Ecosystem
Predictions
& Perspectives

2021

arm

Contents

Foreword

Rene Haas, President, IP
Products Group (IPG) at Arm

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This report can't tell you exactly what the world will look like in a year's time—I wish it could—but it does reinforce my confidence that the Arm ecosystem will emerge from the current uncertainty far stronger and more resilient.

The COVID-19 pandemic quickly revealed humanity's extraordinary capacity for inventiveness and flexibility, with technology forming a foundation for much of this resilience. Videoconferencing rapidly helped fill the void, at least partially, of face-to-face meetings. Smart manufacturing enabled manufacturers and distributors to quickly reconfigure production lines and supply chains to deal with shortages of PPE and other vital commodities. And, as you'll discover from the report's findings, Arm partners stepped forward very positively in the fight to establish a 'new normal'.

This report features a range of opinions from free-thinking companies throughout the Arm-based world. There's also further insight and analysis from three senior Arm leaders: Dipti Vachani, GM of our IoT and Automotive business, Chris Bergey, who runs our Infrastructure group, and Paul Williamson, whose Client business works with partners across the mobile computing realm.

The result paints a vivid picture of the impact the pandemic has had on the technology sector and how the lessons learnt will ripple on into the future.

You'll have to read on for the full details but one area that stood out for me was security, with the majority of respondents saying protecting their technology had become even more of a critical need. This is a testament to the trust the technology sector knows is important to guarantee a robust compute-driven world—whether that means organizations choosing the most secure Cloud infrastructure, or hardware and software developers ensuring that they are treating security as a ground-up design priority.

The security subject resonates with me strongly as it's at the heart of Arm's Total Compute strategy. For example, ensuring developers have the tools they need to optimize code for realistic use cases rather than synthetic benchmarks, resulting in a more robust solution. Put simply, security equals trust, and in the current COVID-19 driven economy the T Factor (Trust Factor) is just as important as the famous R number, the rate at which the virus is able to replicate itself.

I hope you enjoy reading the following pages, and if you have comments or questions, please let us know. Almost all great ideas begin with a simple exchange of thoughts.

Overview

This report is based on the views of more than 900 respondents in varying roles, regions and focuses across the Arm ecosystem—from small and medium sized enterprises to multinationals, OEMs to chipmakers, foundries and developers.

While responsibilities range from CEO to student, the **majority of respondents self-identified as software (38 percent) and hardware (29 percent) engineers.**

It is worth noting that the level of statistical variation between roles, regions and focuses is very low: the same interests and concerns are shared throughout the ecosystem. Only when comparing by regional headquarters did we note a variance in opinion, which may be due to differing regional experiences based on how the COVID-19 pandemic affected them. We'll explore this disparity further in the next section.

When asked about the role of Arm technology in their work, two-thirds of respondents answered 'very or extremely important'. This is a nice proof point for us to see on how fundamental Arm IP, tools and developer support has become in the three decades since our company was founded.

As the industry looks forward, we can also see how roadmaps are beginning to polarize around two fundamental areas: **autonomous endpoint devices (22 percent)** and technology within the cloud and data center (23 percent).
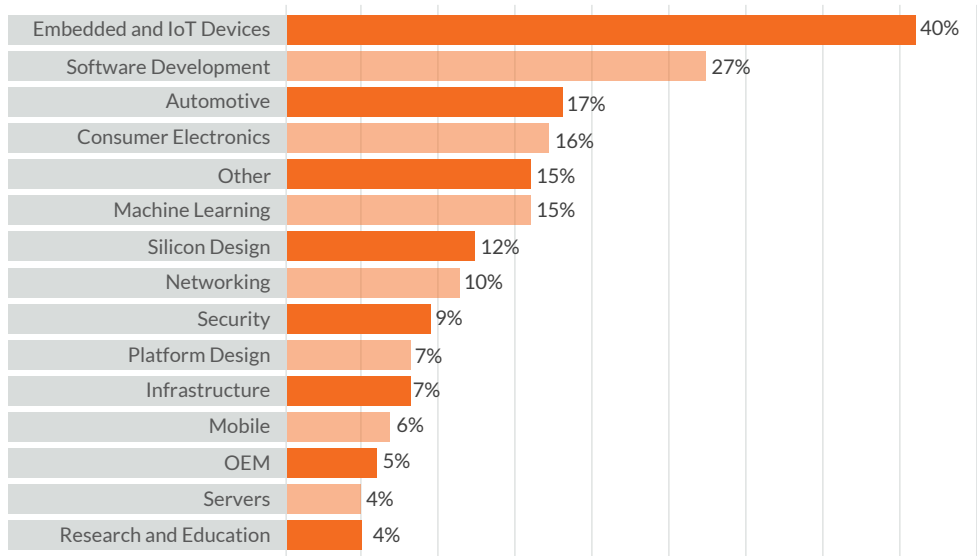
93%

of hardware and software engineers that said Arm technology was a foundation element in their designs
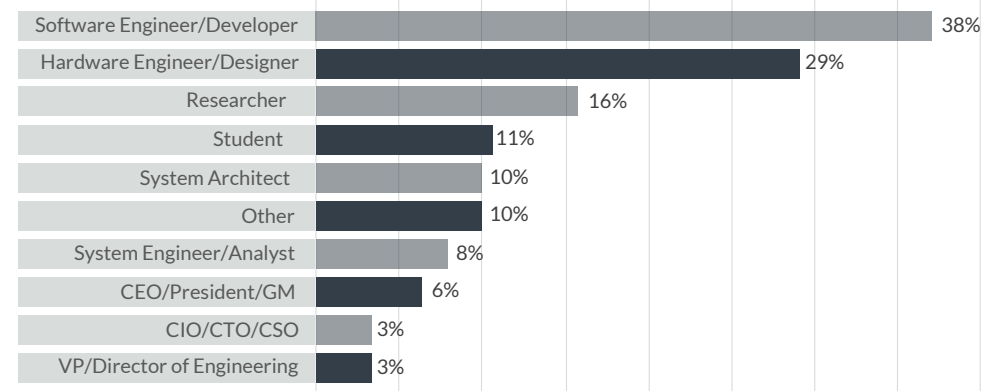
2-5 years

Average length of time most respondents have been using Arm technology
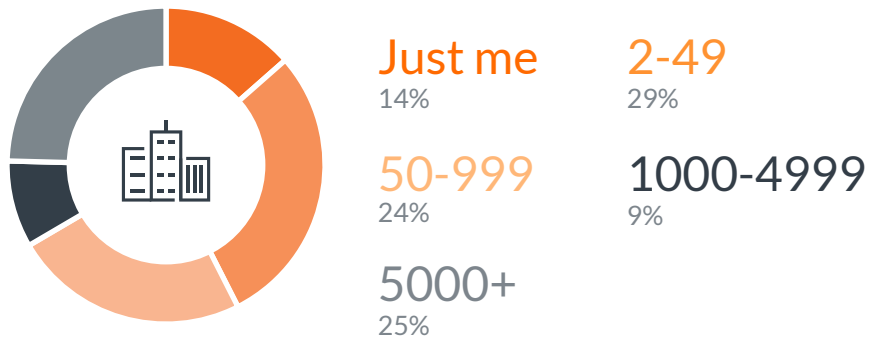
Overview | Survey Responses

Which of the following best describes your company's focus?

