

STATE OF CONTINUOUS DELIVERY REPORT

The Evolution of Software Delivery Performance

Created by

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The analyst of the developer economy | formerly known as VisionMobile
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1. Introduction

1. Introduction

Continuous delivery (CD) is a software development practice that enables developers to release small but frequent software updates reliably and safely. Closely linked to the broader DevOps cultural movement, CD consists of a set of practices that aim to automate and streamline the software delivery process. These practices, in turn, allow developer teams to innovate faster by collecting regular user feedback and prioritising the product features and fixes that matter. But to what extent, really, have developers embraced continuous delivery practices and the DevOps culture to increase the effectiveness of their software development and release process?

In this report, commissioned by the Continuous Delivery Foundation (CDF) and authored by SlashData, we explore the current state of the CD developer ecosystem and how this has evolved over the past year and a half. We will look at what proportion of developers are involved in the broader DevOps space and how many work with continuous delivery technologies in particular.

Moreover, we will see how developers' software delivery performance has changed over time. Finally, we will explore how developers' engagement with modern cloud technologies, such as microservices and containers, and the breadth of their DevOps tool and technology usage contribute to software delivery performance.

The findings in this report are based on data from SlashData's past four Developer Nation surveys, which reached more than 70,000 respondents worldwide over 18 months, from Q3 2020 to Q1 2022.

Key takeaways

- As of Q1 2022, less than a quarter (23%) of developers are not involved in any DevOps-related activities, indicating continued growth in the adoption of practices that increase an organisation's ability to deliver software at high velocity.
- 47% of developers use either continuous integration or deployment, but only one in five use both continuous integration and deployment approaches to automate all building, testing, and deployment of code to production.
- We've seen an increase in DevOps adoption in every development sector. Mobile app development has now even leapfrogged desktop development, such is its shift in embracing DevOps approaches.
- Medium-sized businesses and large enterprises are experiencing the most significant growth in DevOps adoption.
- Large enterprises are becoming the most significant beneficiaries of DevOps practices. In large enterprises, the proportion of low performers for lead time for code changes has dropped significantly from 34% to 24% in the last six months, while the proportion of top performers has also increased from 13% to 21%.
- Large enterprise developers also see a significant improvement in the proportion taking less than one hour to restore service - now at 22% - and in the proportion taking more than one week - falling from 23% to 18%.
- There remains a strong correlation between speed and stability metrics, rather than one compromising the other.
- Adoption of modern backend technologies such as microservices, containers, and Kubernetes generally correlates with improved performance for lead time for code changes and time to restore service but fails to significantly improve deployment frequency.
- Those using containers are twice as likely to have lead times of less than one day, compared to those not working with container technologies. Likewise, Kubernetes users are one-third more likely to be top performers than those who do not use the technology.
- There is a strong correlation between the breadth of individual developers' involvement with DevOps technologies and their likelihood of being among the top performers in terms of lead time for code changes, deployment frequency, and time to restore service. The more DevOps technologies a developer uses, the more likely they are to report improved delivery performance.

2. Who is into DevOps?

2. Who is into DevOps?

For the fourth consecutive time in SlashData's biannual Developer Nation surveys, we asked developers whether they are involved in any of the activities that commonly fall under the DevOps spectrum, such as continuous integration (CI), continuous delivery (CD), and infrastructure monitoring.

As of Q1 2022, less than a quarter (23%) of developers are not involved in any DevOps-related activities. This represents a 3 percentage point decrease from Q3 2021, indicating continued growth in the adoption of practices that increase an organisation's ability to deliver software at high velocity. Just as we highlighted in our previous report, however, relatively few developers describe their role as "DevOps engineer/specialist" – this now stands at 7%, up from 5% six months prior. Despite this slight growth, many developers continue to engage in DevOps practices without necessarily self-identifying with the term or considering themselves as 'specialists'.

Since Q3 2021, we see no shifts in the popularity ranking of DevOps-related development activities. However, we see a 3-4 percentage point increase in the proportion of developers engaged in each activity, demonstrating that DevOps involvement is growing uniformly across a range of related activities, rather than disproportionately in any particular area.

2. Who is into DevOps?

Monitoring software and infrastructure performance and using continuous integration to automatically build and test code changes remain the most popular DevOps-related activities, carried out by 36% of developers. 47% of developers use either continuous integration or deployment (up from 44% in our previous survey), but only one in five (20% – up from 18% previously) use both continuous integration **and** deployment approaches to automate all building, testing, and deployment of code to production. Around one-third (34%) of developers manually approve code deployments to production, confirming that fully automated software delivery pipelines are still not pervasive.

