

DEVELOPER ECONOMICS

THE STATE OF CLOUD NATIVE DEVELOPMENT

THE LATEST TRENDS FROM OUR Q1 2021 SURVEY
OF 19,000+ DEVELOPERS



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CLOUD NATIVE
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2021



We help the world understand developers

We survey 30,000+ developers annually – across web, mobile, IoT, cloud, Machine Learning, AR/VR, games and desktop – to help companies understand who developers are, what they buy and where they are going next.



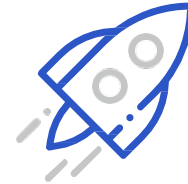
WHO DEVELOPERS ARE

Developer population sizing
Developer segmentation



WHAT THEY BUY

Why developers are adopting
competitor products – and how you
can fix that



WHERE THEY ARE GOING

Emerging platforms – augmented &
virtual reality, machine learning

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the leading tech platforms



OUR CLIENTS

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The analyst of the developer economy | formerly known as VisionMobile
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KEY INSIGHTS

- The global number of cloud native developers has grown in the last 12 months by 0.3 million, to 6.8 million. At the same time, the proportion of backend developers involved in cloud native technologies has declined by 3 percentage points from 44% to 41%.
- Across regions, North America (47%) and Western Europe (46%) have the highest adoption rates. Overall, larger organisations and more experienced developers in these regions are driving adoption.
- Kubernetes is used by 31% of all backend developers, which is an increase of 4 percentage points in the last 12 months. Currently, 5.6M* developers use Kubernetes.
- Across sectors, edge computing has experienced rapid growth in the adoption of Kubernetes and now has the highest usage rates of both containers and Kubernetes.
- Among edge developers only, Kubernetes usage increased in the last 12 months by 11 percentage points to 63%. Edge technology has the highest adoption rate among all surveyed sectors.
- Serverless architecture is also appealing to edge developers: 48% of all edge developers are using serverless compared to just 33% of all backend developers.
- Among serverless tools, AWS Lambda continues to be in the driving seat. However, Google Cloud Run has been gaining considerably in the last 12 months.

**Our methodology has been updated since our Q1 2020 report to ask all backend developers if they use Kubernetes, rather than just developers who identify as using container orchestration tools & management platforms. This results in an increase in the number of developers who say they use Kubernetes. In Q1 2020, using this approach, we observed 3.9M Kubernetes developers in the total population of backend developers, compared to the stated 2.7M who identified as using container orchestration tools & management platforms.*

1. Introduction

1. INTRODUCTION

A. Background

The way software is developed has drastically changed since containers came about and cloud native technology gained popularity. Commissioned by Cloud Native Computing Foundation (CNCF), SlashData has performed an in-depth analysis of the cloud native developer ecosystem to better understand its current state and expected evolution. The analysis is based on the 20th edition of SlashData's Developer Economics survey, which ran between November 2020 and February 2021 and reached more than 19,000 developers globally. 3,800+ survey participants answered questions relating to the development of backend services and the technologies they use.

1. INTRODUCTION

B. Roadmap

As in our previous report¹, we use CNCF's definition of cloud native computing as a guide for this analysis:

“Cloud native technologies empower organisations to build and run scalable applications in modern, dynamic environments such as public, private, and hybrid clouds. Containers, service meshes, microservices, immutable infrastructure, and declarative APIs exemplify this approach. These techniques enable loosely coupled systems that are resilient, manageable, and observable. Combined with robust automation, they allow engineers to make high-impact changes frequently and predictably with minimal toil.”

The first chapter of this report provides estimates for the global number of cloud native developers and an in-depth regional overview of usage rates.

Kubernetes is arguably at the heart of cloud native applications and in the second chapter, we examine developers' usage and awareness of Kubernetes and attempt to identify the drivers that facilitate its adoption across different developer profiles and technologies.

Particular attention is given to edge computing in the third chapter of this report. Edge computing naturally intersects with the cloud native space. We investigate the trends and preferences of edge developers and the infrastructure that is needed to facilitate the adoption of cloud native computing. Many use cases of edge computing require applications to reside on-premises or in the cloud, while others run dynamically at the edge. Edge computing thus recommends itself as a paradigm for adopting Kubernetes, which can handle complex systems with ease through real-time automation and fast scalability of containers.

The report concludes with an in-depth overview of various orchestration and serverless solutions of selected vendors and highlights notable trends in this exciting space.

¹ [The state of cloud native development Q1 2020](#)

1. INTRODUCTION

C. Market size

Our estimates put the global number of cloud native developers for Q1 2021 at 6.8 million, or 41% of backend developers. This includes 4.6M developers using container orchestration tools and 4M developers using serverless platforms; the numbers correspond to 28% and 24% of backend developers, respectively. The estimate also considers an overlap of 1.8M developers using both orchestration and serverless technologies, corresponding to 11% of backend developers.

Although we find **that the cloud native developer population has grown by 0.3M in the last 12 months**, the proportion of backend developers who are involved in cloud native technologies has actually decreased slightly by 3 percentage points, due to a drop in the adoption of serverless architecture. The growth of the cloud native developer population has been driven by a robust increase in the total number of backend developers from 14.7M to 16.6M.

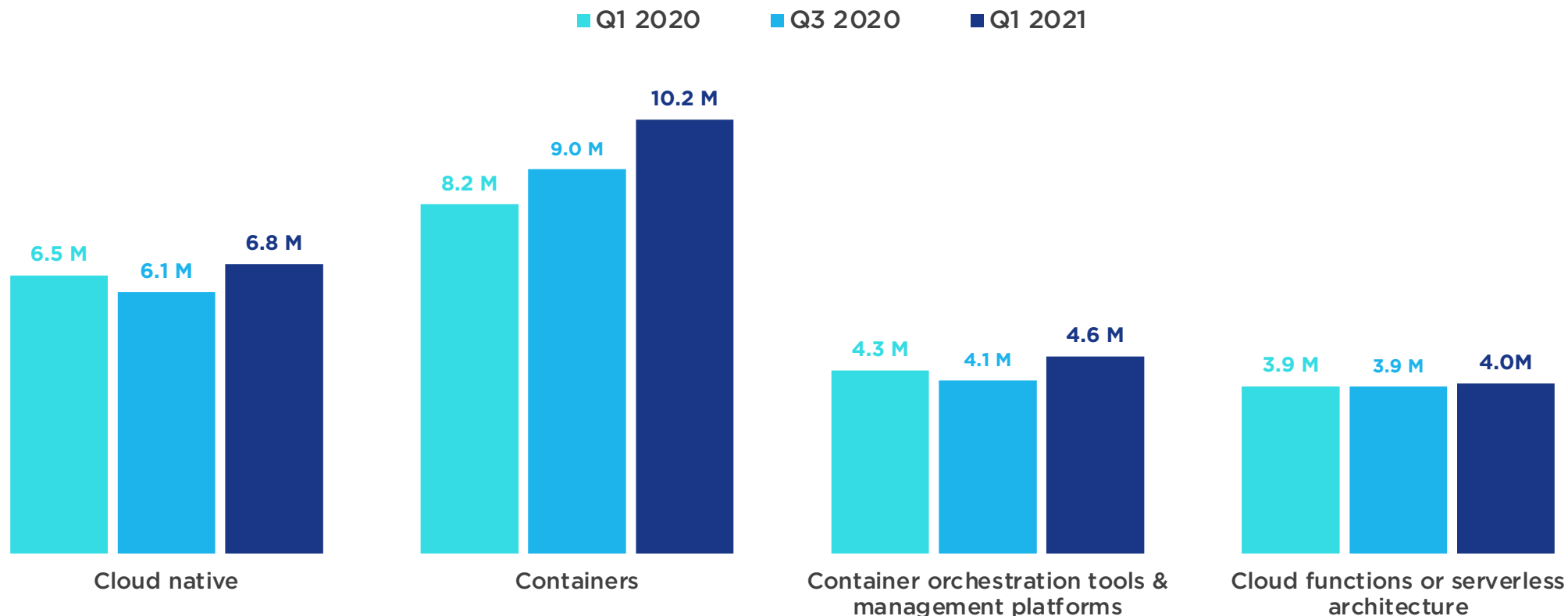
We previously noted in our Q1 2020 report that developers are reluctant in their adoption of serverless architecture. Recent data continues to substantiate this trend. While the total number of developers involved in serverless architecture stagnates at around 4M, the proportion of developers involved in serverless architecture has decreased from 27% to 24%.

