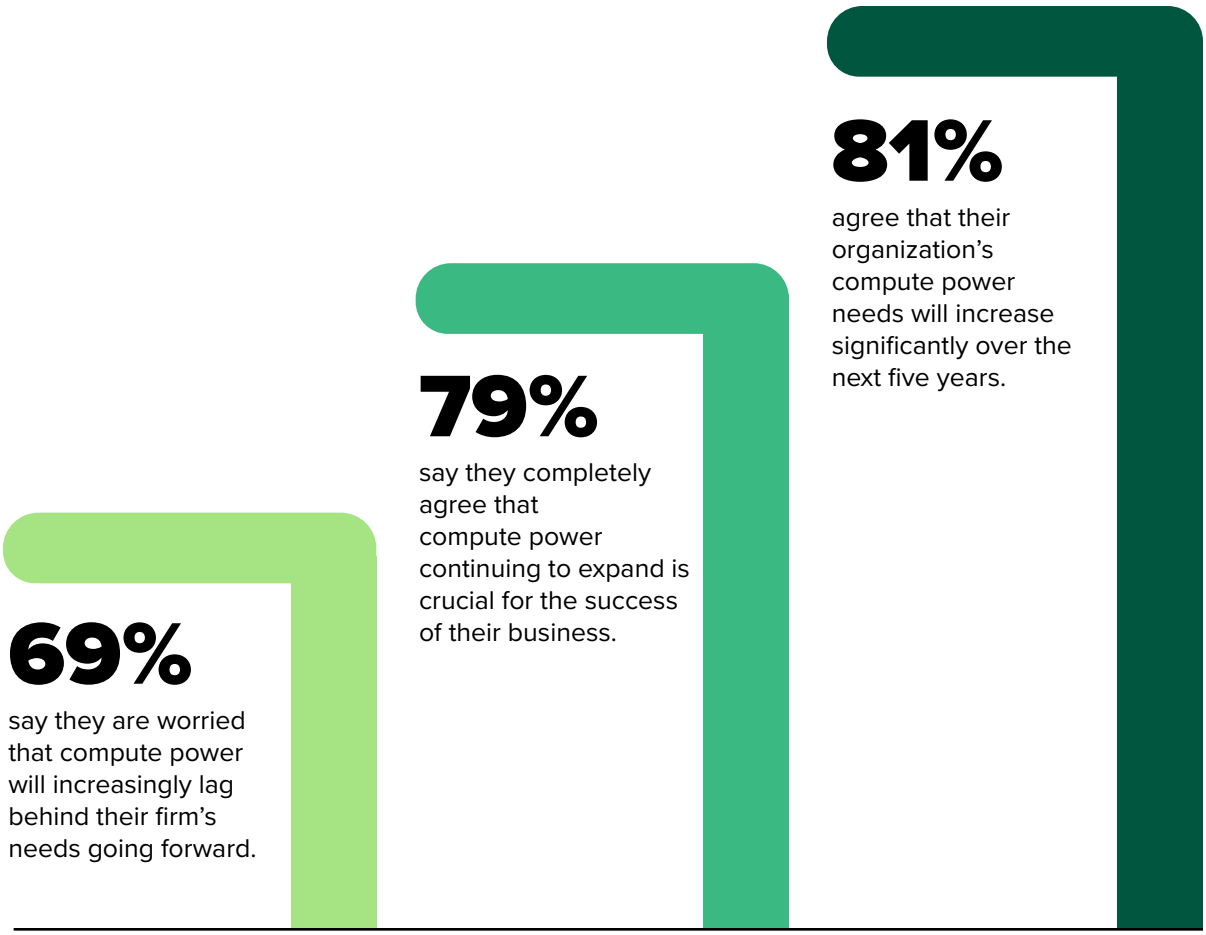
say data storage and/ or communications are significant bottlenecks today.

Base: 641 technology decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

- **Today's computing needs are only a sliver of what's to come.** Eighty-one percent of tech leaders indicated that they expect their organization's compute power needs will increase significantly over the next five years and 69% say they are worried that compute power will increasingly lag behind their firm's needs going forward. If this does indeed come to fruition, it could be a significant bottleneck for many businesses — 79% say that compute power continuing to expand is crucial for the success of their business (see Figure 3).

**Figure 3**

**Compute Power Remains Critical To Business — But Many Worry It Will Start To Lag Behind**




Base: 641 technology decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## The Compute Ubiquity Readiness Index

The world needs significantly more compute capability over the next decade and data centers and cloud services are expanding — but the greatest explosion in capacity is coming right at the point of need. Nearly everything everywhere will have computing embedded to make it smart and connected. The ubiquity of compute will require trillions of new processors of all sizes and capacities. Ubiquitous compute will collect data, process it, and take action locally and across geographies. These compute nodes will cooperate under software control to perform complex functions that single devices cannot. A new approach to networking will make this all possible since these devices will need to communicate with high speed and low latency.

To better understand the level of preparedness organizations currently have for a ubiquitous compute world, we developed the Compute Ubiquity Readiness Index.

This index analyzed respondents' organizations across three key areas and scored them from zero to 10, with 10 representing complete readiness for a ubiquitous compute world. The overall average was 4.7 across all respondents' organizations globally, representing only moderate readiness (see Figure 4). The three key areas used in the index include:

1. **Future of compute readiness.** This includes adoption and awareness of future technology as well as the ability to utilize future technology in a sustainable way. The average score was 3.2 (low readiness).
2. **Supply-chain future readiness.** This includes the maturity of supply chain practices and preparedness for future supply chain disruptions. The average score was 5.2 (medium readiness).
3. **Data security future readiness.** This includes preparedness to secure data as it proliferates out to less secure connected devices, awareness of the need to secure data while it is in use on those devices, and awareness of the data security technology that will define a ubiquitous compute world. The average score was 5.7 (medium readiness).

In this research, we'll touch upon each of these pillars and explore what it will take for organizations to be fully prepared for a ubiquitous compute world.