Category	Percent
Embedded and IoT Devices	40%
Software Development	27%
Automotive	17%
Consumer Electronics	16%
Other	15%
Machine Learning	15%
Silicon Design	12%
Networking	10%
Security	9%
Platform Design	7%
Infrastructure	7%
Mobile	6%
OEM	5%
Servers	4%
Research and Education	4%

What is your main role?

Role	Percent
Software Engineer/Developer	38%
Hardware Engineer/Designer	29%
Researcher	16%
Student	11%
System Architect	10%
Other	10%
System Engineer/Analyst	8%
CEO/President/GM	6%
CIO/CTO/CSO	3%
VP/Director of Engineering	3%

How many employees are there in your company?

Just me
14%

2-49
29%

50-999
24%

1000-4999
9%

5000+
25%

Where is your company headquartered?

45%
Americas

35%
Europe, Middle East and Northern Africa

20%
Asia Pacific

5

Overview | Survey Responses

For how many years have you used Arm technology?

- 10+ 17%
- 6-9 18%
- 0-1 23%
- 2-5 42%
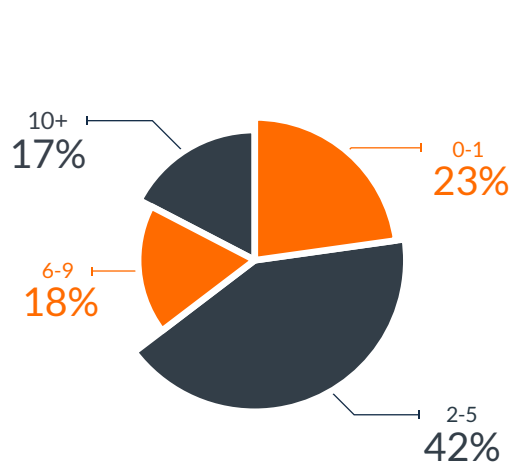
How important is Arm technology to your work?

- Not At All Important 2%
- Not So Important 9%
- Somewhat Important 26%
- Extremely Important 28%
- Very Important 35%
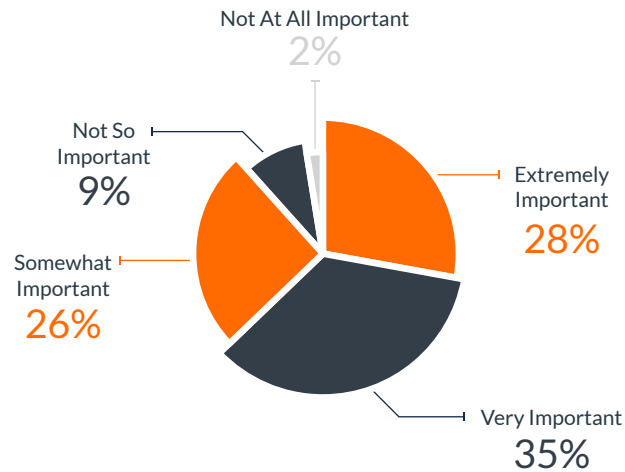
Where do you see the majority of your company's commercial and technical focus being directed in the next 5 years?

- Other 11%
- Independent autonomous endpoint devices 22 %
- Automobiles 11%
- In the cloud and data centre 23%
- Across the edge of the network 17%
- Smartphones and other interactive personal computing devices 15%
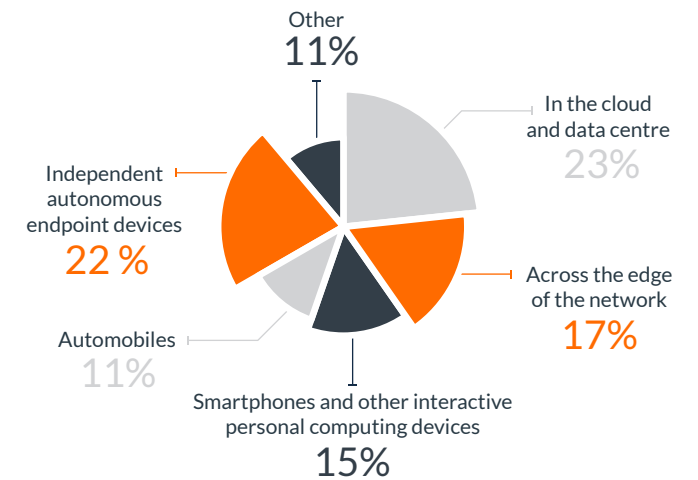
A Year of Change | Introduction

COVID-19 has had a profound effect on almost every aspect of our lives, yet the overall picture painted by our respondents is one of resilience and cautious optimism. Almost two-thirds of people told us they'd been able to return to pre-COVID levels of productivity, though a third admitted they struggled initially.

This gap between then and now was most evident in Asia-Pacific (APAC) regions where **40 percent of respondents said they found work more difficult initially but they were almost back to normal now.** That compared to 30 percent in other regions. We are editorializing but the difference is likely the result of APAC countries generally moving swiftly to control the virus with strict lockdown protocols and then holding them in place rigidly.

Comparing job roles reveals that students have been most affected by the pandemic: **42 percent stated that it was more difficult to work now,** compared to only 18 percent of software engineers, for example. When it came to business strategy, CEOs were unsurprisingly most likely to be kept up most at night: **1 in 5 CEOs said their company's business strategy has been affected a great deal.**

Respondents noted that the pandemic had also placed greater importance on certain technologies—ranking video conferencing and high-speed broadband as most integral to life in the 'new normal'.