Notwithstanding the hype around serverless architecture, what causes the lag in its usage? This downward trend appears to reflect the voice of many pundits that claim that serverless solutions may lack the flexibility to facilitate widespread adoption. For instance, companies are reluctant to lock themselves into specific vendors.

1. INTRODUCTION

The cloud native developer population has grown to 6.8 million

Active cloud native developers (in millions)



1. INTRODUCTION

D. Regional usage of cloud native technologies

The usage of containers and cloud native technologies varies significantly by region. Despite a significant increase in the adoption rates of containers in the last 12 months in almost all regions - except for the Middle East and Africa - **the adoption of serverless solutions has been slightly dwindling**, whereas the adoption of container orchestration remained somewhat unchanged in many regions, including Europe and North America.

Notwithstanding, the increase in the adoption of containers continues the positive trend that we noticed in our previous report. Presently, 61% of backend developers use containers. Western Europe boasts the highest usage rates, with three out of four developers having adopted containers, while the lowest adoption rates are found in the Middle East and Africa. Less than half of developers are managing their application processes through containers in this region.

Unlike the usage of containers and container orchestration, serverless solutions have experienced a significant drop in their usage in many regions, such as North America (-6 percentage points), Eastern Europe (-8 percentage points), South Asia (-6 percentage points), and the Middle East and Africa (-4 percentage points). The two regions that currently defy the negative trend are Oceania (+9 percentage points) and South America (+5 percentage points).

Overall, cloud native computing is now most widely adopted in Oceania (56%), North America (47%), and Western Europe (46%). It remains the least adopted in the Middle East and Africa (28%) and Eastern Europe (37%).

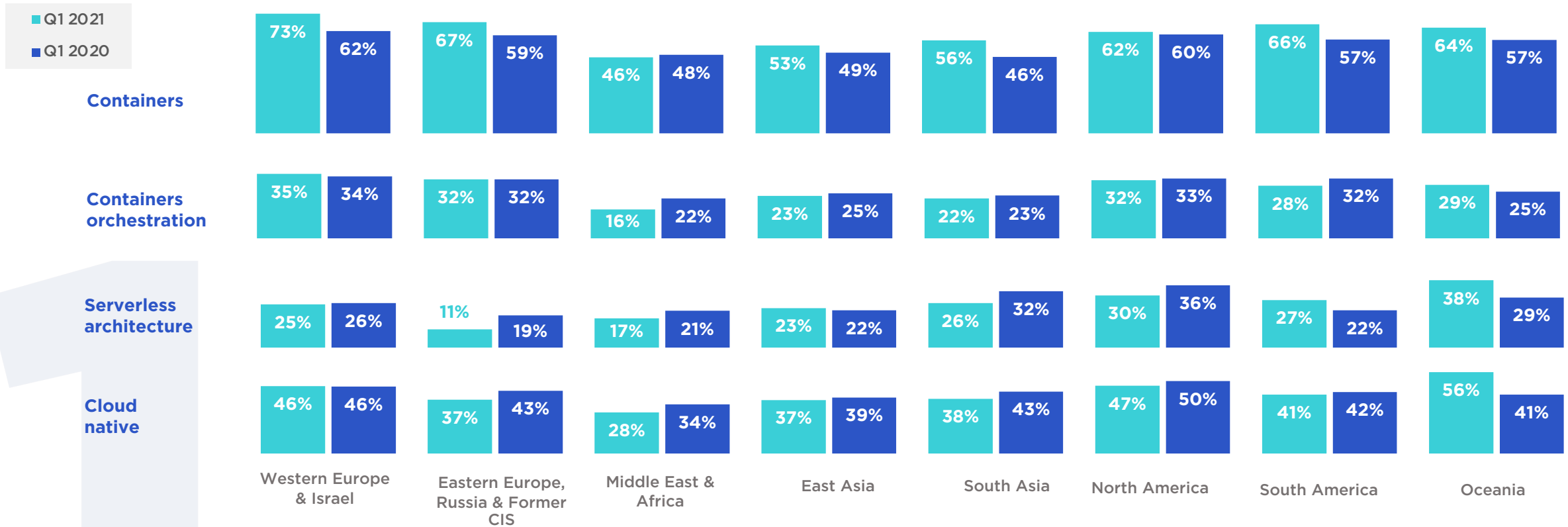
There are good reasons for this divergence in usage rates. As we will see later, **the adoption of container orchestration is closely tied to the company size**; that is, we observe substantially higher adoption rates within larger organisations, likely driven by project complexity. When excluding small organisations with 10 or fewer employees from our analysis, cloud native adoption rates become more balanced across regions, for example, Western Europe (49%), the Middle East and Africa (45%), and Eastern Europe (43%).

1. INTRODUCTION

Usage of cloud native technologies has been shrinking in North America, Eastern Europe, and the Middle East and Africa

% of backend developers in each region (Q1 2020 n=4,179 | Q1 2021 n=3,836)

Usage of cloud native technologies across regions



2. USAGE AND AWARENESS OF KUBERNETES

2. USAGE AND AWARENESS OF KUBERNETES

A. Kubernetes and containers usage and awareness among backend developers

We asked around 7,000 backend developers about their awareness and usage of both Kubernetes and containers. This large sample comprised both cloud native and non-cloud native developers and provides an unbiased picture of how well-known these cloud native technologies are among the whole population of backend developers.

This section explores backend developers' awareness and usage of Kubernetes and containers and examines interesting trends in the data. As of Q1 2021, 57% of backend developers had used containers in the last 12 months, but only 31% of developers used Kubernetes to orchestrate these: 5.6M developers in total. Their overall **usage of Kubernetes has increased by 4 percentage points in the last 12 months**. Kubernetes thus seems to exhibit a distinctive positive trend within the cloud native space, and there is arguably still room to grow.

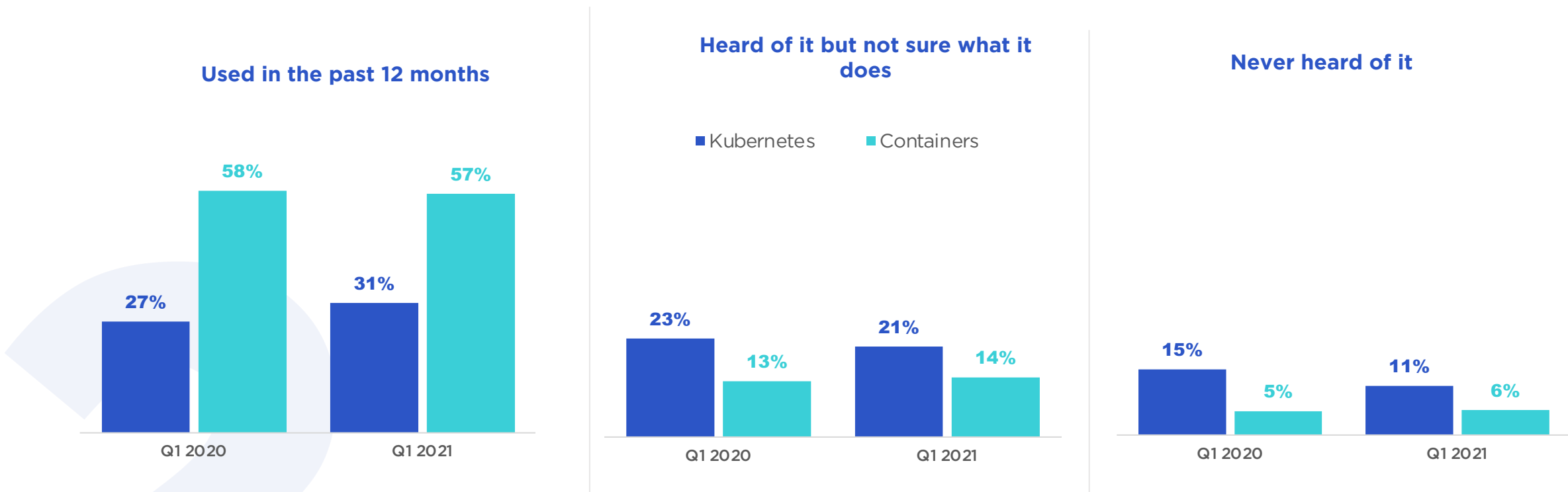
However, 21% of backend developers say they have heard of Kubernetes but are unsure what it does. Another 11% say they have not heard of Kubernetes. **While overall awareness of Kubernetes has significantly increased, many backend developers remain unsure of what it can do for them.** To shed more light on this matter, we will next examine in more depth the profiles of developers who have adopted Kubernetes.