As noted in our previous report, DevOps practices are broadly adopted in all sectors of the software economy. In fact, we've seen an increase in adoption in every sector, typically around 3-4 percentage points. The sectors with the previously lowest levels of adoption – games and mobile development – have both closed the gap slightly on other development areas, with 7 and 6 percentage point increases, respectively. Mobile app development has now even leapfrogged desktop development, such is its shift in embracing DevOps approaches.

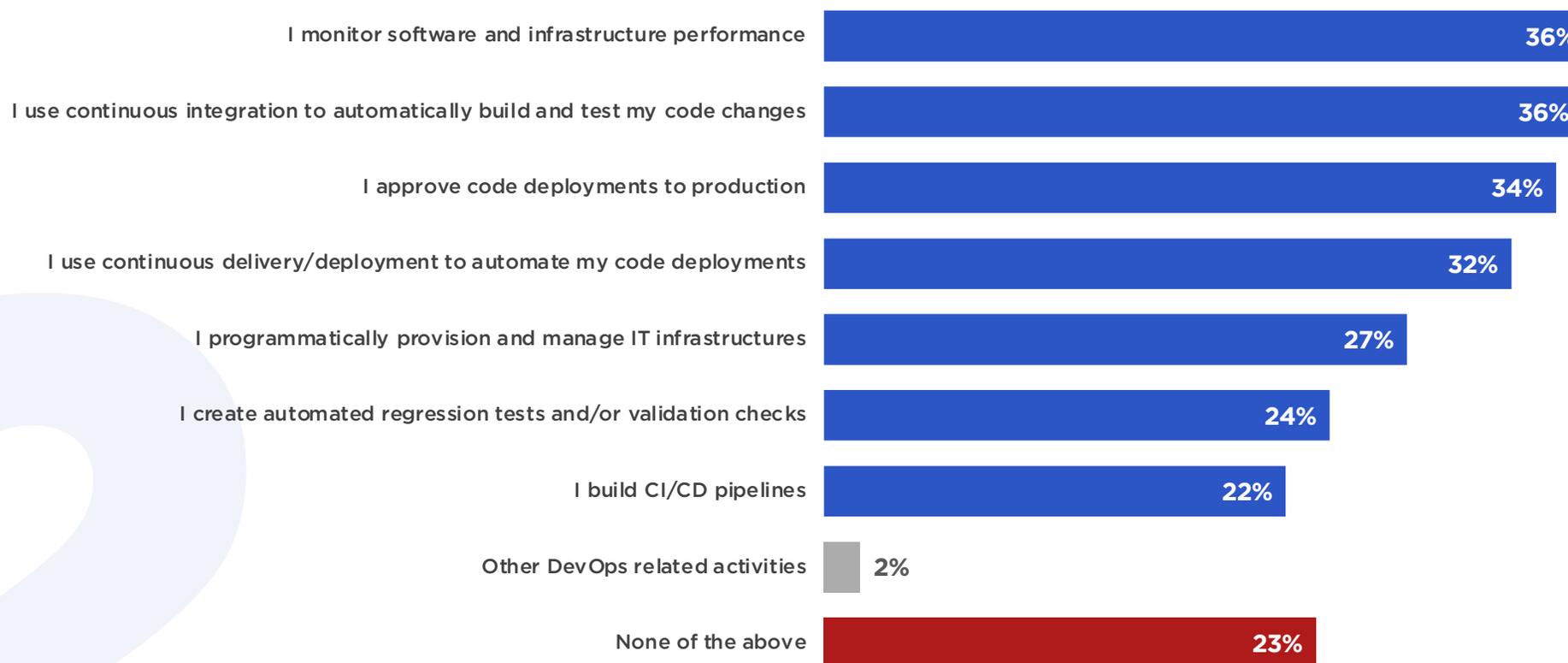
In terms of organisation sizes, our data reveal that medium-sized businesses and large enterprises are experiencing the most significant growth in DevOps adoption. In medium-sized businesses, the proportion of DevOps practitioners is up to 90%, from 85% previously, and in large enterprises, it currently stands at 88%, up from 84%. Freelance developers in particular appear to be falling behind in joining the DevOps movement, with only 72% engaging in any DevOps-related activities. As outsiders to established software development teams, it's possible that freelancers require more support to become involved in communication, collaboration, and integration between software developers and IT operations.

2. Who is into DevOps?

More than three-quarters of all developers are now involved in DevOps activities

% of developers (Q1 2022 n=18,585)

Which of the following development activities are you involved in?