This awareness of shifted priorities has led many to reassess their plans: **the overwhelming majority (93 percent) of respondents felt that the new remote working model would be a consideration in future technology designs,** with a third labelling it 'extremely important' to consider.
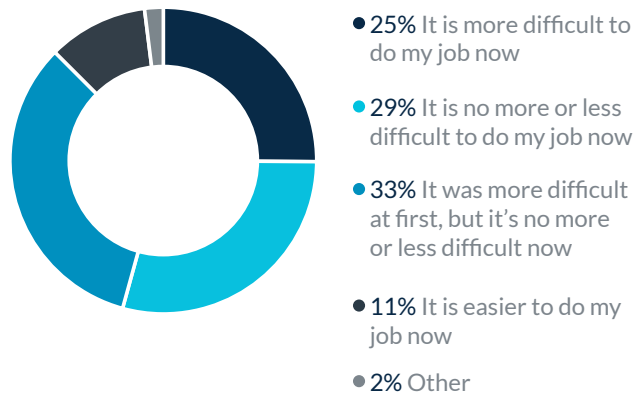
93%

of respondents feel remote working models could be here to stay for design teams

1 in 10

respondents say it has actually become easier to do their job as a result of the pandemic
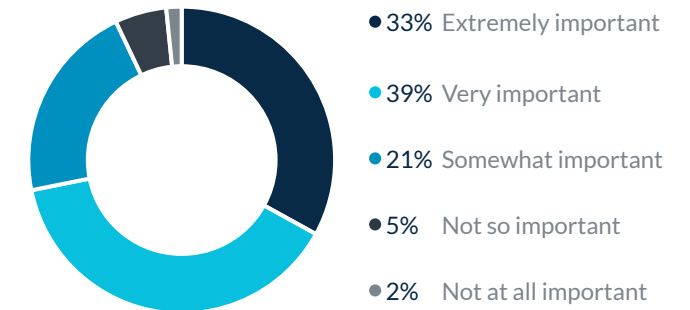
A Year of Change | Charts

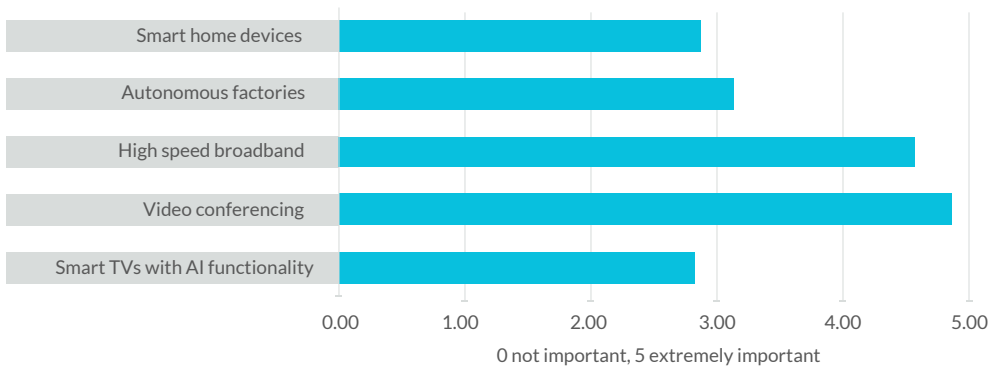## How has the COVID-19 pandemic affected your work personally in 2020?

- 25% It is more difficult to do my job now
- 29% It is no more or less difficult to do my job now
- 33% It was more difficult at first, but it's no more or less difficult now
- 11% It is easier to do my job now
- 2% Other

To what extent has the COVID-19 pandemic affected your company's business strategy in 2020?

- 14% A great deal
- 19% A lot
- 31% A moderate amount
- 26% A little
- 10% None at all
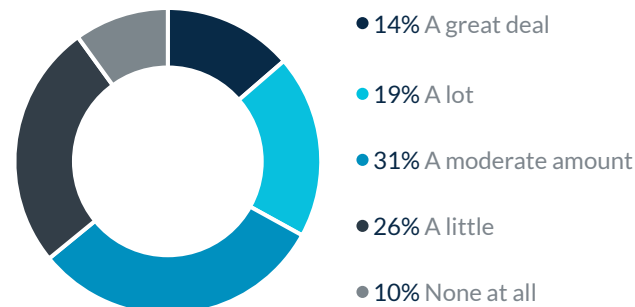
How important of a consideration is the new remote workforce in designing future devices?

- 33% Extremely important
- 39% Very important
- 21% Somewhat important
- 5% Not so important
- 2% Not at all important

Rank the following technologies by those that have become more important due to COVID-19

Technology	Rating
Smart home devices	
Autonomous factories	
High speed broadband	
Video conferencing	
Smart TVs with AI functionality	

0.00   1.00   2.00   3.00   4.00   5.00

0 not important, 5 extremely important

Client | Introduction

Arm's Client line of business focuses on the core IP powering devices in everyday use: smartphones, tablets, laptops, wearables and smart home devices such as smart speakers and smart TVs.

The consumer device sector is ripe with innovation as consumers demand new features, form factors and ever more immersive experiences.

No surprise, then, that our ecosystem is keen to capitalize on consumers' changing needs: the desire to connect with friends and family via video devices is reflected in **the majority (43 percent) of respondents' interest to explore new AI features inside camera technology in 2021.**

Health and fitness monitoring is a close second (35 percent), beating XR (AR and VR) technology (24 percent)—and **when we asked about the biggest benefit from XR might be, 63 percent of respondents named healthcare.** It may be surprising to those for which XR is synonymous with gaming that only 24 percent of respondents saw that as the big draw. It suggests our partners are looking past the obvious consumer applications at how XR might benefit other sectors.

There's a notable difference in opinion over whether developers have enough access to the software and hardware needed to optimize their apps. **65 percent of hardware engineers say yes—yet only 25 percent of CIOs, CTOs and CSOs agree.** Perhaps this a result of fragmented toolchains presenting a confused view of what is available to those in C-suite roles: something Arm is actively addressing through Total Compute (more on that later in the report).

60%

of respondents thought developers have enough access to the software and hardware they need to optimize their apps

⅔

of respondents will be focusing more on security in 2021

NB. The results within this section are based on a sample size of 124 responses

Client | Insight

Paul Williamson, VP and General
Manager, Client Line of Business at Arm

"

These results show a clear shift
in people's long-term behaviors
and value assessments of what
we all want from technology.

It's no surprise that the majority of respondents said the global shift towards remote working will be an important consideration in future product designs. The pandemic has demonstrated to many companies and their employees that remote working can be efficient, and I believe we'll see long term behavioral changes as people mix the social and learning benefits of being in a shared space with the freedom to work wherever they are most productive: office, home, coffee shop or park.

For that to happen, our key productivity devices need to be available whenever and wherever we need them. I believe we'll see increased demand for laptops capable of all-day working as users look for go-anywhere devices that don't need recharging after a few hours of Zoom calls.