It's important to note that we updated our methodology the Q1 2020 report to ask all backend developers if they use Kubernetes, rather than just developers who identify as using container orchestration tools & management platforms. This change resulted in an increase in the number of developers who say they use Kubernetes. In Q1 2020, using this approach, we observed 3.9M Kubernetes developers in the total population of backend developers, compared to the stated 2.7M who identified as using container orchestration tools & management platforms.

2. USAGE AND AWARENESS OF KUBERNETES

Kubernetes and containers usage and awareness among backend developers

% of backend developers who have used each technology in the past 12 months (Q1 2020 n=6,554 | Q1 2021 n=6,927)



2. USAGE AND AWARENESS OF KUBERNETES

A. Kubernetes and containers usage and awareness among backend developers

We further examined usage of Kubernetes and containers by sixteen technologies that developers are currently working on. For example, we considered technologies such as fog and edge computing, 5G, robotics, quantum computing, cryptocurrencies, and other blockchain applications, among others.

Developers working on edge computing have the highest usage for both containers and Kubernetes. Containers have been used here in the last 12 months by 76% and Kubernetes by 63% of developers currently working on edge computing applications.

While there is arguably some headroom to adopt Kubernetes in edge computing - there's a 13 percentage point gap between containers and Kubernetes in terms of adoption - there are other technologies worth mentioning here. The largest headrooms are in technologies that involve the development of mini apps and computer vision, with 27 percentage point and 23 percentage point gaps between the usage of containers and Kubernetes, respectively.

On the flip side, the technologies with the smallest headroom are haptic feedback¹ (5 percentage points), quantum computing (6 percentage points), and self-driving cars (8 percentage points).

Why are developers in certain technologies more reluctant to adopt Kubernetes despite the high usage of containers? At first glance, the technologies providing less headroom seem more demanding or complex in terms of development needs, for example, as presumed in the cases of quantum computing or haptic feedback.

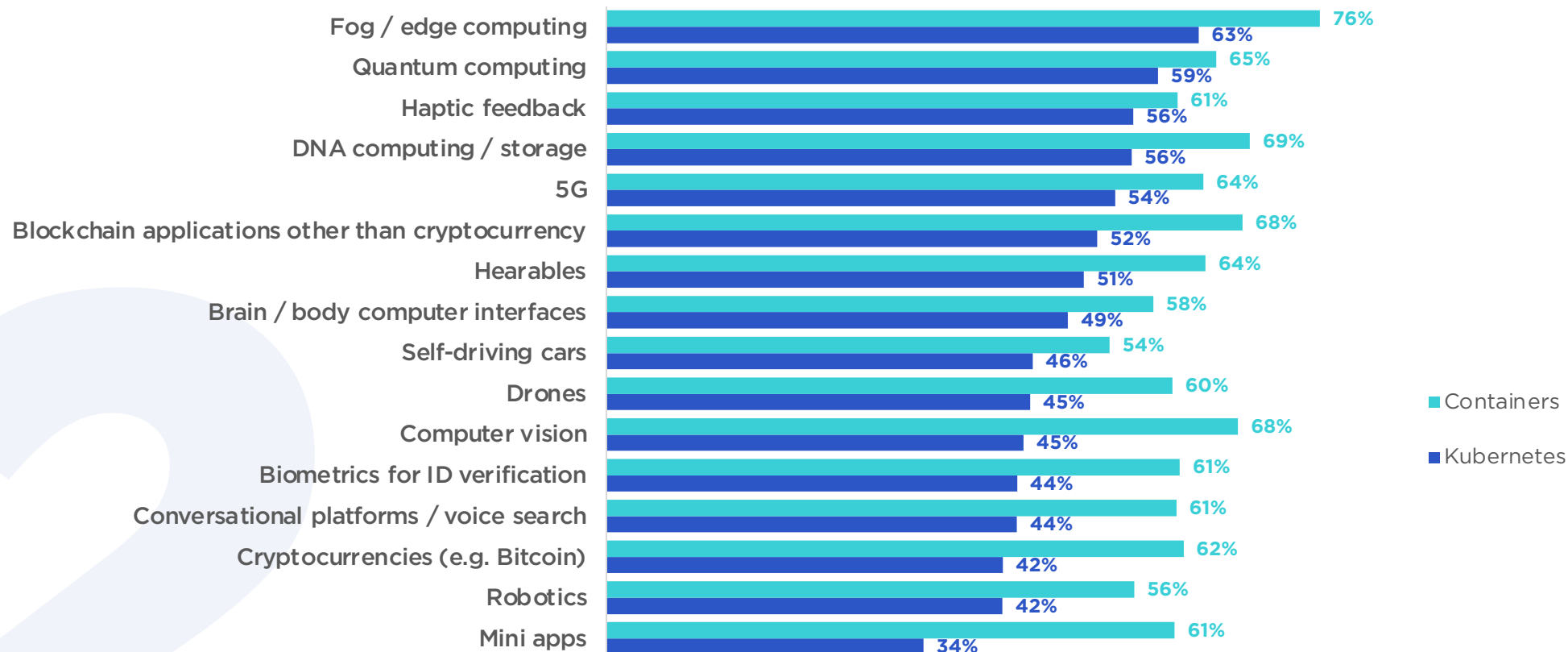
¹Haptic feedback is the use of touch feedback to end-users through vibrations or motions.

2. USAGE AND AWARENESS OF KUBERNETES

Kubernetes and container usage and awareness among backend developers

% of backend developers using containers and Kubernetes by area of involvement (Q1 2021 n=6,927)

Usage of Kubernetes and containers in the last 12 months by technology



2. USAGE AND AWARENESS OF KUBERNETES

B. Profile of backend developers using Kubernetes

To test the claim of the complexity of the technology driving Kubernetes usage, we segmented the data by developers' professional status, experience, and the size of the organisation they are working in and ran a statistical model. **The most significant predictor that drives Kubernetes adoption is the size of the organisation that a developer works for** and this relationship holds regardless of the fact that larger companies have, in general, more experienced developers working for them.

Indeed, **the adoption of both Kubernetes and containers skyrockets for large organisations with more than 500 employees**. Moreover, the average headroom across all technologies decreases from 20% for developers in small and medium-sized organisations to just 11% for developers working in large organisations. In some technologies, Kubernetes adoption even matches container usage. For example, 83% of developers working on haptic feedback technology, i.e., the use of touch feedback to end-users through vibrations or motions, in large organisations use both containers and Kubernetes.

Interestingly, **the difference between container and Kubernetes usage is just 5% within large organisations with high adoption rates for both containers (83%) and Kubernetes (78%)**. Therefore, within larger organisations, the adoption of Kubernetes among edge developers is already high relative to the adoption of containers. It stands to reason that edge developers are also more likely to be employed in larger organisations, for example, in the industrial IoT sector.