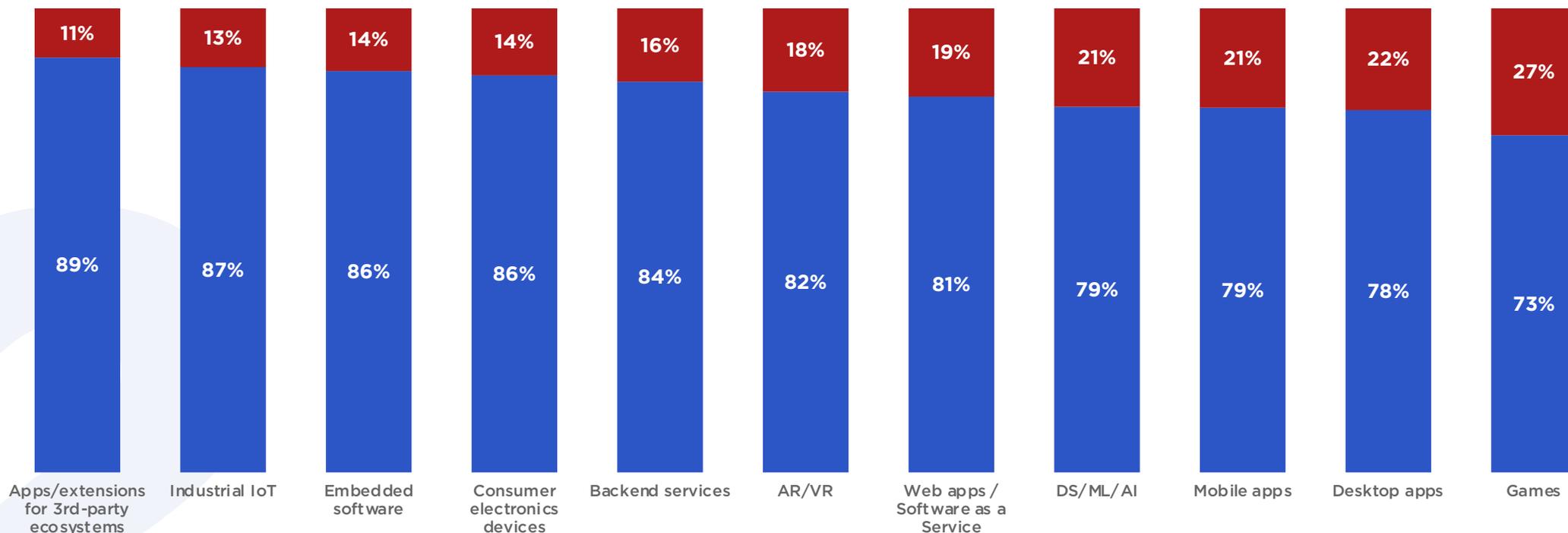
2. Who is into DevOps?

DevOps involvement has increased in all software development areas

% of developers involved in DevOps activities by software sector (Q1 2022 n=18,585)