**Figure 4**

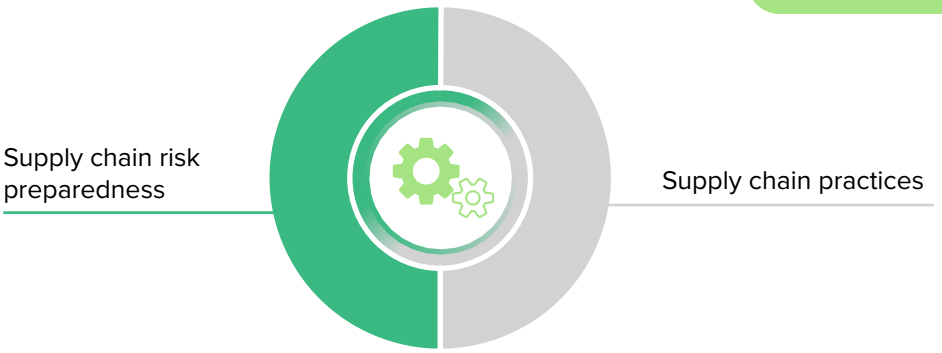
## Compute Ubiquity Readiness Index

### Future Of Compute Readiness

**Average Score: 3.2**

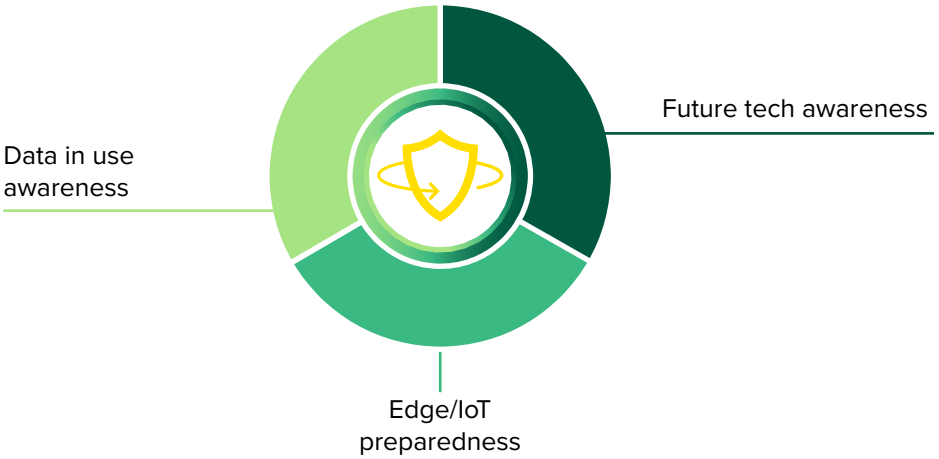

### Supply-Chain Future Readiness

**Average Score: 5.2**




### Data Security Future Readiness

**Average Score: 5.7**




Base: 641 technology decision-makers at consumer electronic device organizations
Note: Scores ranked between 0 and 10.
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## Future Of Compute Readiness: Pervasive, Perpetual, And Powerful

Compute and other semiconductor innovations have irreversibly changed business and society since the 1940s. As these capabilities become ubiquitous over the next decades, people in all corners of society will adapt to the new realities — some more nimbly than others. Modern technology has long been controlled by central authorities like corporate IT departments and cloud providers, but compute will only be ubiquitous if the power shifts to the people. The next few years will be shaped by society, enterprises, and individuals rapidly increasing their readiness for ubiquitous compute.

In the Compute Ubiquity Readiness Index, future of compute readiness represents an evaluation of readiness based on future technology adoption; the availability of the semiconductor technologies needed to power a ubiquitous compute world; organizational awareness and preparedness to adopt future compute technology; and maturity of power and sustainability practices required to meet the energy requirements of that future technology.

### DECENTRALIZATION

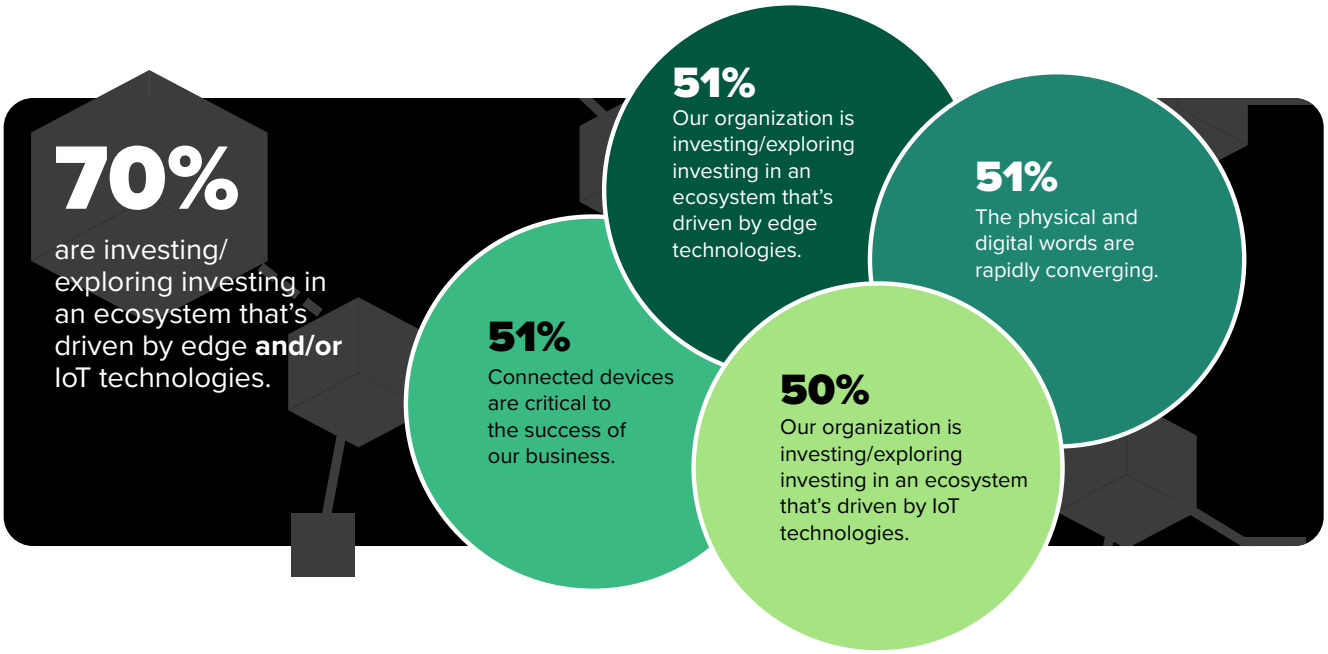
As we move towards a ubiquitous compute world, businesses must take decisions closer to where they matter whether it is a retail branch, a doctor's office, a hospital, or a warehouse. To support better customer experiences, improve operations, and optimize efficiencies, firms are investing in building disaggregated, decentralized technology architectures. While the majority of study respondents say their firms are engaging customers with the use of local data, 71% also believe today's systems lack power or need higher computing power to support tomorrow's business needs.