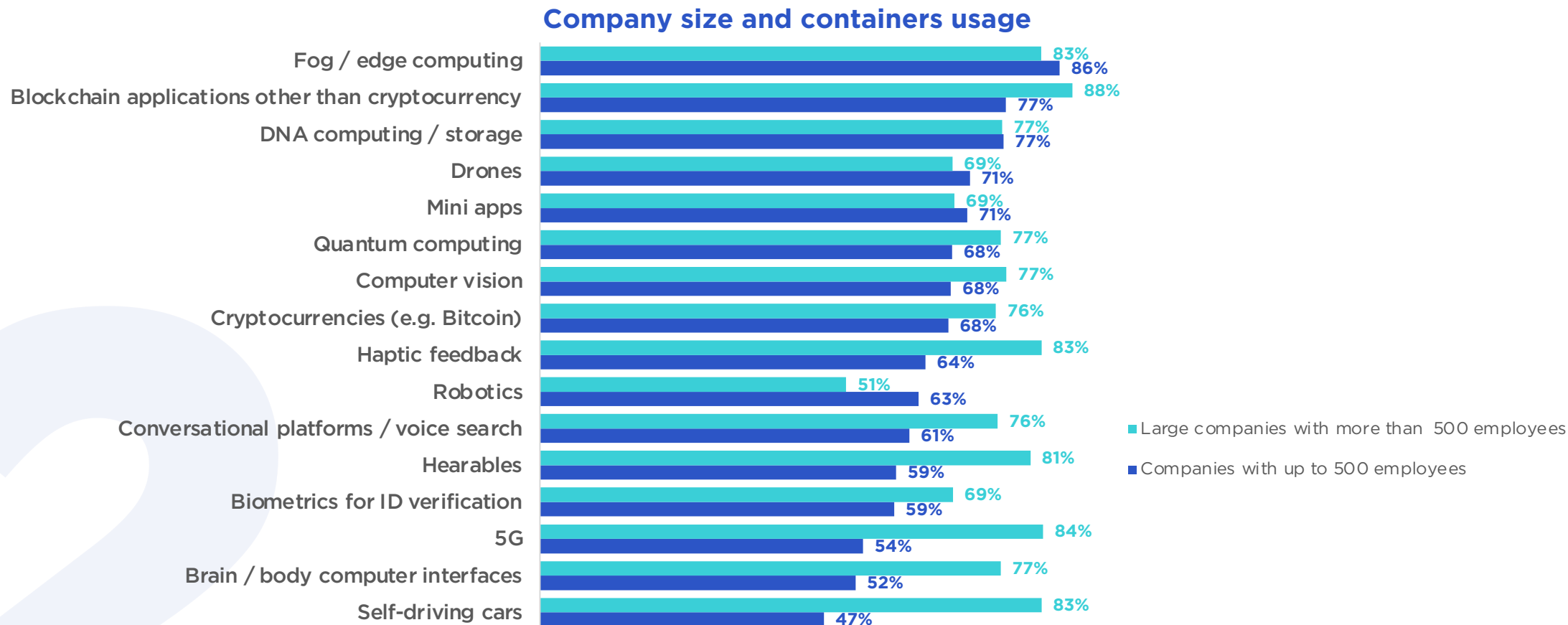
The technologies that have **the most considerable difference between container and Kubernetes usage among developers working in large companies are self-driving cars (19 percentage points), biometrics for ID verification (19 percentage points), blockchain applications other than cryptocurrency (18 percentage points), and 5G (17 percentage points)**.

The adoption of Kubernetes arguably requires a significant investment of time and resources with a cluster of several machines by default. The data backs up a strong positive correlation between the Kubernetes adoption relative to the adoption of containers and technologies that are likely to be targeted in larger organisations. Large organisations involved in complex technologies have better means and use cases to adopt Kubernetes.

2. USAGE AND AWARENESS OF KUBERNETES

Container usage is greater in large companies and is reaching a plateau

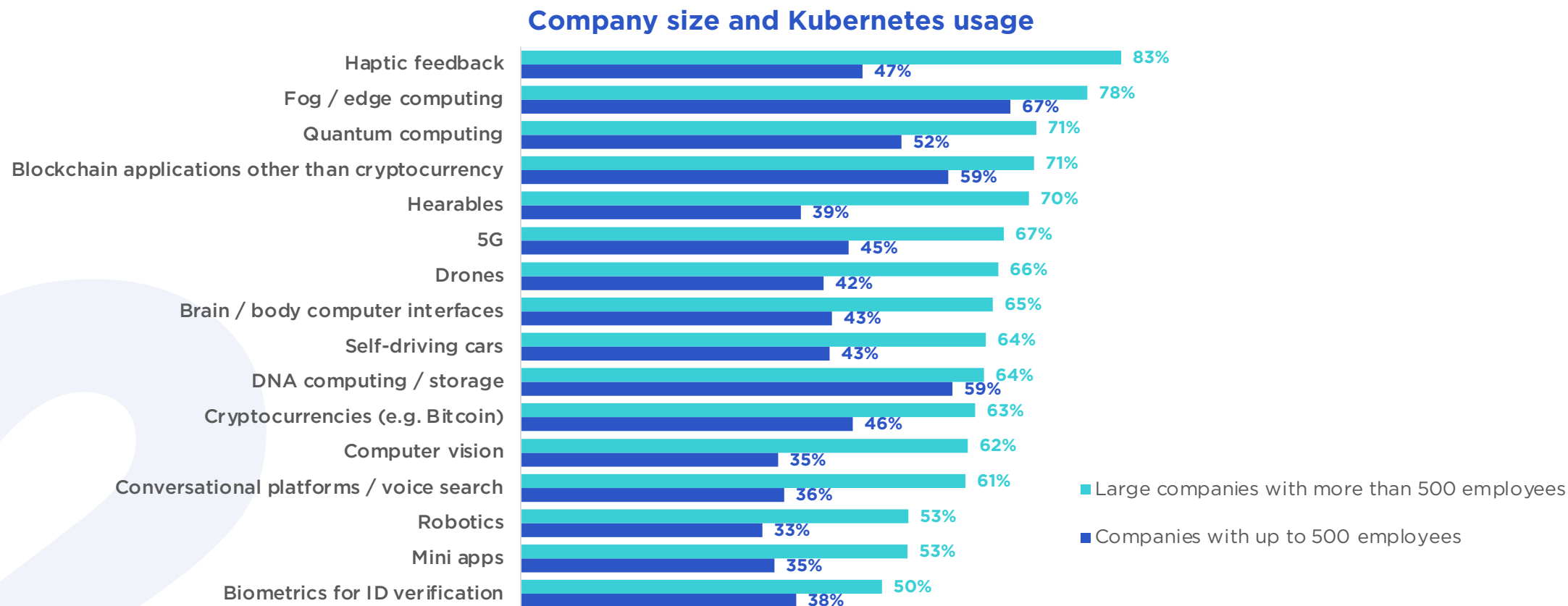
% of backend developers using Kubernetes by area of involvement (Q1 2021 n=4,442)



2. USAGE AND AWARENESS OF KUBERNETES

Kubernetes usage skyrockets in large companies, but there are still considerable variations across areas

% of backend developers using Kubernetes by area of involvement (Q1 2021 n=4,442)



3. EDGE COMPUTING AND CLOUD NATIVE SPACE

3. EDGE COMPUTING AND CLOUD NATIVE SPACE

A. Trends in edge computing

In the previous chapter, we noted that developers who work on edge computing are more likely to rely on both containers and Kubernetes. In this chapter, we go a level deeper and look at the detailed usage profile of edge developers and bring out trends at the intersection between edge and cloud native spaces.