All-day battery life isn't the only feature we've become used to in smartphones that consumers will start asking for in laptops. As video conferencing has become commonplace, it's led many to a key realization: their laptop's camera isn't a patch on their smartphone's.
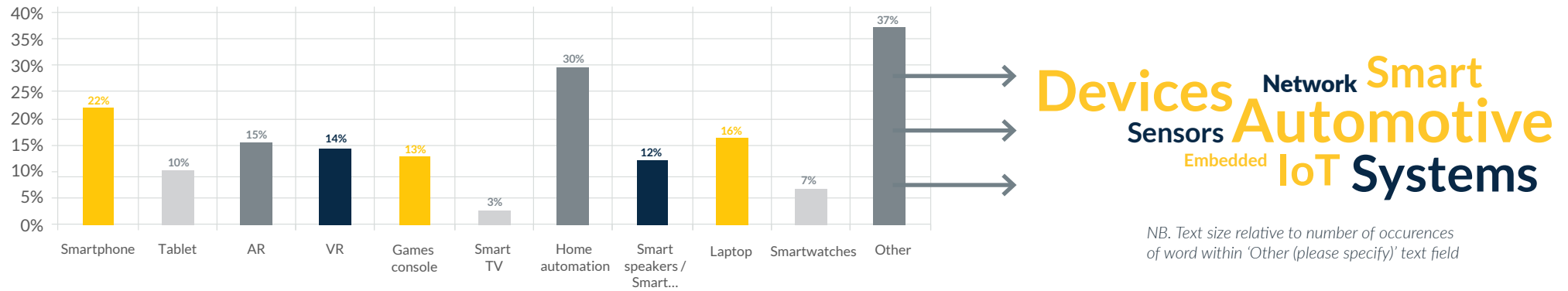
While there's hope we'll all get to see each other again soon, I don't think we'll ever go back to audio-only as the conferencing platform of choice. Perhaps one reason why the majority of respondents, when asked, identified AI Camera as the most interesting emerging application to explore in 2021.

Expect better and better image quality from cameras with dedicated system on chips (SoCs) capable of AI-powered image correction in future generations of laptop-class devices, bringing an even more immersive experience to productivity devices.

We've also spent more time in our homes recently, and that's led to us about the possibility of richer and more immersive experiences on our own doorsteps. It's telling that so many respondents said they were interested in exploring home automation technology in 2021. It puts an onus on the technology sector to think about how some of the smartphone features we love might be replicated inside a broad set of smart home devices, with an emphasis on ease of use and excitement.
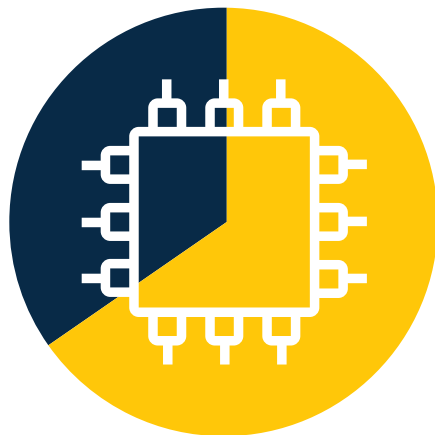
Client | Survey Responses

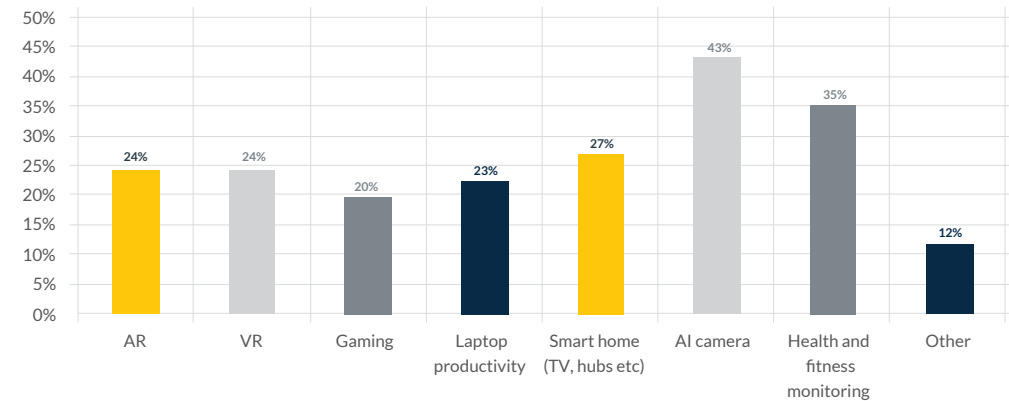## What devices will you be building or developing for in the next year?

Bar chart values:
- Smartphone: 22%
- Tablet: 10%
- AR: 15%
- VR: 14%
- Games console: 13%
- Smart TV: 3%
- Home automation: 30%
- Smart speakers / Smart…: 12%
- Laptop: 16%
- Smartwatches: 7%
- Other: 37%

Word cloud: Devices, Network, Smart, Sensors, Automotive, Embedded, IoT, Systems

NB. Text size relative to number of occurences of word within 'Other (please specify)' text field

Are you contemplating entering new markets or product categories in 2021?

67% YES

33% NO

Which of these emerging applications and use cases are you most interested in exploring in 2021?


Bar chart values:
- AR: 24%
- VR: 24%
- Gaming: 20%
- Laptop productivity: 23%
- Smart home (TV, hubs etc): 27%
- AI camera: 43%
- Health and fitness monitoring: 35%
- Other: 12%

Client | Survey Responses

Do you think developers have enough access to the software and hardware needed to optimize their apps?

40%
NO

60%
YES
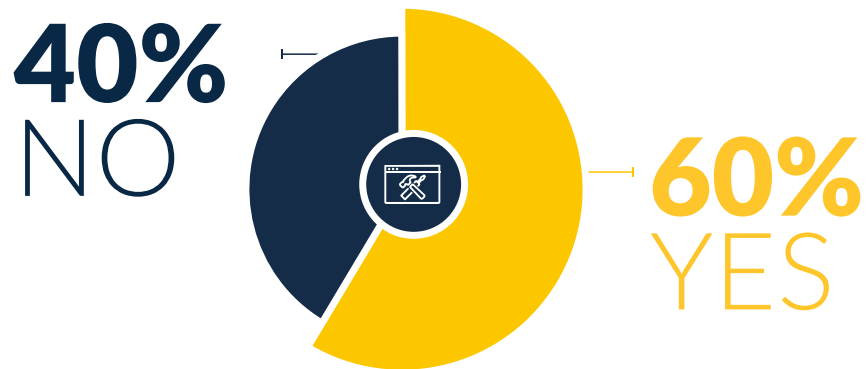
What are more important to you with respect to system performance measurements?