- **Edge and IoT are drivers of future business growth.** Edge and IoT technologies will be key drivers of future technology ecosystems. Seventy percent of respondents say their organization is investing or exploring investing in an ecosystem that's driven by edge and/or IoT technologies and 79% say they are scaling to more small compute nodes (see Figure 5).

**Figure 5**

**Edge And IoT Tech Will Drive Future Ecosystems**

(Showing “Agree” and “Completely agree”)



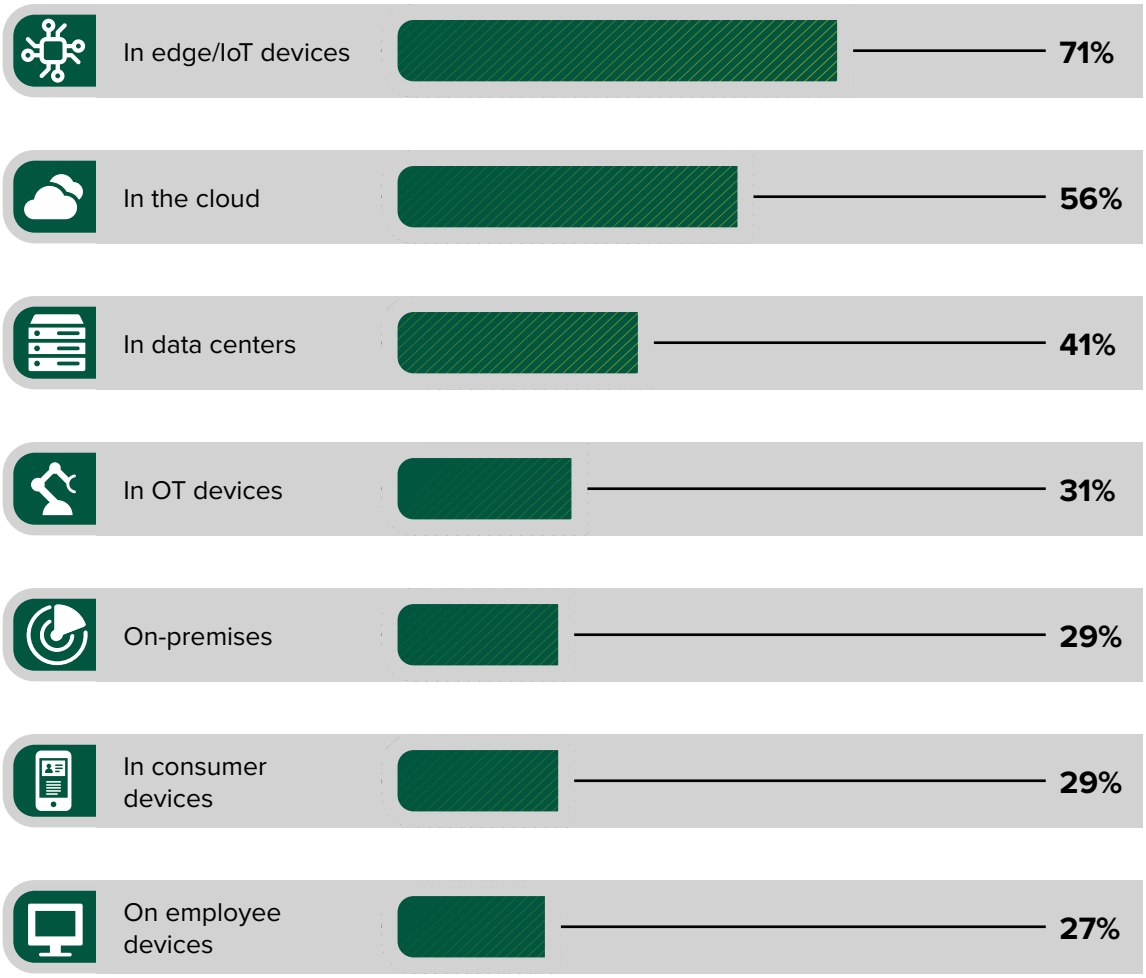

Base: 641 technology decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

- **Tech leaders are already exploring ecosystems based at the edge.** Half of the survey respondents say their firm is investing/exploring investing in an ecosystem that’s driven by IoT technologies. Nearly 60% of survey respondents note their organizations are decentralizing to the edge and are using IoT capabilities to migrate compute and data to engage customers in real time.
- **A transition to the edge will necessitate substantial innovation in computing power.** To support edge and IoT driven ecosystems, organizations will require significant improvements in computing power. Technology leaders expect edge and IoT devices to be where computing power demands will increase the most over the next five years. When asked what the top deployment areas requiring computing power increases are expected to be, 71% ranked edge/IoT devices in the top three, compared to just 56% for computing power needs in the cloud and 41% for data center deployments (see Figure 6 ).

## Figure 6

**“Where do you believe computing power demands will increase the most over the next five years?”**

(Showing top 3 Ranked)




Base: 641 technology decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## FUTURE TECHNOLOGY

Forrester believes that there are three key technology megatrends that will be fundamental in powering the future of compute. This includes:

1. **Collaborative compute nodes.**
2. **Customization of compute engines.**
3. **Democratization of design.**

While these are very nascent technology areas with little to no adoption today, organizational awareness of their value and preparation for adoption is key to future readiness. Specifically, leaders at high-future-tech-awareness organizations were more likely to feel that needs were growing to engage customers in real time, more efficiently using physical assets they own, and operating in a more decentralized way.[1] This makes up the future tech awareness portion of the Compute Ubiquity Readiness Index.

### Perspectives On The Future Of Compute

"On the demand/consumer side, the need to command more data through intuitive and augmented/virtual reality-like interfaces will drive the need for high-performance and more efficient computing capabilities. Other demands in enterprises include dealing with huge manufacturing-related data. Sensor data and decision-making logs from autonomous control will also play large roles."

**EVP, major electronics manufacturer**

"Most industries, such as artificial intelligence, robotics, clean energy, electric vehicles, virtual reality, LED, lighting, display, and electronics, need big improvements in semiconductors' fast and highly efficient computing capability."