At first glance, we see that container usage, for both backend developers in general and those working on edge computing projects, has been rather unchanged in the last 12 months. At the same time, the adoption of Kubernetes among backend developers grew by 4 percentage points. Moreover, **among edge developers only, the adoption of Kubernetes increased by 11 percentage points.**

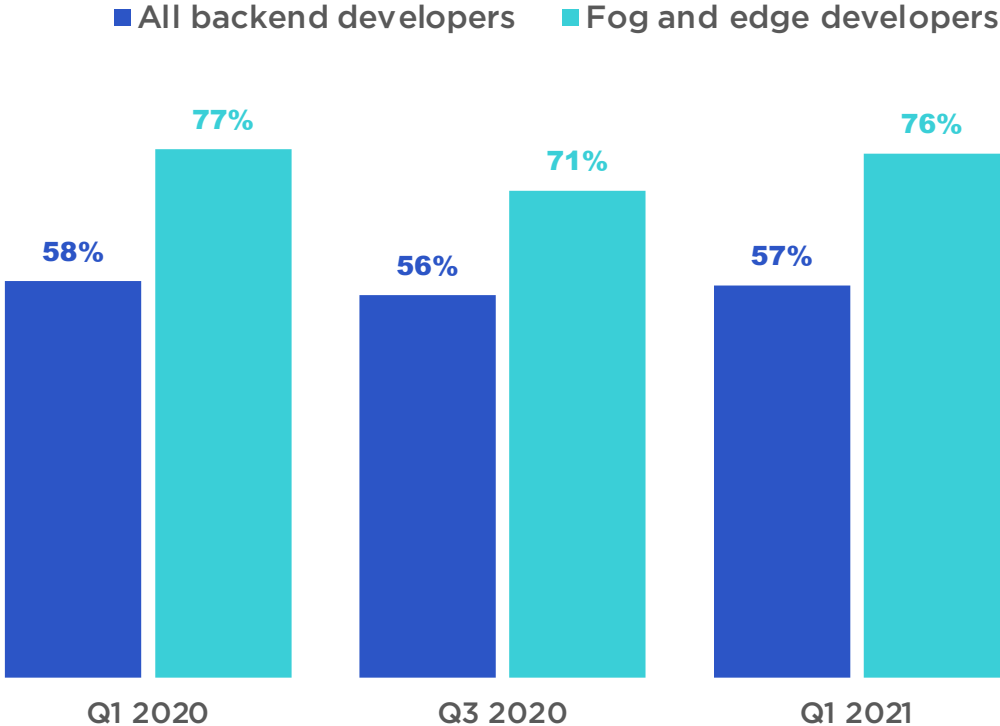
As adoption of containers has not been trending upwards, it may be a sign that it is already or slowly reaching a high plateau; that is, a point where further adoption becomes less likely. On the other hand, the usage of Kubernetes appears to still have plenty of room to grow.

3. EDGE COMPUTING AND CLOUD NATIVE SPACE

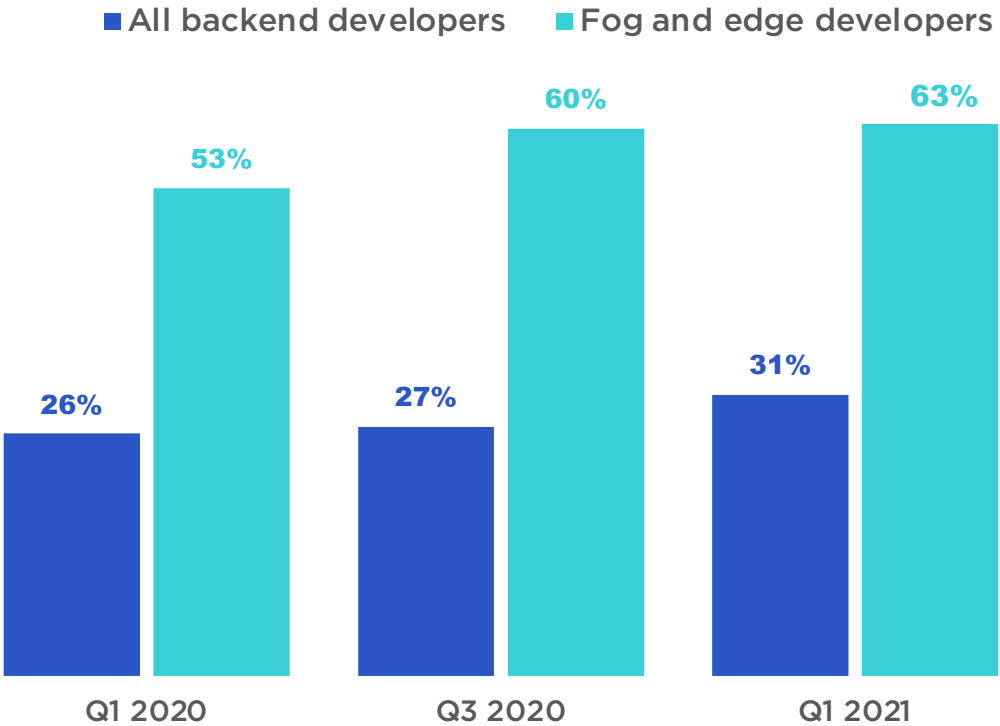
Two in three edge developers now use Kubernetes

% of backend developers who have been involved in each area in the past 12 months
(Q1 2020 n=131 | Q3 2020 n=151 | Q1 2021 n=106)

Containers usage



Kubernetes usage



3. EDGE COMPUTING AND CLOUD NATIVE SPACE

A. Trends in edge computing

The adoption of Kubernetes increases in larger organisations, and, in the space of edge computing, almost matches the adoption of containers. Yet, growth in adoption can be still achieved twofold:

Increasing awareness of and exploring use cases for Kubernetes for small and medium-sized organisations. Although the adoption of Kubernetes among edge developers in small and medium-sized organisations has been continuously growing and currently stands at 60%, the data shows that **17% of edge developers in small companies are still not sure what Kubernetes does** - a figure that has doubled within a year.

Even if the Kubernetes adoption rate reaches a plateau by matching the container adoption rate, the underlying growth in the sector will continue to propel the total usage of Kubernetes. For example, IoT, arguably the key driver of many edge solutions, has been on a steep trajectory. **The IoT sector is expected to grow by approximately 19% per year**, as forecast in our IoT population report.

When it comes to the use of serverless technologies, **48% of edge developers currently go serverless compared to only 33% of all backend developers**. The lightweight nature of a serverless architecture is particularly appealing to edge developers since they don't have to manage the underlying infrastructure. However, serverless usage rates have grown at a slower pace than Kubernetes and recently even experienced an unexpected drop. A drop in serverless usage has also been noticeable among all backend developers and, while the cause of it is not fully understood, it remains to be seen if it will constitute a more permanent shift.

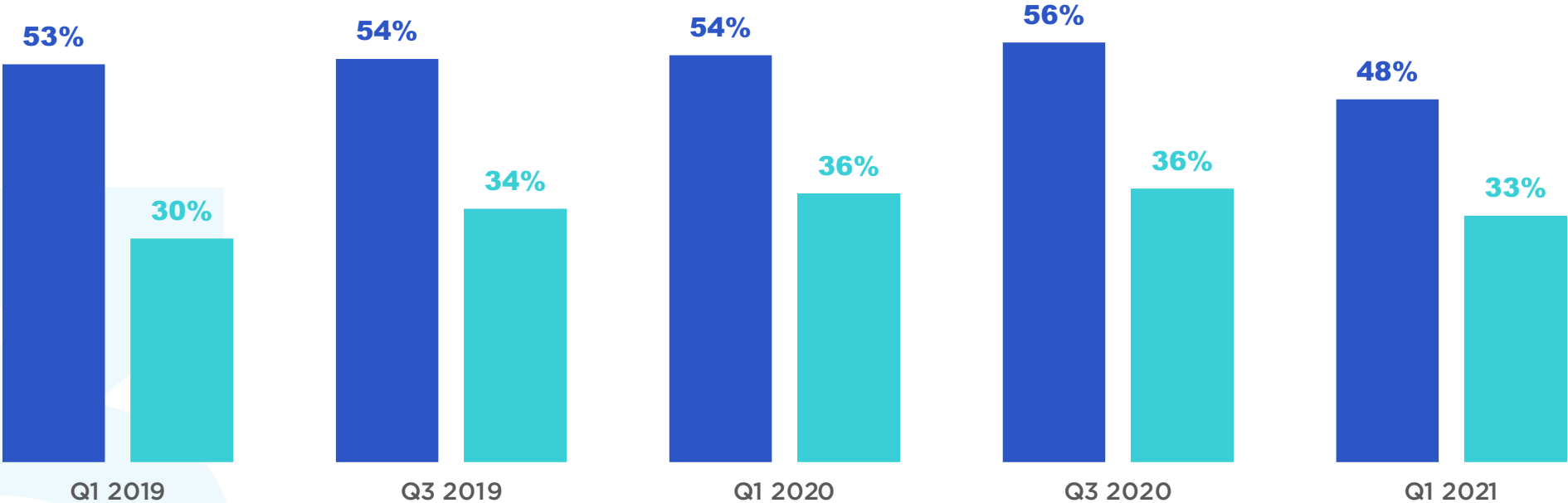
3. EDGE COMPUTING AND CLOUD NATIVE SPACE

Serverless solutions experienced a recent drop in usage

% of backend and edge developers
(Q1 2019 n=2,288 | Q3 2019 n=1,868 | Q1 2020 n=1,817 | Q3 2020 n=1,752 | Q1 2021 n=870)

Usage of serverless architecture

■ Edge developers ■ All backend developers



3. EDGE COMPUTING AND CLOUD NATIVE SPACE

B. Infrastructure usage of edge developers

In our survey, we asked backend developers where their code runs, with potential answers including public cloud, private cloud, hybrid cloud, multi-cloud, and on-premise servers. These options are not mutually exclusive. For greater clarity, within the survey, we define a private cloud as a cloud that is only available to certain users regardless of whether it is hosted on-premise or in a third party's data centre. We also define hybrid clouds as using a combination of public and private clouds for a single project and multi-clouds as using multiple public clouds for a single project.