90%
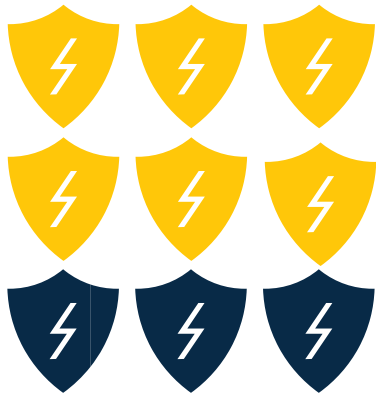Real life-based use cases

10%
Synthetic benchmarks
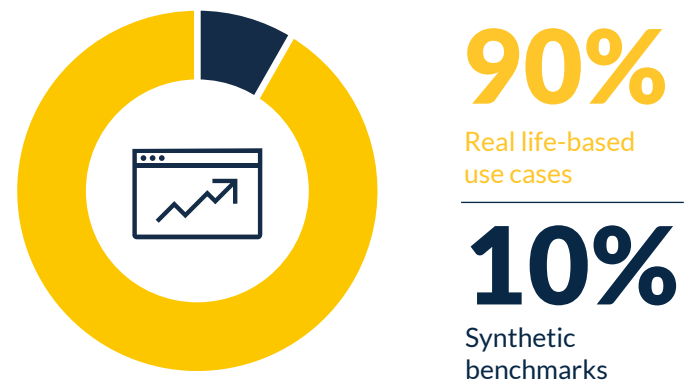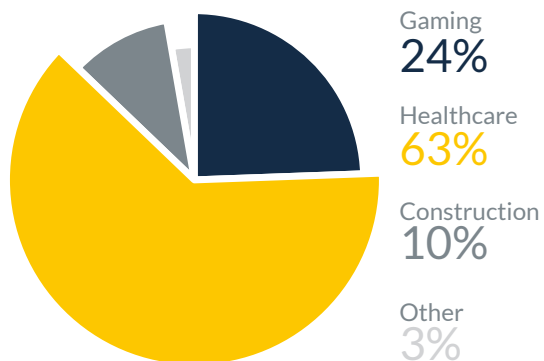
Client | Survey Responses

Will you be focusing more on security in 2021 than previous years?

67% YES

33% NO

What sectors do you think will benefit the most from implementing XR?

Gaming
24%

Healthcare
63%

Construction
10%

Other
3%

Paul Williamson
VP and General Manager,
Client Line of Business at Arm

"

AR, VR, AI camera: Building in advanced AI features into devices comes with a long list of design considerations due to the inherent complexity.

Arm's role is to give our partners a platform of foundational technology that extracts some of that complexity so those same partners can focus on the ultimate end user experience. Our path is built around a Total Compute strategy, moving beyond individual IP elements to designing and optimizing the System on Chip (SoC) as a system of elements. As part of the first key pillar of Total Compute—performance—optimizing an SoC also requires designing for real-life use cases rather than relying on synthetic benchmarks and I'm glad to see that 90 pecent of respondents agree that this is the way forward.

The second pillar of Total Compute is security, and again, it's reassuring to hear that two-thirds of respondents will focus more on security in 2021 than in previous years. Looking at the responses across IoT and infrastructure, security is clearly top of mind for many of our partners. That is perfectly in line with our Total Compute strategy as it is founded on the principle of ensuring manufacturers and application developers can address privacy concerns of end users more easily.

The third pillar deals with developer access: consolidating our toolchain across the entire SoC, ensuring developers have everything they need to build what they want to in the best way possible. While 60 percent of developers have access to the technology they need to optimize their apps, we need to address the fact that 40 percent of respondents felt they did not. This will be a key focus for Total Compute in the coming years.

Read more about *Arm Total Compute* *on Arm Blueprint*

13

IoT and Automotive | Introduction

Arm's Automotive and Internet of Things (IoT) lines of business may seem to target opposite ends of the device spectrum, but they have far more in common than you might think.

The automotive, industrial and consumer IoT industries are both being disrupted by the rise of autonomous decision-making—and over half our respondents recognize the benefits to these industries. The combination of autonomous technology and 5G connectivity means that autonomous vehicles will effectively become AI endpoints within the IoT.

Automotive and industrial IoT applications must also operate to similarly high levels of reliability and functional safety—especially when interacting with humans. The results of our survey suggest that the Arm ecosystem is in agreement on this: **when we asked respondents to rank five key factors in achieving success with autonomous computing, functional safety came out on top**. In fact, when asked what the biggest challenge was in achieving the mass deployment of Level 4 (self-driving in most environments) vehicles, **the majority (41 percent) called out functional safety**.

When it comes to future IoT innovation, **sensor processing is seen to be the most important factor (48 percent), followed by computer vision (38 percent).** Voice recognition is only seen to be key by 13 percent of respondents, perhaps because it is felt to already be well established. Of course, there's plenty more to be done to enable voice in standalone devices, but it's clear that respondents are now interested in what use cases other senses might enable.

It's interesting to note that **57 percent of respondents believe that productivity—working from the car—will be a major draw for autonomous vehicles**. This might be surprising given the other options (games with family or enjoying movies and TV) but given how much time many people spend commuting via road (at least, in a normal year), this is perhaps indicative of people wanting to take that 'wasted' time back.

58%

of respondents think the ability to work from the vehicle will be the most popular feature in future mobility solutions

Functional safety

is the #1 factor for achieving success with autonomous computing, according to our survey

NB. The results within this section are based on a sample size of 725 responses

IoT and Automotive | Insight

Dipti Vachani, Senior VP &
General Manager, Automotive &
IoT Line of Business at Arm

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It's clear to me that the Arm ecosystem is about relentless and quickening change – change in the innovation rate in IoT and automotive sectors as each embraces new and powerful levels of autonomous technology. Companies that embrace the change will succeed and those that hesitate may struggle.

At the core of widespread industry transformation is a simple but disruptive trend: Software is increasingly driving hardware definition and design. And nowhere is this clearer than along the journey to autonomous capability.

We often talk about the challenges in the hardware, but it's the challenges in the software that are causing a revolution in hardware design. In this new world of autonomous, it's really about heterogeneous compute. You have applications coming together – the camera, sensors, ML algorithms, CPUs, GPU. How do we bind those together and yet give enough flexibility to the software because it's software-driven hardware? You have to have flexibility in the software. Today, it's 'here's the software I need to run. Build me the hardware to run it on.' That's turning the old equation upside down.

I also note in the survey that functional safety is seen to be by far the most important factor for achieving success in autonomous computing. This is important, but let's remember most of the ideas and concepts around functional safety were created for a car that had few or no autonomous features. As we go into a transition to the world of fully autonomous cars and the burden on the electronics rises, how does the technology of functional safety need to change? How are we consistent across our industry or ecosystem in how we apply and use functional safety?