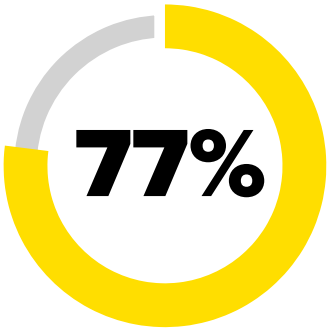
**Senior mechanical engineer, consumer electronics manufacturer**

"[The future of compute will be defined by] a shift to dedicated compute architectures, commoditization of CPUs, and the dominance of GPUs for AI training."

**Corporate strategy consultant, large consumer technology organization**

## COLLABORATIVE COMPUTE NODES

Ubiquitous compute implies a sharp increase in the number of computers. Many of these are appearing in small form factors for edge computing, IoT, and even tiny experimental chips smaller than a grain of rice. With so many compute nodes available in diverse locations and performing diverse functions, aggregate power will be realized by combining nodes. These aggregates will assemble on demand with each node communicating with the others directly. Software design, abstraction technologies, network architectures, and protocols will adapt.




of security leaders said they wish to combine many compute nodes into a single aggregate compute platform (i.e., collaborative compute nodes).

As these compute nodes unify edge, data center, and cloud technologies to quickly perform functions that were previously impossible, we expect the unit prices for compute to be far lower. This will create a virtuous cycle, once again exponentially improving compute economics.

More complex compute applications will appear first in the military; traffic control is only a year or two away, while the most advanced medical applications will come late in the decade. There are hurdles to power such devices which will need to be overcome to support a wider range of use cases.

### Perspectives On Collaborative Compute Nodes

> "[Collaborative compute nodes] will help us easily access more available compute resources with reasonable cost. [They will] definitely reduce the operating cost and increase the profit."

*Hardware engineer, major technology company*

> “It would take anywhere from four to five years for [things like GPU sharing] to become commonplace. And that's my current thinking on swarm computing because it would take sharing for that to happen.”
>
> ***Strategy director, major technology company***

> “For the world, swarm computing will have considerable application in the military where intelligence and targeting will be more efficient with the number of sensors and computing nodes at different platforms. I can see improvements in traffic control, autonomous driving being more efficient when compute nodes could easily collaborate.”
>
> ***Senior principal engineer, major technology company***

## CUSTOMIZATION OF COMPUTE ENGINES

General-purpose compute engines like microprocessors will always be the heart of modern technology. They are flexible and powerful — but for some demanding applications, they can impose performance compromises. Compute that is customized for a specific purpose will significantly outperform these general computers. Nearly 80% of technology leaders say they see the value of customized compute engines as opposed to general-purpose platforms, and 78% desire the ability to tailor compute platforms to their firm’s unique needs.

Migrating functions from software to silicon will speed execution by at least two orders of magnitude. Because unnecessary circuitry can be eliminated, specialized processors are more energy efficient. Specifically, applications like pharmaceutical development, surveillance, real-time retail experiences, and automotive control will benefit greatly from customized compute. Wherever repetitive, high-performance compute is required, custom compute can prove valuable.

However, developing custom compute and programming it is not easy. Development tools and chip architectures themselves must evolve to enable broader adoption. Many do not recognize the power of such compute, let alone how to make it realistic, which underscores the need for an education campaign.

## Perspectives On Customized Compute Engines

> "[The ability to easily customize compute/semiconductors would allow] advanced access to solutions and total system design with superior performance across multiple applications as well as cross-function interactions."
>
> ***VP strategy and new business, semiconductor design and manufacturing company***

> "To leverage [the ability to easily customize compute/semiconductors to our needs], a different skill set and understanding of this technology will be needed than we currently have at my company."
>
> ***Manufacturing engineering leader, electrical equipment manufacturer***

> "[The ability to easily customize compute/semiconductors to specific needs would allow us to] design more image or AR/VR-processing-oriented chips for wearable devices or even automobile-medical devices equipped with AR capability."
>
> ***Hardware engineer, appliance and electronics manufacturer***

## DEMOCRATIZATION OF DESIGN

The design of compute engines like microprocessors currently requires extensive specialized engineering skills, limiting the opportunity to create chips optimized for specific applications. Innovations that borrow from low-code application development platforms will put power into the hands of people without electrical engineering degrees. Decision-makers from this study envision democratizing design onto hardware using low-code and no-code deployments as having the potential to increase agility, flexibility of integration, scalability, and connect application development processes to their core IT/OT systems among other benefits.

> "[Collaborative compute nodes] will help us to easily access more available compute resources with reasonable cost. [They will] definitely reduce the operating cost and increase the profit."
>
> **Hardware engineer, major technology company**

However, democratized design is still a radical concept. The community of citizen chipmakers will only start to emerge when programmable chips and low-code development environments emerge around 2026/2027. Expect chipmakers to begin delivering early capabilities by 2025. As with any bold new idea, customers will need to learn why this matters and how they can benefit before they even take the first steps toward implementation. Some leaders who were interviewed for this study were particularly skeptical of the possibility for democratized design.

> While I think there's a lot of value in electronics companies being able to bring [custom chip design] in-house, I think it would depend on truly how low-code and actually democratized that type of skill set can become. … Given the talent crunch today, organizations are not going to be wanting to hire a whole new set of people to be able to do this function in-house if they don't have to. So, they might likely continue deferring to their current outsourced vendors that will do their custom FPGA and their ASICs for them
>
> **Corporate strategy decision-maker, major electronics company**

## MATURE SUSTAINABILITY PRACTICES ARE ESSENTIAL TO SUPPORTING RISING POWER NEEDS

Semiconductors are ubiquitous in intelligent devices, making them a central part of power consumption optimization efforts across all industries as carbon footprint calculations become a central agenda. Globally, the advent of regulations, trends in energy transition, and scrutiny from consumers mean that sustainability will be a central part of decision making and procurement processes across the IT stack.



Today, CPUs and GPUs account for 30% of an organization's carbon footprint on average.