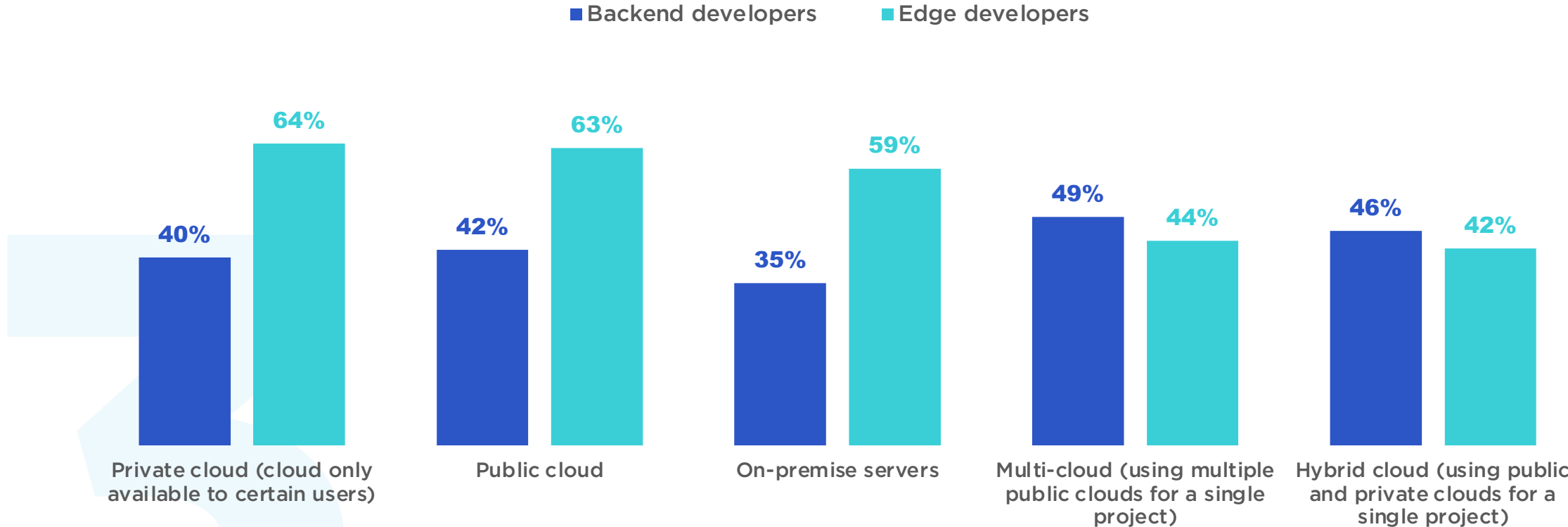
While the average backend developers who use Kubernetes seem less concerned with the choice of the infrastructure that hosts their code, **an edge developer shows a clear preference of private clouds (64%), public clouds (63%), and on-premises servers (59%) over multi-clouds (44%) and hybrid clouds (42%).** The figures suggest that developers working on edge applications relying on Kubernetes gravitate towards a more secure and less complex infrastructure. Vast volumes of sensitive data are handled over much larger distances and achieving reliable and secure connectivity between providers comes with major challenges, while varying functionality and user experience of each cloud platform pose roadblocks on their own.

3. EDGE COMPUTING AND CLOUD NATIVE SPACE

Hybrid and multi-cloud are less popular among Kubernetes users

% of backend developers (n=1,874)

Where do Kubernetes users run their code?



3. EDGE COMPUTING AND CLOUD NATIVE SPACE

B. Infrastructure usage of edge developers

Next, we look at the cloud vendors that Kubernetes users prefer. Here, we compare edge developers' vendor preferences to those of traditional backend developers.

Amazon Web Services (AWS) is the most widely used cloud service provider among backend developers who rely on Kubernetes, with a dominant share of 64%. Their lead is trailed by Google Cloud Platform (45%) and Microsoft Azure (42%). So far, the results only reflect the findings in our previous report; however, an interesting pattern surfaces when we further segment the data by edge developers.

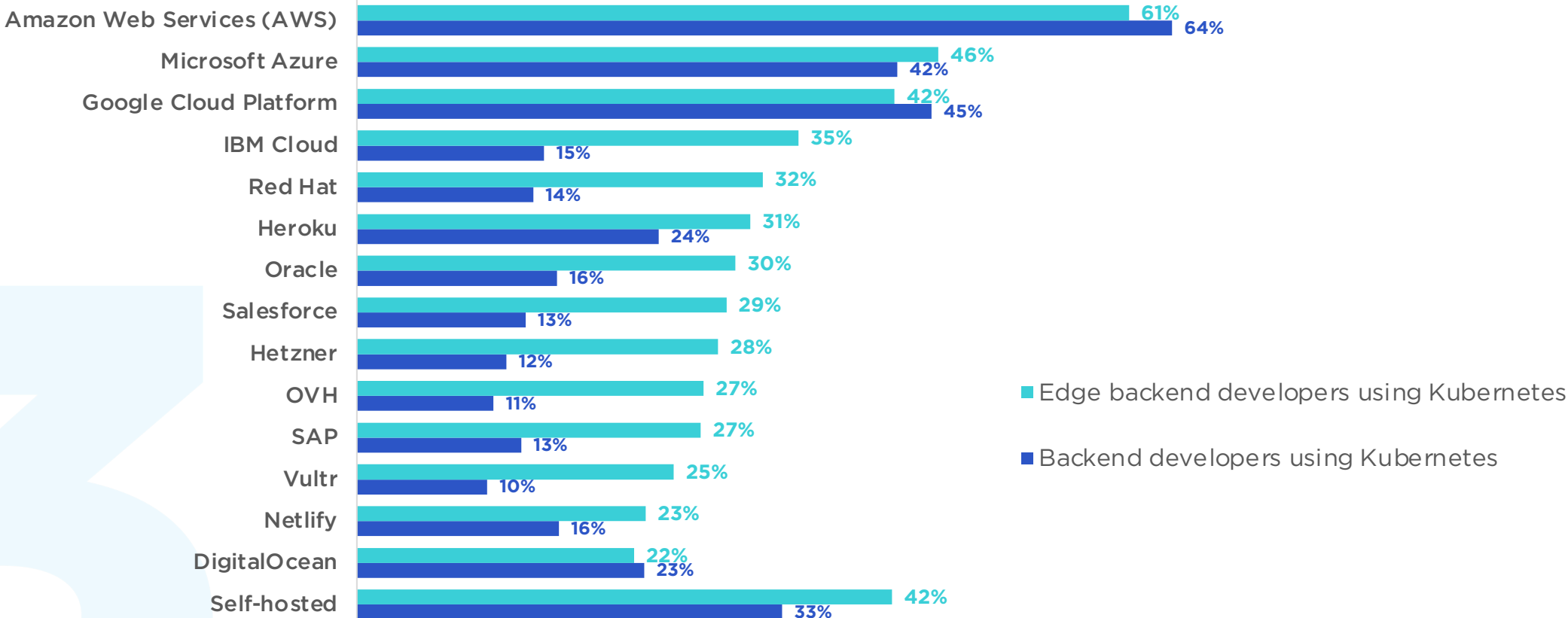
While the three top vendors show a similar usage for developers working on edge applications, self-hosted solutions and many other players are significantly gaining popularity. For example, 42% of edge developers using Kubernetes prefer a self-hosted solution compared to only 33% of traditional developers. Similarly, IBM Cloud becomes much more appealing among edge developers (35%) than when compared to the average backend developer (15%). **The vendor landscape becomes overall more balanced within the space between cloud native computing and edge.**

3. EDGE COMPUTING AND CLOUD NATIVE SPACE

Kubernetes together with edge flattens the usage landscape of vendors

% of backend developers using Kubernetes (n=1,244)

Usage of cloud vendors



3. EDGE COMPUTING AND CLOUD NATIVE SPACE

C. Solutions used by edge developers

In this section, we look at the specific container orchestration solutions that developers use. With regards to usage, the most adopted solutions are self-hosting (35%), Amazon Elastic Container Services (ECS) (33%), Google Kubernetes Engine (32%), and Amazon Elastic Kubernetes Services (EKS) (30%).