Involvement in DevOps by software sector

■ Not involved in DevOps ■ Involved in DevOps

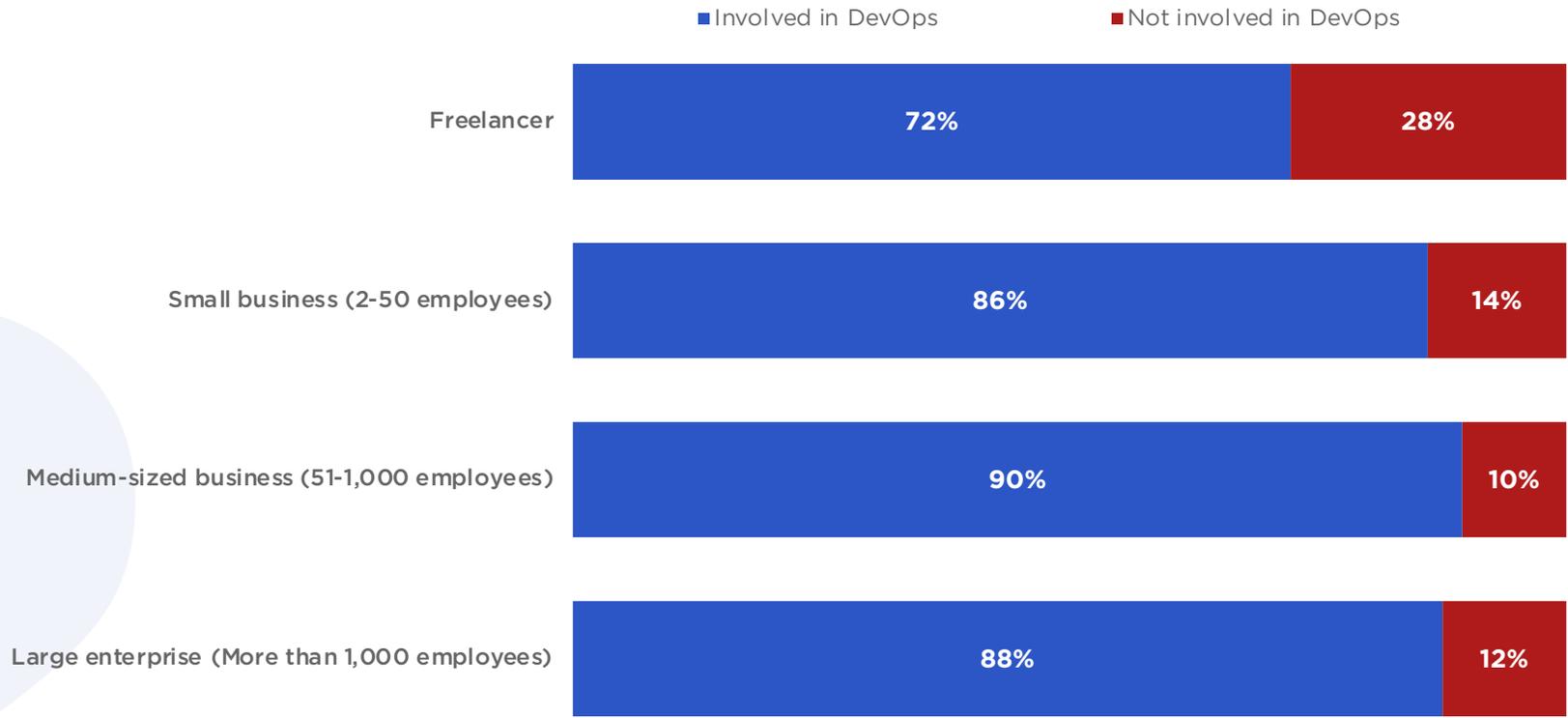


2. Who is into DevOps?

Developers in medium-sized businesses in particular are embracing the DevOps movement

% of professional developers involved in DevOps activities by company size (Q1 2022 n=13,203)

Involvement in DevOps by company size



**3. How has software
delivery
performance
evolved over time?**

3. How has software delivery performance evolved over time?

For individuals and organisations to be able to measure the effectiveness of their continuous delivery efforts, they need a set of robust performance metrics to track their progress. Research by Nicole Forsgren et al.¹ identified four key metrics – known as DORA metrics – that are used to measure software delivery performance and are also predictive of organisational performance. In our survey, we ask questions related to three of these, namely lead time for changes, deployment frequency, and time to restore service.

Within the general developer population, our data shows no clear signs that the velocity for code changes has increased over the past 18 months. Despite a small increase in the percentage of top performers – those with a lead time of less than one day – from 14% to 16%, and a decrease in low performers – lead times of more than one month – compared to six months ago, Q1 2022 performance metrics closely resemble those of Q3 2020. It's possible that the increase in DevOps practices is being counteracted by a simultaneous increase in the scale and complexity of the software being developed.

However, when we focus specifically on large enterprises, we find that the percentage of low performers for lead time for code changes has dropped significantly from 34% to 24% in the last six months, while the proportion of top performers has also increased from 13% to 21%. There are no such sizable shifts among developers in small and medium-sized businesses, indicating that large enterprises are becoming the most significant beneficiaries of DevOps practices.

For deployment frequency metrics, Q1 2022 sees the smallest proportion of low performers – those deploying code less frequently than once per month – at 33%. However, the proportion of top performers – with multiple deploys per day – remains stable at 11%. Hence, it appears that growing engagement in DevOps may be helping to raise the minimum standard, but is less effective at enabling even more to achieve excellence.

¹ Forsgren, N., Humble, J., Kim, G. 2018. *Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations*. IT Revolution Press.

3. How has software delivery performance evolved over time?

There was a steady deceleration in the time it takes to restore service across the three survey waves from Q3 2020 to Q3 2021. In Q1 2022, this deceleration appears to have abated. However, there is no change in the proportion of top performers and only a 2 percentage point decrease in the share of low performers. 30% of all DevOps practitioners take more than one week to restore service. As with lead time for code changes, it is large enterprise developers who appear to be bucking the trend, with a significant improvement in the proportion taking less than one hour to restore service (rising from 17% to 22%) and in the proportion taking more than one week (falling from 23% to 18%).