- **Power consumption of chips takes center stage.** The rising power consumption of semiconductor chips is a growing concern in the tech industry. Sixty-three percent of respondents surveyed say the power efficiency of their servers, storage, and networks must improve significantly. Data centers consumed around 0.9% to 1.3% of global final electricity demand in 2021 and will grow in the coming decade as workloads become more compute intensive and newer use cases emerge.[2] Today, CPUs and GPUs account for 30% of an organization's carbon footprint on average — a percentage that will only grow without fundamental change. Our analysis showed a critical need for measuring the sustainability metrics in chips: both from embodied carbon from the manufacturing of chips as well as lifecycle emissions
- **Users balance the benefits vs. risks in computing power.** Nearly two-thirds of surveyed leaders said that an increase in computing power can reduce their carbon footprint by increasing intelligence and efficiency in products. Sustainability-related use cases for IoT, edge computing, AI/ML, and blockchain indicate the growing need for active decarbonization measures.[3]

**Perspectives On The Sustainability**

“Certainly, it has an impact. New AI/ML infrastructures require a large data center surface and power supply. Currently, the infrastructure for AI/ML applications is not efficient, in the sense that we need servers and accelerators that are not dense enough due to power/thermal issues. They are threatening the sustainability of IT operations for many enterprises. ESG puts yet another set of challenges in the operation.”

**EVP, manufacturing conglomerate**

“It is top priority for many semiconductor companies as part of their corporate social responsibilities. The customer is paying more attention to operational sustainability, the power consumptions of their tools and facilities, renewable energy use, carbon, and emissions.”

**Market sector director, consumer appliance manufacturer**

"Companies will need to allocate increasing resources to ensure ESG standards throughout their business. This includes, but is not limited to, a proactive approach to early identify potential pitfalls and related mitigation scenarios. On the other hand, distributed computing and machine learning can be one tool of choice to assess such risks and provide data-based modeling and prediction.”

**Director test engineering, semiconductor solutions**

## Supply-Chain Future Readiness: Supply Chain Rupture Risks Wrath and Ruin

Leaders are aware now more than ever of the risks of a vulnerable supply chain. Faced with new supply chain compliance mandates, inflation, and economic uncertainty, business and technology leaders must rethink their supply chain strategies and supporting technologies going forward. For organizations to thrive in a ubiquitous compute world, the ability to source hardware, especially silicon, when it is needed and at scale will become of ever greater importance. Critically, we found that respondents whose organizations have high supply chain future readiness were not only far better prepared for supply chain risks but were also more prepared for other risks like cybersecurity threats, economic uncertainty, labor market challenges, and pace of technological change.[4]

- **Supply chain concerns are more pressing than ever.** When we asked decision-makers about the key challenges that will impact the way their organization plans for the future, concerns about supply chain came up again and again. Supply chain issues ranked only behind cybersecurity threats in terms of leaders' top concerns for disruptions to their organization over the next five years.

> "Presently, we are seeing supply chain issues as a key challenge [in the semiconductor industry]. Alongside this is the increasing isolationism in certain markets, limiting the number of countries we can freely outsource components from. This looks likely to get worse before it gets better."
>
> **Senior engineer, security product manufacturer**

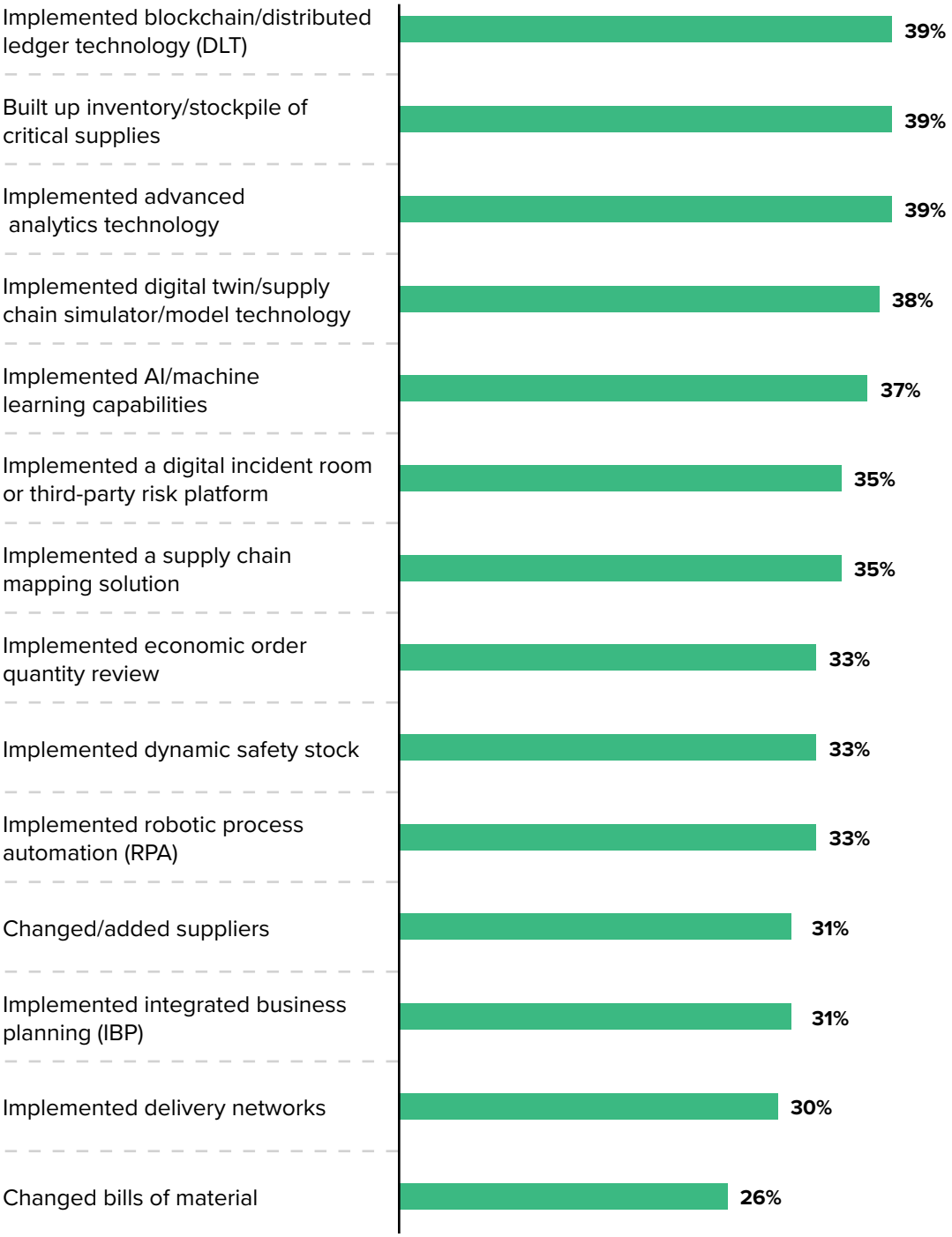
**62%**

of surveyed decision-makers rank cybersecurity threats as the force with the greatest disruptive effect to their supply chain over the past three years