The complexity and interconnected nature of IVI and other systems in your car require not only a holistic approach to design but the need to embrace heterogeneous compute approaches, simply because of the diversity of requirements.
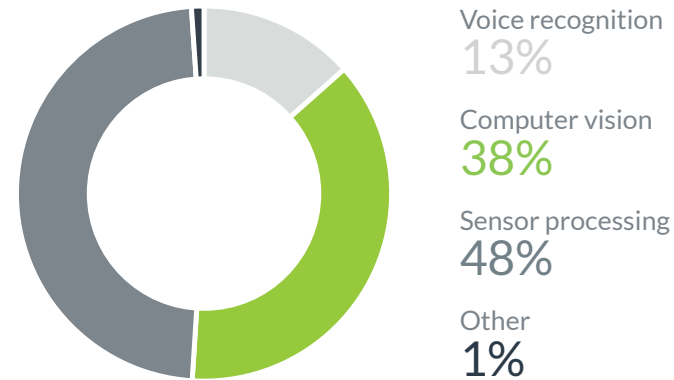
In so many ways, we're in uncharted waters. As an industry and now more than ever, we need to work together to move forward and overcome the biggest challenges that lie ahead.
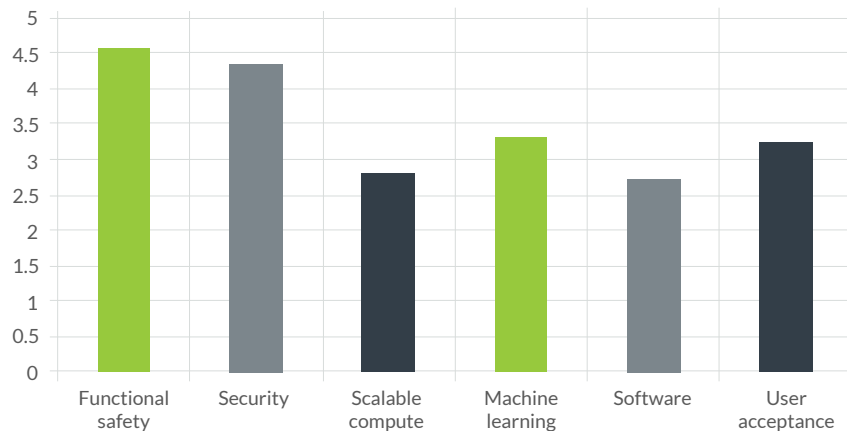
IoT and Automotive | Survey Responses

In which application areas do you see potential for autonomous decision-making, i.e. computers making decisions for people?
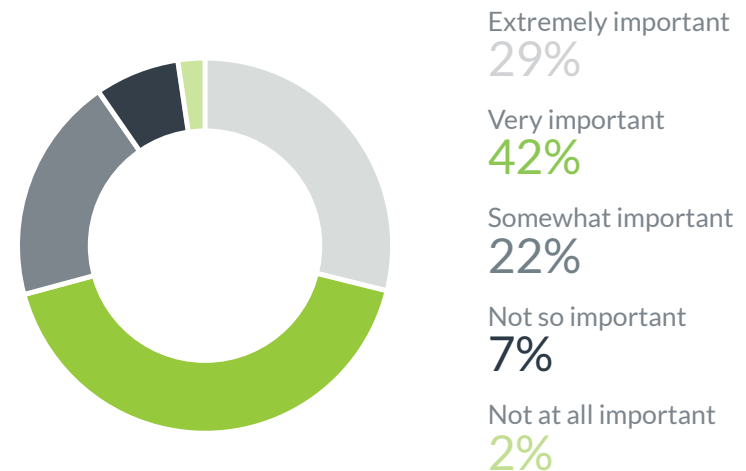
Self-driving cars	65%
Consumer IoT	59%
Industrial manufacturing	57%
Other	7%
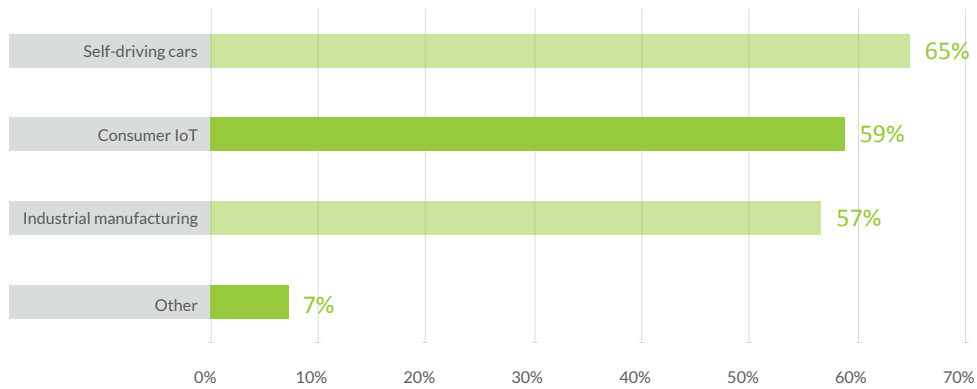
What kind of IoT workloads will be key to future innovation?

Voice recognition
13%

Computer vision
38%

Sensor processing
48%

Other
1%

What is the most important factor for achieving success with autonomous computing?

Functional safety · Security · Scalable compute · Machine learning · Software · User acceptance

How important is fast/seamless verification and tooling to your product development cycle?