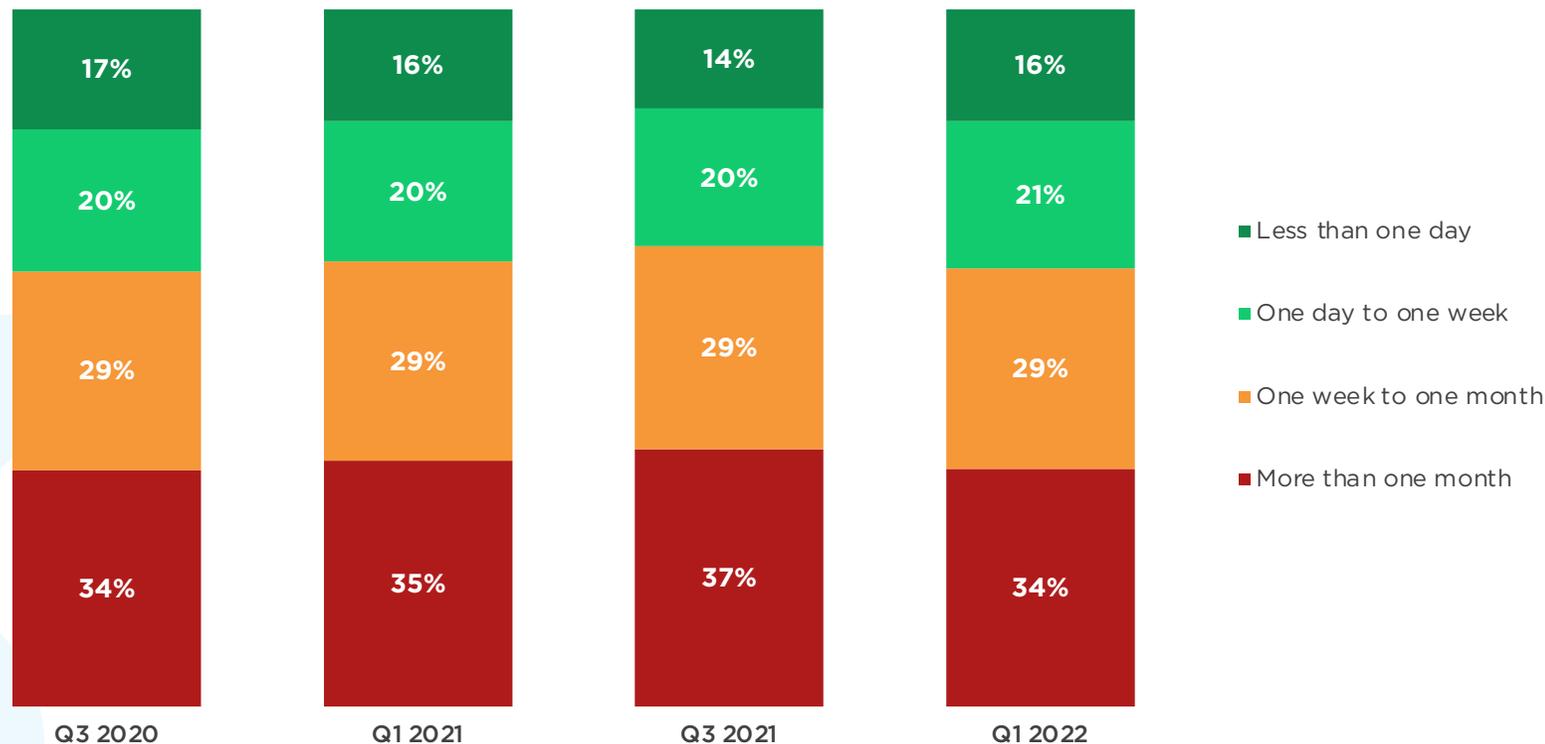
There remains a strong correlation between speed and stability metrics, rather than one compromising the other. Over half of developers for whom it takes more than one month to commit code changes also perform poorly in restoring service, taking more than one week. By contrast, less than 10% of high performers in software delivery speed are low performers in stability. Similarly, nearly a third of top performers in lead time for code changes excel in time to restore service. In comparison, only 5% of low performers in software delivery throughput are top performers in stability.

3. How has software delivery performance evolved over time?

The proportion of top performers in lead time for code changes has not significantly shifted in the last 18 months

% of DevOps practitioners (Q3 2020 n=10,252 | Q1 2021 n=8,572 | Q3 2021 n=8,784 | Q1 2022 n=9,640)