- **Enterprise value depends on supply chain resilience.** Supply chain risk exposes enterprise value to double jeopardy, devouring working capital in the form of inventory to protect against disruption.[5] They risk lost revenue when out of stock and eroding profitability as they spend on expedited transportation or offer discounts to move stagnant stock, all of which also negatively impact customer experience.
- **Most respondents do not feel like their organizations are prepared for potential future disruptions**. Every decision-maker in this study cited at least one type of supply chain disruption that their organizations are less prepared for today than they were five years ago. Over half of decision-makers still feel that to adequately prepare for disruptions over the next five years, their organizations will need to significantly change or completely overhaul their supply chain strategy and technology.
- **Edge compute will drive supply chain execution excellence.** Meeting the demands of B2B customer expectations requires low latency analysis and response in supply chain logistics and operations. Supply chain resilience depends on deploying prescriptive models to edge devices, analyzing local data and offering real time local next best actions. To that end, many organizations are looking to adopt emerging technologies that can address significant issues. While overall adoption rates are fairly low today, organizations have begun to implement blockchain, advanced analytics capabilities, and AI/ML as a response to recent supply chain disruptions (see Figure 7). Respondents at high-readiness firms note they were more likely to have increasing compute power demands, yet they are actually more confident about their ability to get the tools and supplies needed to meet their demands.

## Figure 7

**"Which of the following changes did your organization make in response to recent supply chain disruptions?"**

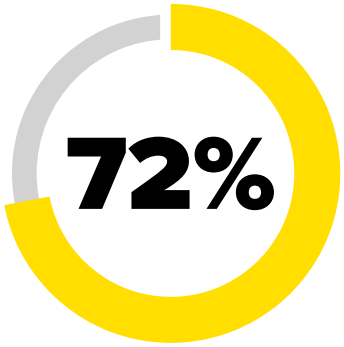



Base: 565 technology and supply chain decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## Data Security Future Readiness: Protecting Data At Its Foundational Source

Devices all around us are collecting and processing as much data as possible to make our lives easier. However, IoT and edge devices are handling sensitive information but lack the processing power to perform encryption, malware analysis, and other security controls. Sixty-one percent of security leaders reported having more sensitive data in less secure locations than in the past and yet 73% say that their edge/IoT devices lack the computing power to properly secure them. As more workloads are carried out in the cloud, companies must protect their information from agents who have direct and privileged access to the compute devices processing their data.

In this world of ubiquitous compute, security can no longer be an optional add-on. It must be a prerequisite embedded at the lowest levels of the technology stack protecting data and devices where they are used.

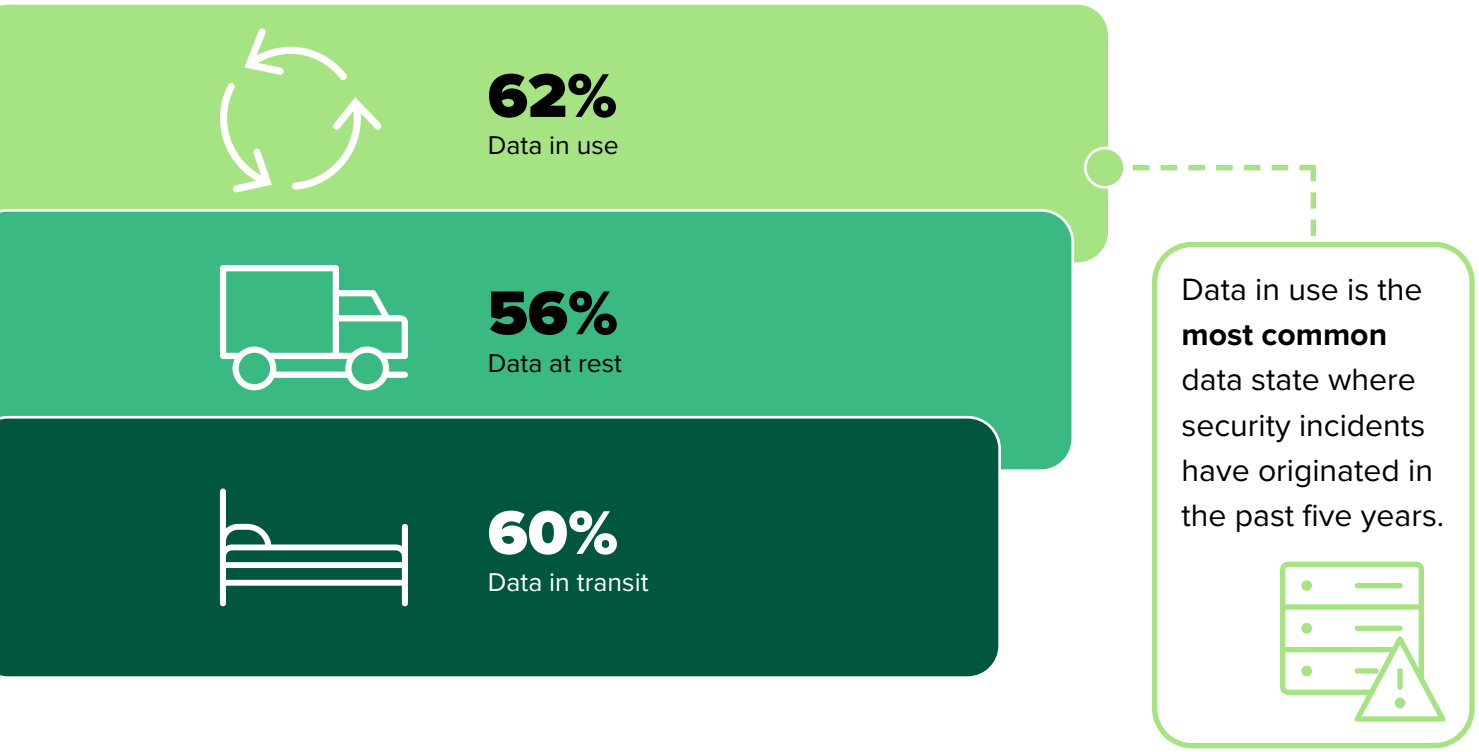



of surveyed decision-makers say **data in use** is **not** something they normally think about from a security perspective.