The landscape markedly lifts to new heights for developers who are working on edge computing projects. The higher adoption rates across all services underline our previous insight that **edge developers gravitate towards using Kubernetes**. Top beneficiaries of this lift are Google Kubernetes Engine (+35 percentage points) and IBM Cloud Kubernetes Service (+33 percentage points). Edge developers see particularly good value in these two services.

Although both Amazon ECS and Amazon EKS benefit from an increase in their usage among edge developers, it is their Kubernetes-based service, Amazon EKS, that gains considerably more inflow of developers (+27 percentage points) than their own homegrown container orchestration service ECS (+17 percentage points).

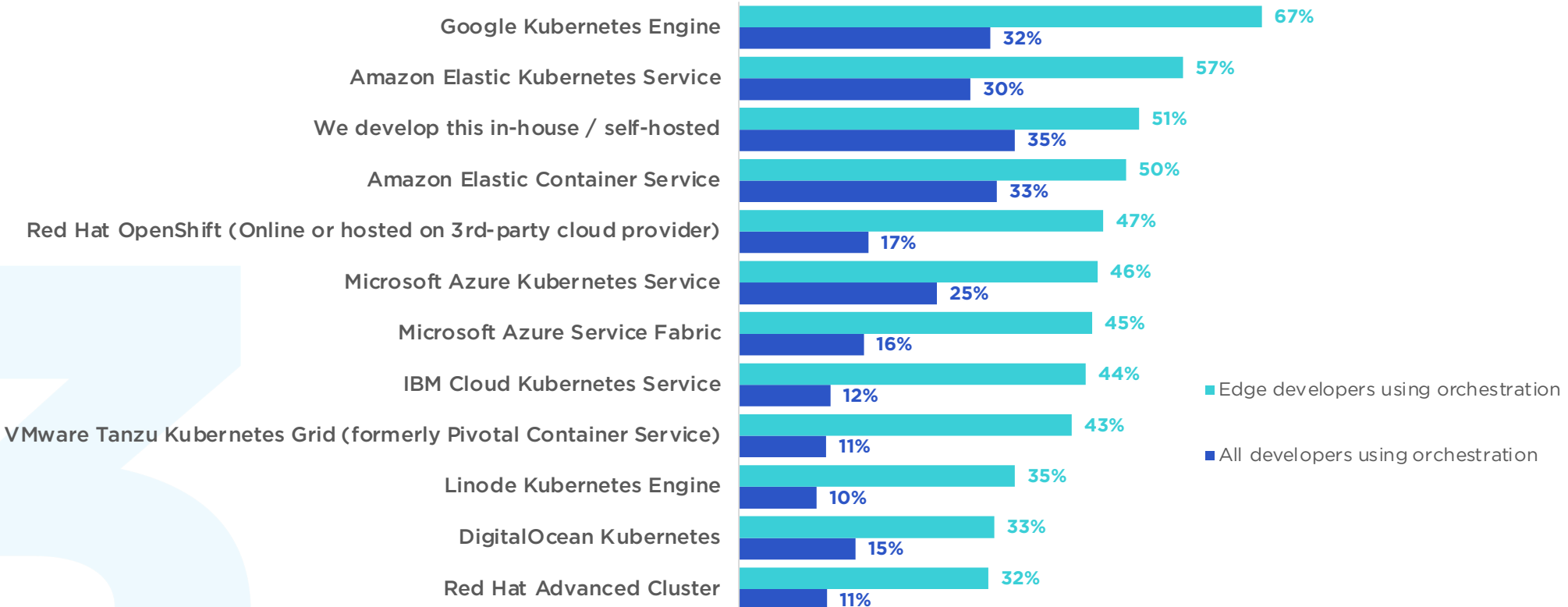
An insightful glimpse into how developers perceive each orchestration service is given by comparing the proportions of edge developers who evaluated but rejected a service, out of all developers who have been using or used a service. **Red Hat Advanced Cluster, Google Kubernetes Engine, and IBM Cloud Kubernetes Service for Kubernetes pass with flying colours among edge developers and can boast almost negligible rejection rates.** With little to complain about, it certainly drives adoption among edge developers.

3. EDGE COMPUTING AND CLOUD NATIVE SPACE

Google Kubernetes Engine is the most popular container orchestration platform among edge developers

% of backend developers using orchestration tools (n=873)

Usage of orchestration solutions



4. USAGE TRENDS OF ORCHESTRATION AND SERVERLESS TOOLS

4. USAGE TRENDS OF ORCHESTRATION AND SERVERLESS TOOLS

As we noted in the introduction, 4.6M developers are using container orchestration technologies and 4M developers are using cloud functions. This corresponds to 28% and 24% of the backend population, respectively. Here, we look at which orchestration and serverless solutions are the most popular among cloud native developers and whether there have recently been any interesting trends.

Overall, the top three competitors offering orchestration services - Microsoft, Amazon, and Google - are competing head-to-head in terms of adoption and leaving behind other vendors. 33% of developers using orchestration technologies are currently using Amazon ECS, making it the most widely adopted solution. However, their lead has arguably been crumbling with no gain to bring home, while Google Kubernetes Engine has been closing in with a substantial growth of 4 percentage points in the last 12 months. Of all solutions, Amazon EKS had the largest gain of 8 percentage points and is now ranked third, with 30% of orchestration developers currently using it.

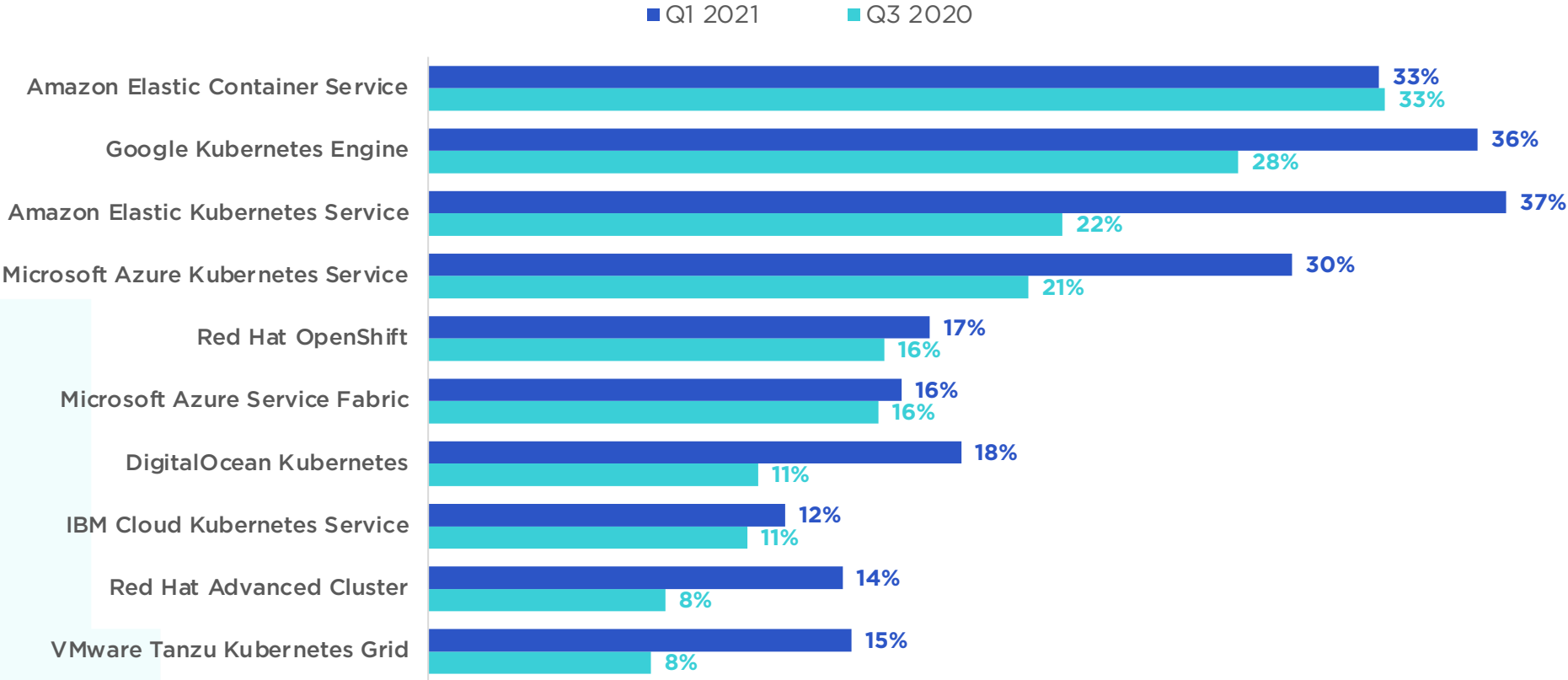
AWS Lambda continues to be the most popular serverless solution, with 53% of serverless developers using it. Lambda's pole position stems from the fact that it was the first serverless product on the market. Compared to Q1 2020, though, **Google Cloud Run** - Google's serverless compute platform with built-in Kubernetes containers converges the best of two worlds - **has notably advanced, gaining 8 percentage points in the last six months**, whereas Google Cloud Functions experienced a drop of 3 percentage points - the only service that records a loss.