Software delivery performance - Lead time for code changes

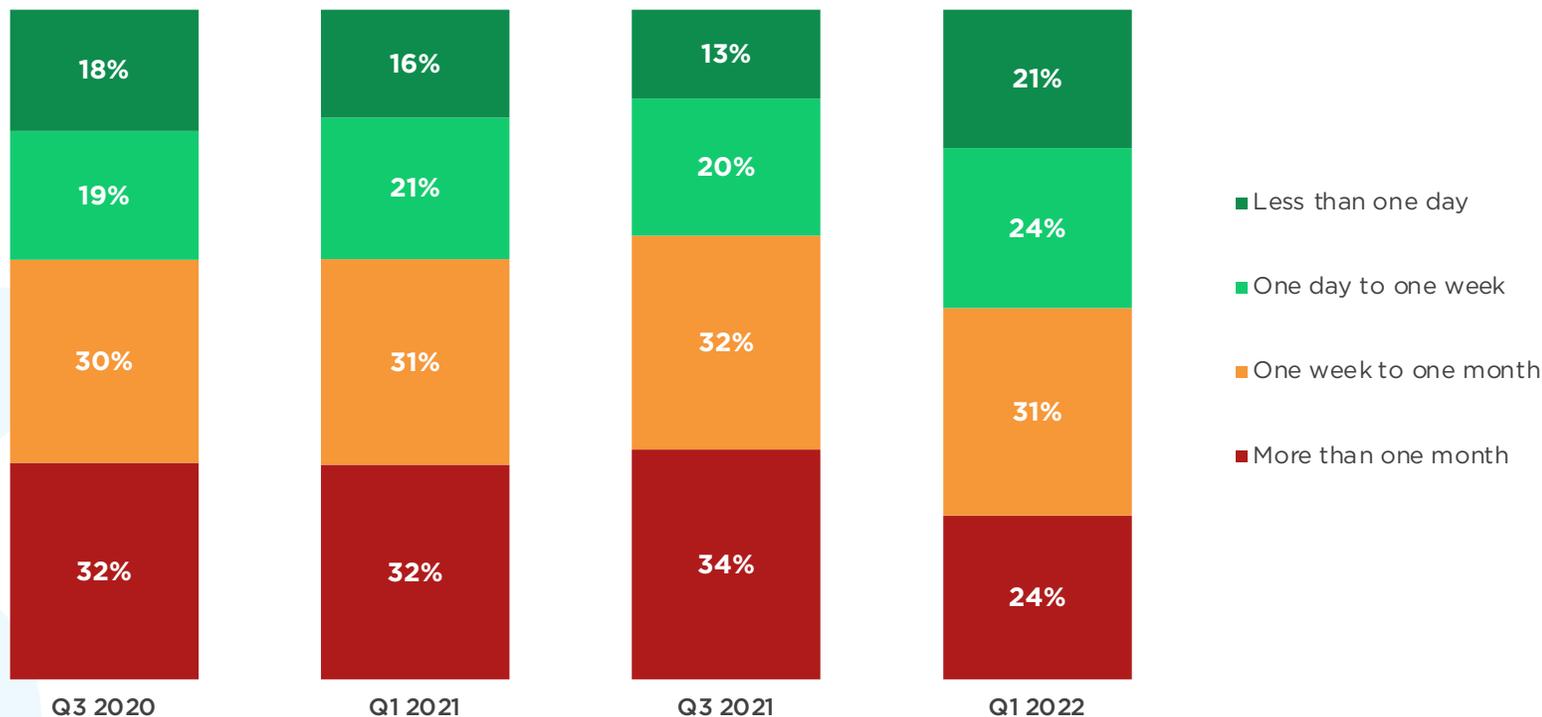


3. How has software delivery performance evolved over time?

In large enterprises, lead time for code changes has improved significantly in the last six months

% of DevOps practitioners in large enterprises (more than 1,000 employees) (Q3 2020 n=1,986 | Q1 2021 n=1,400 | Q3 2021 n=1,557 | Q1 2022 n=1,695)