- **Security leaders are not thinking about data in use.** Security leaders focus on two of the three data states: data at rest and data in transit. They forget about the third data state, data in use. Security decision-makers rate data in use as the least important for their organization's security compared to data in transit and data at rest, and rate data in use as posing the least significant security risk for their organizations. This creates a significant blind spot as more data processing is pushed to edge devices, which can create significant consequences as threat actors find the path of least resistance. Our data showed data in use to be the most common data state for breaches (see Figure 8).

**Figure 8**

**Data In Use Most Common Data State For Security Incidents In Past Five Years**



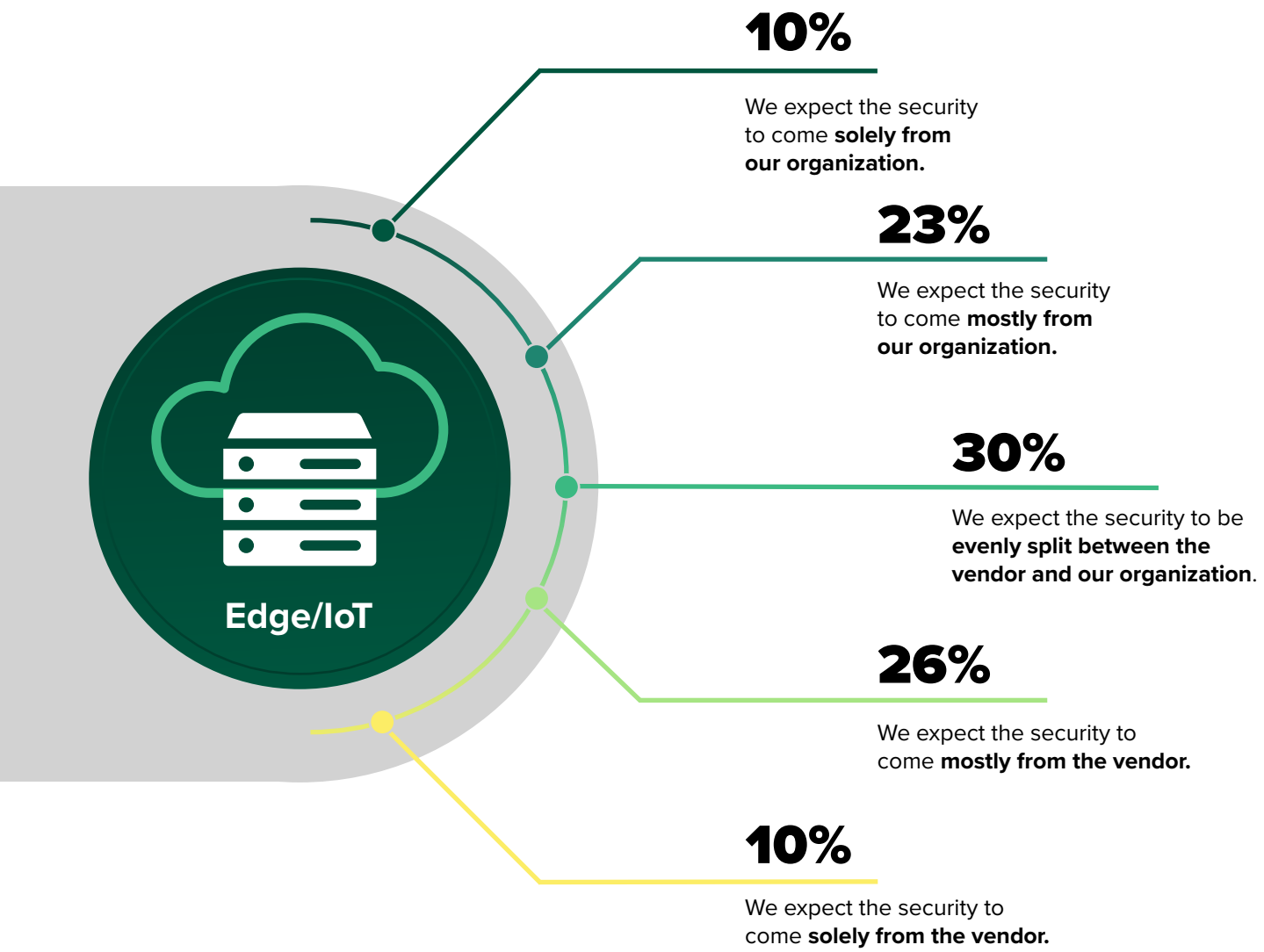

Base: 524 security decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

- **Lack of consensus over ownership of data in use only further exacerbates threats.** In surveying tech leaders, we found an obvious lack of consensus when it comes to the distribution of responsibility for protecting edge/IoT devices between vendors and the organizations themselves (see Figure 9). Much of this may stem from security leaders' inability to trust their hardware manufacturers to create the proper security controls at a hardware level. Only 46% of surveyed security leaders trust their hardware providers to protect their data. The lack of confidence in hardware security requires compensating controls and putting additional stress on limited resources to handle the volume of data processing on edge devices.

- **To solve these pain points, leaders must embrace innovation.** Quantum computing threatens to make current encryption algorithms obsolete. Over 70% of respondents believe that quantum-resistant encryption will be important in the next five years. The increase in computational power, however, has the potential to revolutionize all facets of society. Security leaders rated increases in processing power and speed as the technology breakthrough with the greatest potential for positive impact for their organizations' ability to secure their data but also as a breakthrough that's most likely to have a negative impact on that same security ability. Technology innovation has a history of prioritizing functionality over security. Organizations are already experiencing resource constraints, which will be exacerbated as data use continues to grow, reducing the capacity for added security controls.

**Figure 9**

**Lack Of Edge/IoT Device Security Owner Causes Confusion**




Base: 524 security decision-makers at consumer electronic device organizations
Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## Key Recommendations

Forrester's in-depth survey of technology leaders about current state and future of computing yielded several important recommendations:

**Prepare your organization for drastic tech innovation.**

Your entire organization needs to adapt its institutional philosophy to take risks that can pay off handsomely. Technology will change at an uncomfortable pace, but everyone needs to anticipate these changes and create an environment that rewards rapid and risky innovation. Business models should be built around the expectation that compute will be ubiquitous with almost unlimited power and continually changing. Be prepared to discard aging technology even if it means a lot of sunk investment. Any technology that falls behind is like an anchor on a ship. Cut it loose and move on to something better.