4. USAGE TRENDS OF ORCHESTRATION AND SERVERLESS TOOLS

Amazon EKS, Microsoft Azure Kubernetes Service, and Google Kubernetes Engine are the top gainers in terms of usage

% of backend developers (n=873)

Orchestration solutions usage trends

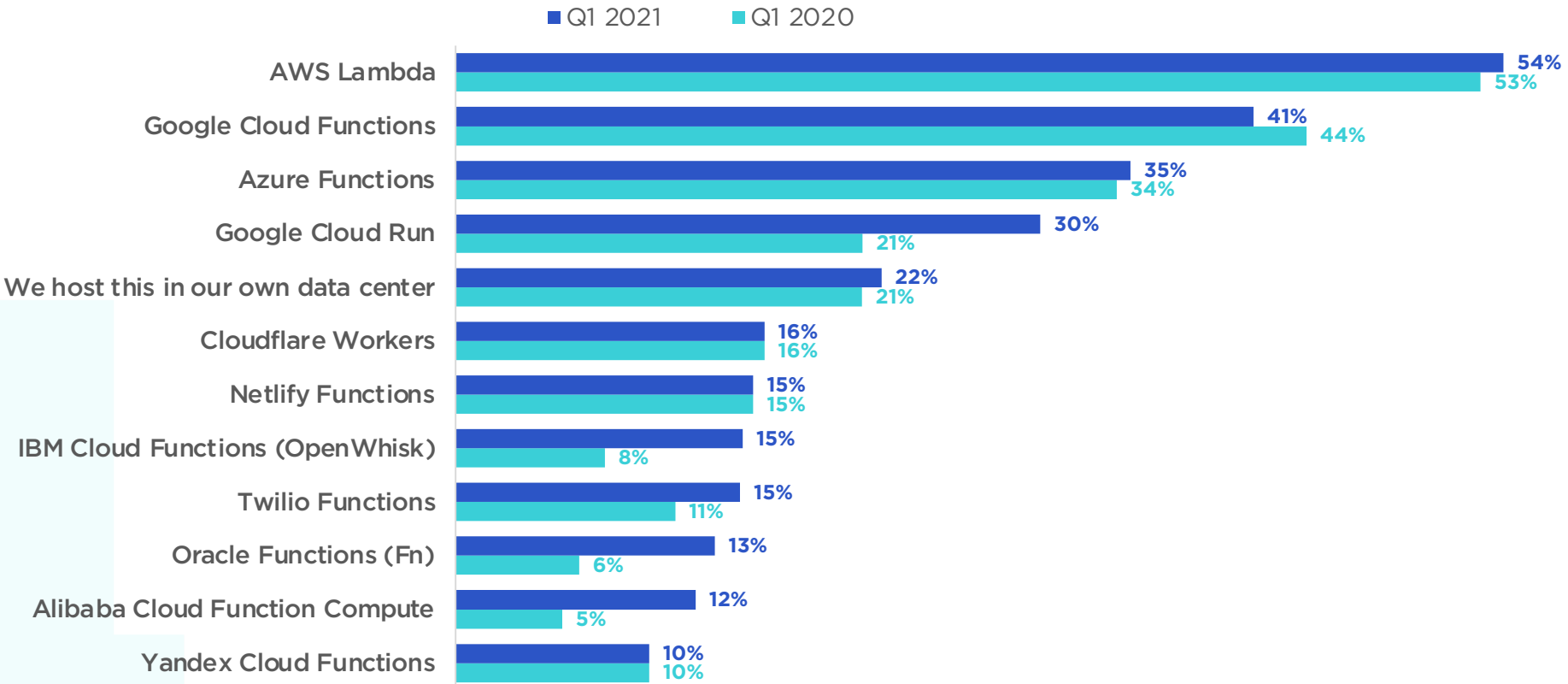


4. USAGE TRENDS OF ORCHESTRATION AND SERVERLESS TOOLS

AWS Lambda is the most popular serverless platform, but Google Cloud Run is growing fast

% of backend developers (Q1 2020 n=960 | Q1 2021 n=802)

Serverless solutions usage trends Q1 2020 - Q1 2021





METHODOLOGY

The Developer Economics Survey

Developer Economics 20th edition reached 19,000+ respondents from 155 countries around the world. As such, the Developer Economics series continues to be the most global independent research on mobile, desktop, industrial IoT, consumer electronics, embedded, third party app ecosystems, cloud, web, game, AR/VR, and machine learning developers and data scientists combined, ever conducted. The report is based on a large-scale online developer survey designed, produced, and carried out by SlashData over a period of ten weeks between November 2020 and February 2021.

Our respondents came from a broad age spectrum, from young coders who are under 18 to the seasoned ones over 55. As software development is still a man's world, 79% of our respondents were male and 20% female, excluding other options and those who did not specify their gender.

Respondents were asked which types of projects they are involved in out of the 13 under study, namely web apps / SaaS, mobile apps, desktop apps, backend services, augmented reality, virtual reality, games, data science, machine learning / artificial intelligence, industrial IoT, consumer electronics devices, embedded software, and apps/extensions for third party ecosystems. They also told us if they are into their areas of involvement as professionals, hobbyists, or students - or as any combination of these - and how many years of experience they have in each.

To eliminate the effect of regional sampling biases, we weighted the regional distribution across eight regions by a factor that was determined by the regional distribution and growth trends identified in our Developer Economy research. Each of the separate branches: mobile, desktop, industrial IoT, consumer electronics, embedded software, third party app ecosystems, cloud, web, games, augmented and virtual reality, and data science and machine learning were weighted independently and then combined.

To minimise other important sampling biases across our outreach channels, we weighted the responses to derive a representative distribution for technologies used and developer segments. Using ensemble modelling methods, we derived a weighted distribution based on data from independent, representative channels, excluding the channels of our research partners to eliminate sampling bias due to respondents who were recruited via these channels.

Again, this was performed separately for each of mobile, industrial IoT, consumer electronics, embedded software, third party app ecosystems, desktop, cloud, web, games, augmented and virtual reality, and data science and machine learning.

For more information on our methodology please visit <https://www.slashdata.co/methodology>.

TALK TO US WORK WITH US

We help you understand Developers.

If you could speak to 30,000+ developers what would you ask them?



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