Software delivery performance in large enterprises - Lead time for code changes

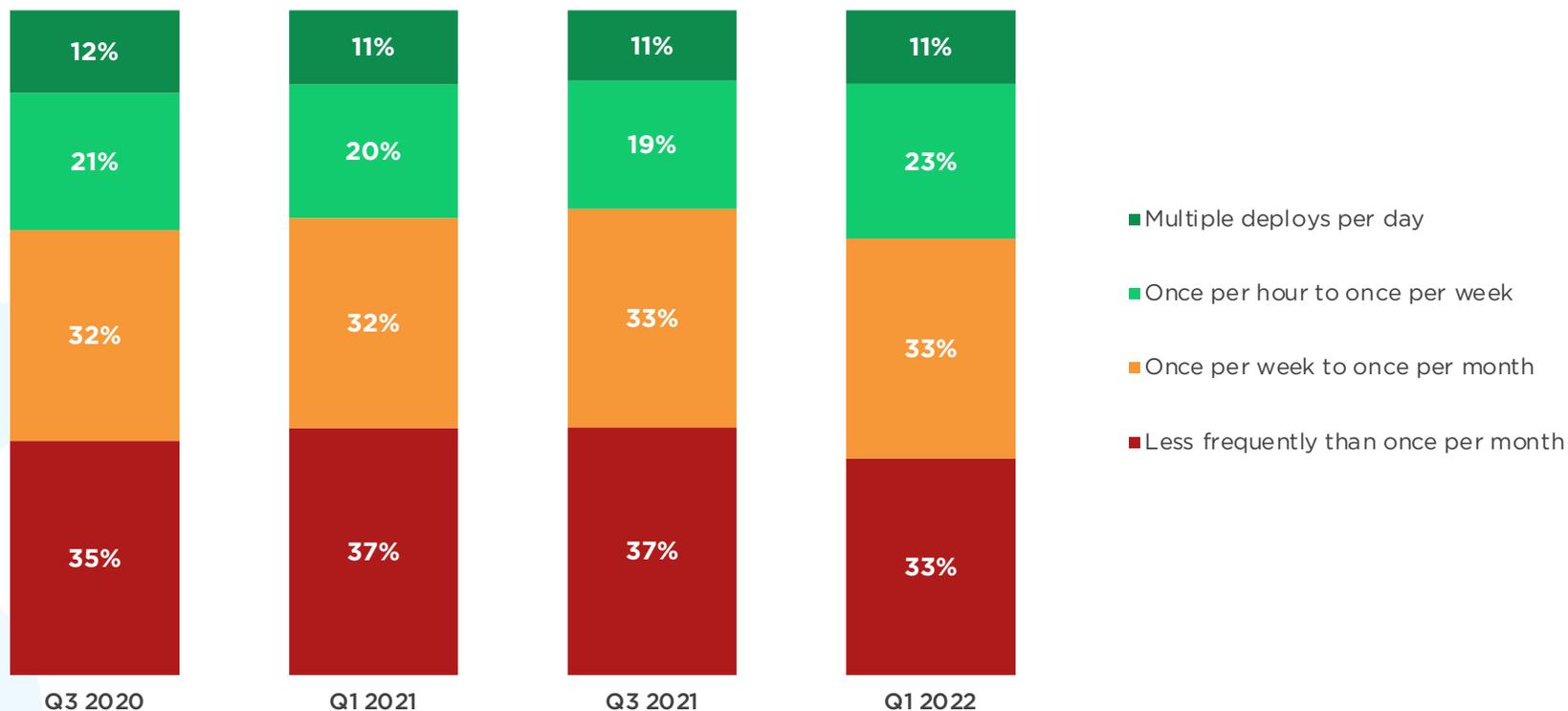


3. How has software delivery performance evolved over time?

The proportion of low performers in deployment frequency has decreased in the last six months

% of DevOps practitioners (Q3 2020 n=10,119 | Q1 2021 n=8,354 | Q3 2021 n=8,619 | Q1 2022 n=9,473)