Extremely important
29%

Very important
42%

Somewhat important
22%

Not so important
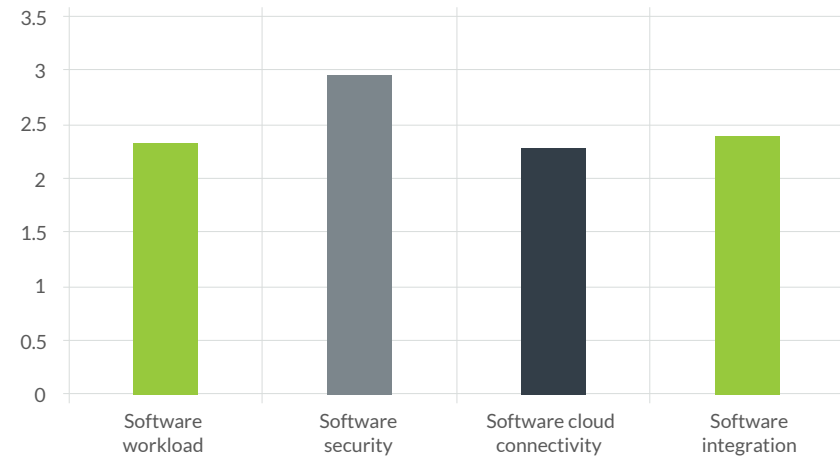**7%**

Not at all important
2%

16

IoT and Automotive | Survey Responses

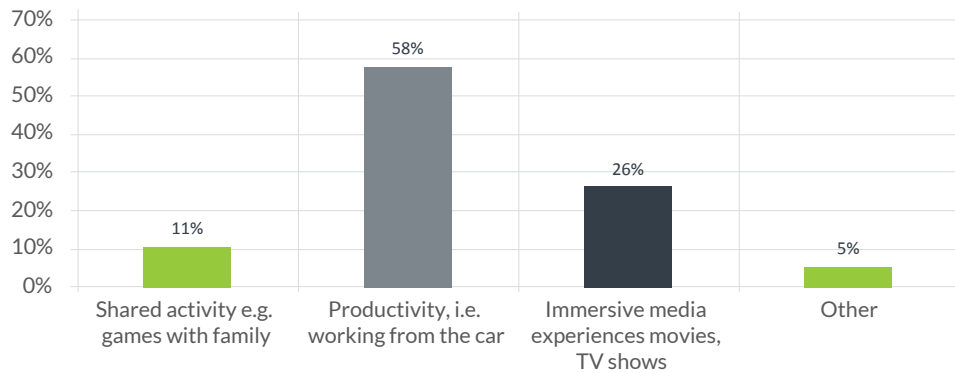**Rank these hardware considerations for the development of IoT devices in order of importance.**
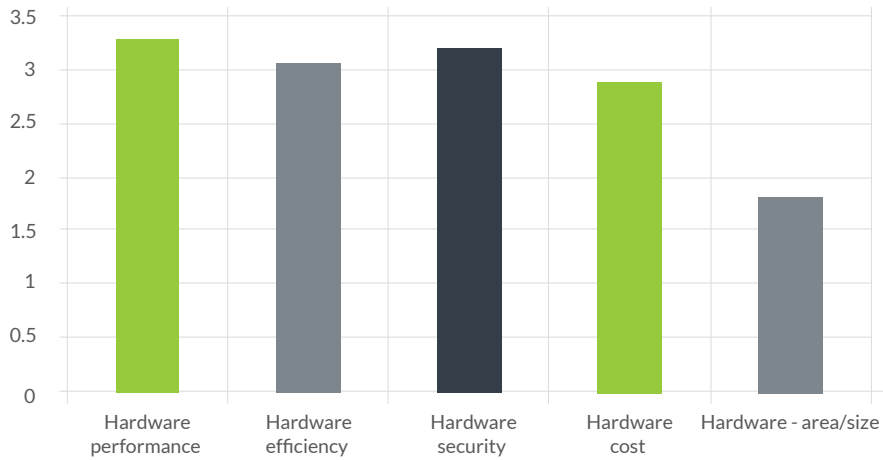
Rank these software considerations for the development of IoT devices in order of importance
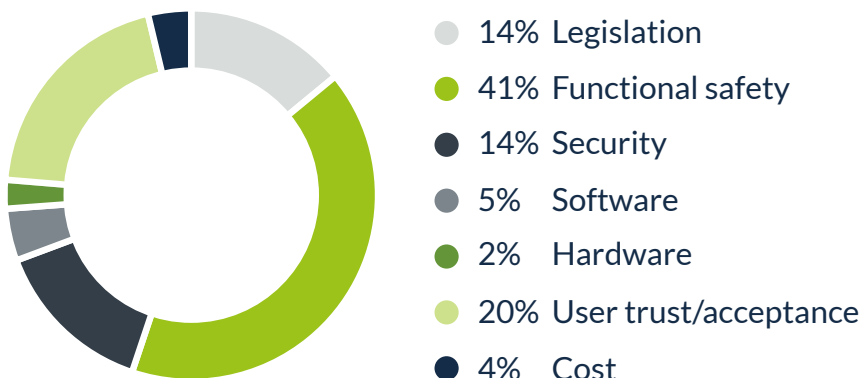
IoT and Automotive | Survey Responses

Dipti Vachani
Senior VP & General Manager,
Automotive & IoT Line of Business at Arm

What kind of in-car experiences do you expect will be most popular for future mobility solutions?

Shared activity e.g. games with family	11%
Productivity, i.e. working from the car	58%
Immersive media experiences movies, TV shows	26%
Other	5%

What is the biggest challenge to achieving the mass deployment of Level 4 vehicles?

- 14% Legislation
- 41% Functional safety
- 14% Security
- 5% Software
- 2% Hardware
- 20% User trust/acceptance
- 4% Cost

"

It's important that the industry thinks about systems being 'ever more secure,' rather than 'secure.' That's the journey we're on. The security bar keeps moving, and there really is no finite end goal: We need to strive for 'more secure' and get comfortable with the fact that we're going to have to learn to keep up.

The survey responses around security (security was the most important consideration for both hardware (28 percent) and software (43 percent) development within the IoT), were really spot on.

We have to think about how we become more secure by working across the industry and that's why standards like Platform Security Architecture (PSA) are really making a difference. Now we know 'here's the bar; here's what it takes to be more secure now.' We learn from each other as we move the bar along that journey.

Infrastructure | Introduction

Arm's infrastructure organization focuses on the semiconductor IP, software and standards needed to build today's high-performance data centers, networks and edge deployments. Arm technology can be found inside some of the largest hyperscale datacenters in the world.

Despite the recent economic downturn, infrastructure remains one of the strongest growth markets in technology as more companies shift their workloads to the cloud and more individuals come to rely on videoconferencing and broadband to work, keep in touch and perform daily tasks like shopping or watching TV.

Cloud providers and carriers, however, are not basking in rosy expectations of success. Competition is intense and service level expectations continue to climb. Security was viewed by nearly half (48 percent) as the most important consideration for customers while cost (49 percent) was viewed as the factor that could have the most important impact in moving applications to the cloud.

The edge is also top of mind, with 30 percent of respondents viewing having a cloud-to-edge architecture as extremely important. 43 percent also added that a distributed cloud architecture, which entails shifting workloads between the edge and the cloud, would become an important factor in their architectures.

The results also showed a growing willingness to experiment with new servers with 56 percent expressing interest in high performance computing in the cloud.

49%

of respondents said cost savings from cloud infrastructure simplification and automation would have the greatest on their organization's future success

56%

of respondents use or plan to increase adoption of high-performance computing (HPC) in the near future

NB. The results within this section are based on a sample size of 53 responses

Infrastructure | Insight

Chris Bergey, SVP and General Manager, Infrastructure Line of Business at Arm

"

The issue of resilience will come up a lot in 2021 as the pandemic has stressed the world's computing infrastructure in ways we could hardly have imagined.

The pandemic is prompting organizations to think more about the quality of their cloud experience. Do we have adequate videoconferencing capacity to keep employees connected at home? Is our data consolidated in one place or should it be replicated in multiple locations for more rapid, reliable access? The physical locality of employees, data and customers is being looked at in a new light.

In the survey, 43 percent predicted distributed cloud architectures would become one of the most important factors in their cloud strategy, second only to cost savings. Expect to see people spend more time and energy looking at multivendor cloud strategies, cloud/

edge/on-premises architectures and other distributed cloud concepts as a way to ensure better data and application access.