**Prioritize sustainability to be future fit.**

Semiconductors are the brains in all intelligent devices. They thus enable energy management and optimization for products, but at the same time, their own power consumption trends have increased each year. Ask tough questions to manufacturers about metrics that will help your organization measure carbon emissions, such as embodied carbon, lifecycle energy consumption, waste management processes, and the energy efficiency capabilities of microchips. These metrics will enable your organization to make decisions on the right refresh cycles for its IT infrastructure and devices at the same time savings on energy, translating into cost savings and significantly reducing your organization's own environmental impact.

**Be the foundation of a cyber resilient future.**

Semiconductors are the building blocks of technical innovation and should dictate the strategic direction for core hardware security controls to enable customers to incorporate additional security features into their end products to protect data in use. Start this journey before increased pressure from customers and regulatory agencies dilutes your influence.

**Prepare for edge as an interdependent yet independent ecosystem.**

Opportunities in the edge abound. While edge presents many possibilities to solve existing challenges, including supply chain issues, business leaders must be ready to operate an interdependent yet independent landscape. Edge deployments will make trust and security an imperative as these technologies will not exist in a silo but expand the data and services beyond the traditional data center and cloud boundaries. Edge services will multiply sustainability concerns much more than they solve as these deployments need a lot more power and cooling for geographically spread hardware.

## Appendix A: Methodology

In this study, Forrester conducted an online survey of 641 technology decision-makers at global organizations to evaluate how several megatrends in compute will shape the future of semiconductors. Survey participants included decision-makers in operations, product development, engineering R&D and others. The survey asked the participants about their organizations' current technology state and their perspectives on the future of computing. Respondents were offered a small incentive as a thank-you for time spent on the survey. The study began in November 2022 and was completed in December 2022.

## Appendix B: Demographics

| TOP 5 INDUSTRIES | |
|---|---|
| Telecommunications services | **6%** |
| Manufacturing and materials | **8%** |
| Financial services and/or insurance | **10%** |
| Retail | **11%** |
| Technology and/or technology services | **12%** |

| COMPANY SIZE | |
|---|---|
| 1 to 499 employees | **12%** |
| 500 to 999 employees | **22%** |
| 1,000 to 4,999 employees | **31%** |
| 5,000 to 19,999 employees | **21%** |
| 20,000+ employees | **14%** |

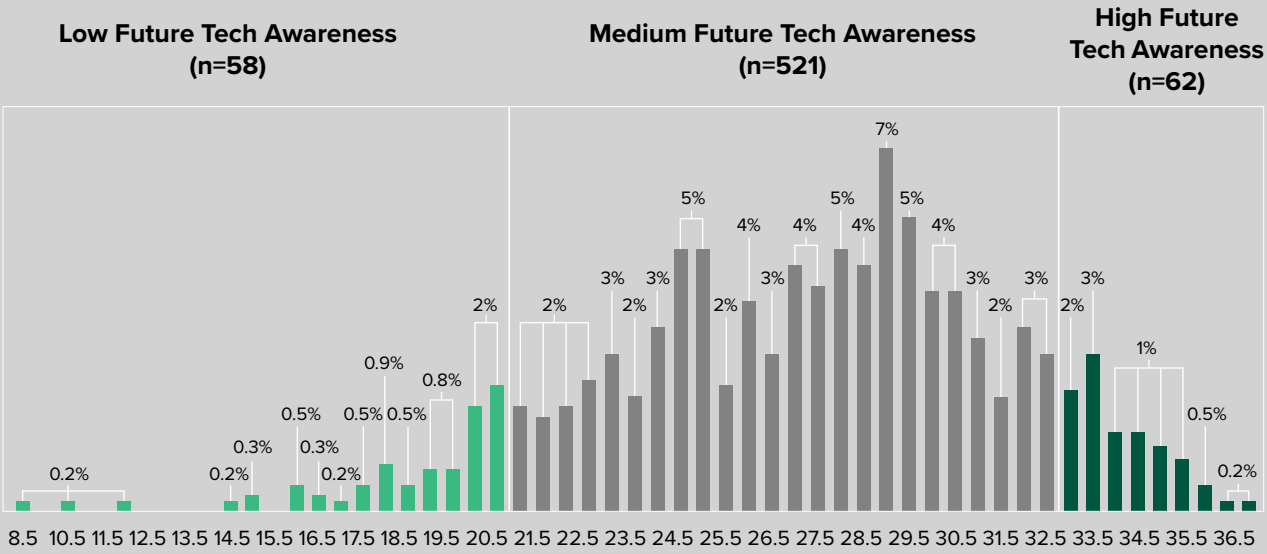
| ROLE | |
|---|---|
| C-Level executives | **20%** |
| Vice president | **34%** |
| Director | **46%** |

| POSITION | |
|---|---|
| Engineering/R&D | **17%** |
| Product development | **18%** |
| Operations | **28%** |
| IT | **37%** |

| GEOGRAPHY | |
|---|---|
| US | **30%** |
| India | **12%** |
| UK | **12%** |
| Japan | **12%** |
| Canada | **11%** |
| France | **11%** |
| Germany | **10%** |

Note: Percentages may not total 100 because of rounding.

## Appendix C: Defining Future Tech Awareness




Source: A commissioned study conducted by Forrester Consulting on behalf of Intel, December 2022

## Appendix D: Endnotes

[1] "High future tech awareness" refers to those respondents whose organizations are thinking about and preparing to utilize the technology that will define a ubiquitous compute world, as compared to those with "low future tech awareness" (see Appendix C for more details).

[2] Source: George Kamiya, "Data Centres and Data Transmission Networks," IEA, September 2022.

[3] Source: "Jekyll And Hyde: The Dual Role Of Emerging Tech In Environmental Sustainability," Forrester Research, Inc., April 20, 2022.

[4] The Supply Chain Future Readiness component of the overall Ubiquity Of Compute Readiness Index is based on supply chain risk preparedness and maturity across 12 supply chain practice areas. To better understand the differences between the extremes in supply chain maturity, we compared those respondents whose organizations had low supply chain future readiness (those with an index score of four or below) with those respondents whose organizations have high supply chain future readiness (those with an index score of seven or above).

[5] Source: "Digitally Remaster Your Supply Chain," Forrester Research, Inc., September 18, 2020.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