Security, naturally, remains a priority. People, in fact, rated security as the most important factor when choosing a cloud provider.

While the cloud can improve security, customers also need assurances against third parties accessing their data, either on purpose or by accident. Enhancing confidentiality, and the perception of confidentiality among users, in a cloud- and edge-centric world will be a concept we hear more about in the coming year.

Infrastructure | Survey Responses
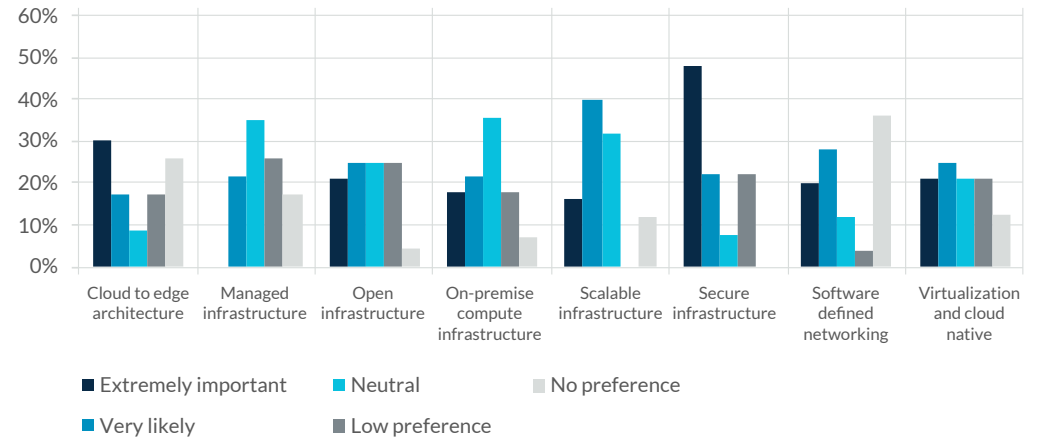
Which of the below outcomes will have the greatest impact on your organization's future success?

Outcome	Percentage
Trust and integrity - delivering secure and reliable solutions	39%
Insight driven operations - predictive and prescriptive	20%
Distributed cloud architectures - ability to shift workloads more easily based on customer	43%
Better customer experiences - on demand and personalized	25%
Cost savings - cloud infrastructure simplified and automation	49%
Business agility - accelerate time to revenue	27%

How relevant are each of these cloud infrastructure choices for your organization?

Legend:
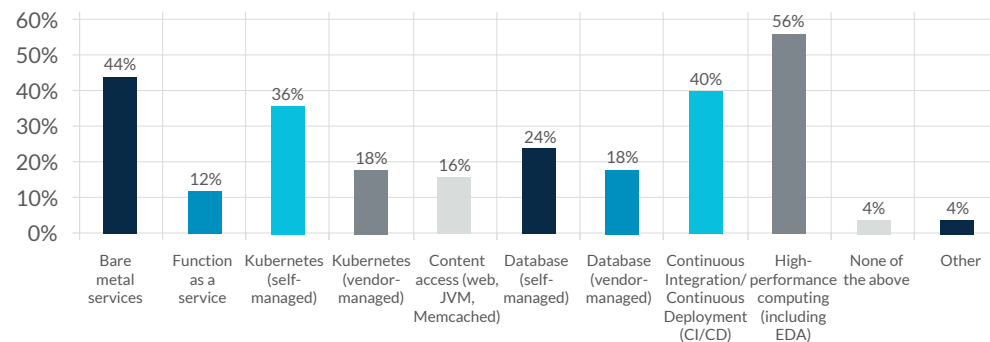- Extremely important
- Very likely
- Neutral
- Low preference
- No preference

Infrastructure | Survey Responses

Which of the following virtualization technologies do you run in your cloud?

Bar chart values:
- Containers: 26%
- Virtual Machines: 34%
- Bare Metal servers: 18%
- Container virtual machines: 30%
- Containers and bare metal: 10%
- Containers and virtual machines: 22%
- Virtual machines and bare: 8%
- None of these: 14%
- Other: 2%
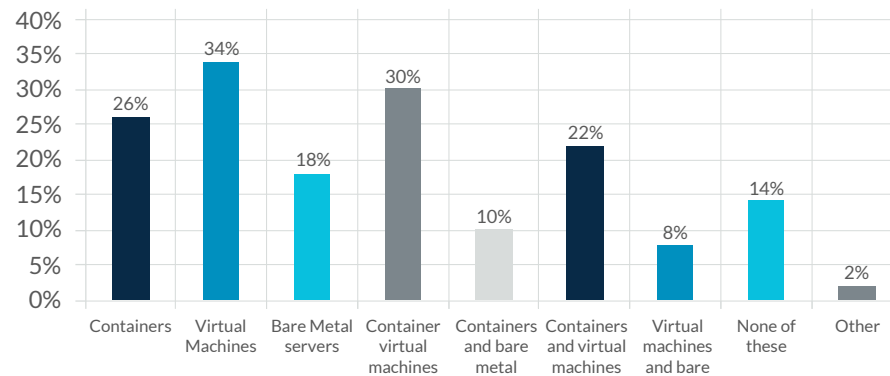
Which of the following cloud use cases do you currently use or plan to increase adoption of in the near future?

Bar chart values:
- Bare metal services: 44%
- Function as a service: 12%
- Kubernetes (self-managed): 36%
- Kubernetes (vendor-managed): 18%
- Content access (web, JVM, Memcached): 16%
- Database (self-managed): 24%
- Database (vendor-managed): 18%
- Continuous Integration/ Continuous Deployment (CI/CD): 40%
- High-performance computing (including EDA): 56%
- None of the above: 4%
- Other: 4%

Chris Bergey
SVP and General Manager, Infrastructure Line of Business at Arm

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The core technology behind infrastructure is in the middle of a quiet revolution.

Simply put, cloud providers will need technologies that can increase their throughput and performance per rack without causing their equipment requirements or energy budgets to snowball. The providers that can boost performance while lowering costs will win market share. As a result, we will see a tremendous amount of experimentation in processors, servers, networking equipment and storage.

You'll also see continued and growing interest in cloud native technologies like Kubernetes and containers, which provide both cloud providers and their customers a greater degree of agility. Cloud native, along with industry standards for security and hardware, will become an elemental part of the fabric linking the cloud and the edge.

It is difficult to predict the future exactly, but when you look at the world we are living in, our insatiable desire for infrastructure connectivity and computing is only accelerating. This means that providers, equipment and technology must continue to provide seamless technological intelligence that just works. The COVID-19 pandemic hasn't caused this change, but it is certainly accelerating it.

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