Software delivery performance - Deployment frequency

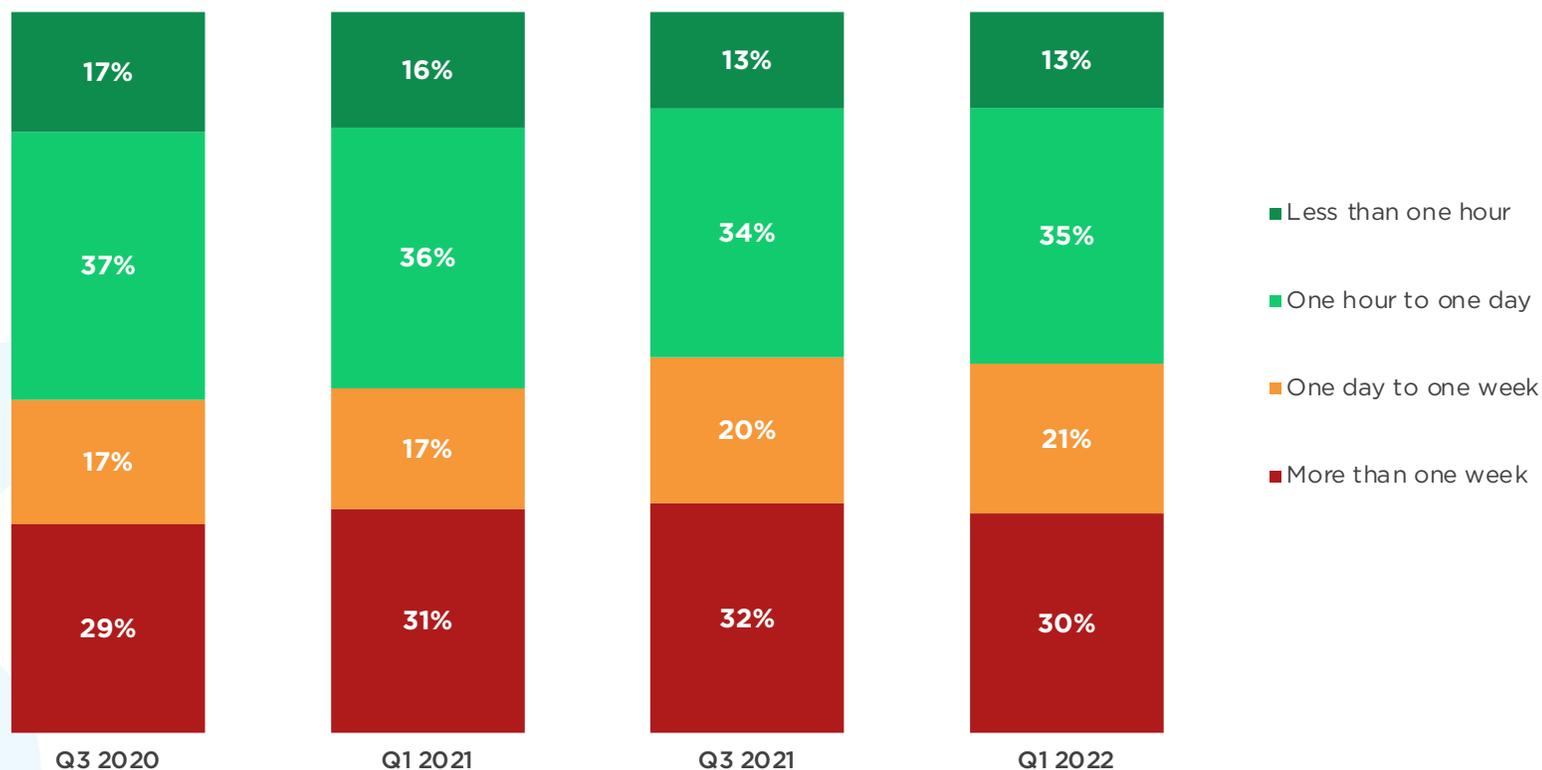


3. How has software delivery performance evolved over time?

Time to restore service has not improved in the last 18 months

% of DevOps practitioners (Q3 2020 n=9,349 | Q1 2021 n=7,941 | Q3 2021 n=8,126 | Q1 2022 n=8,927)

Software delivery performance - Time to restore service



3. How has software delivery performance evolved over time?

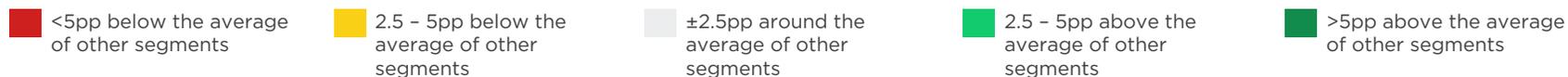
Lead time for code changes and time to restore service are closely linked

% of DevOps practitioners reporting each duration to restore service by lead time for code changes (Q1 2022 n=8,462)

Lead time for code changes

Time to restore service

	More than one month	One week to one month	One day to one week	Less than one day
More than one week	52%	31%	13%	9%
One day to one week	20%	23%	25%	13%
One hour to one day	24%	37%	43%	46%
Less than one hour	5%	9%	18%	32%



4. What drives software delivery performance?

4. What drives software delivery performance?

This chapter investigates the relationship between software delivery performance and the evolution in approaches to building software, for example, moving from monoliths to microservices and scaling applications with container-based infrastructure and orchestration tools. We find that adoption of backend technologies such as microservices, containers, and Kubernetes generally correlates with improved performance for lead time for code changes and time to restore service, but fails to significantly improve deployment frequency.

Modern backend technologies and architectures, such as microservices, enable software systems to be structured in a way that is intended to enable rapid, frequent, and reliable delivery, via loosely coupled, highly maintainable, and independently deployable applications. Indeed, our data reveal that developers who use microservices are two-thirds less likely to be low-performers in lead time for code changes than those who do not use microservices (22% vs. 33%, respectively). They are also 60% more likely to be in the top performing group - with a lead time of less than one day - than those who do not use microservices (24% vs 15%, respectively).

4. What drives software delivery performance?

We also see a significant impact from adopting containerised applications and Kubernetes for automating deployment, scaling, and management of containerised applications. Those using containers are almost half as likely to have lead times of more than one month for code changes and twice as likely to have lead times of less than one day, compared to those not working with container technologies. Likewise, Kubernetes users are only two-thirds as likely to be among the low performers and one-third more likely to be top performers.

It's a similar story when it comes to performance for time to restore service. Those using containers see the greatest overall reduction in the likelihood of being low performers with a time to restore of more than one week, and the largest increase in the likelihood of being top performers with time to restore at less than one day, compared to those not using the technology. Both microservices and Kubernetes technologies also are strongly correlated with vastly improved performance outcomes.

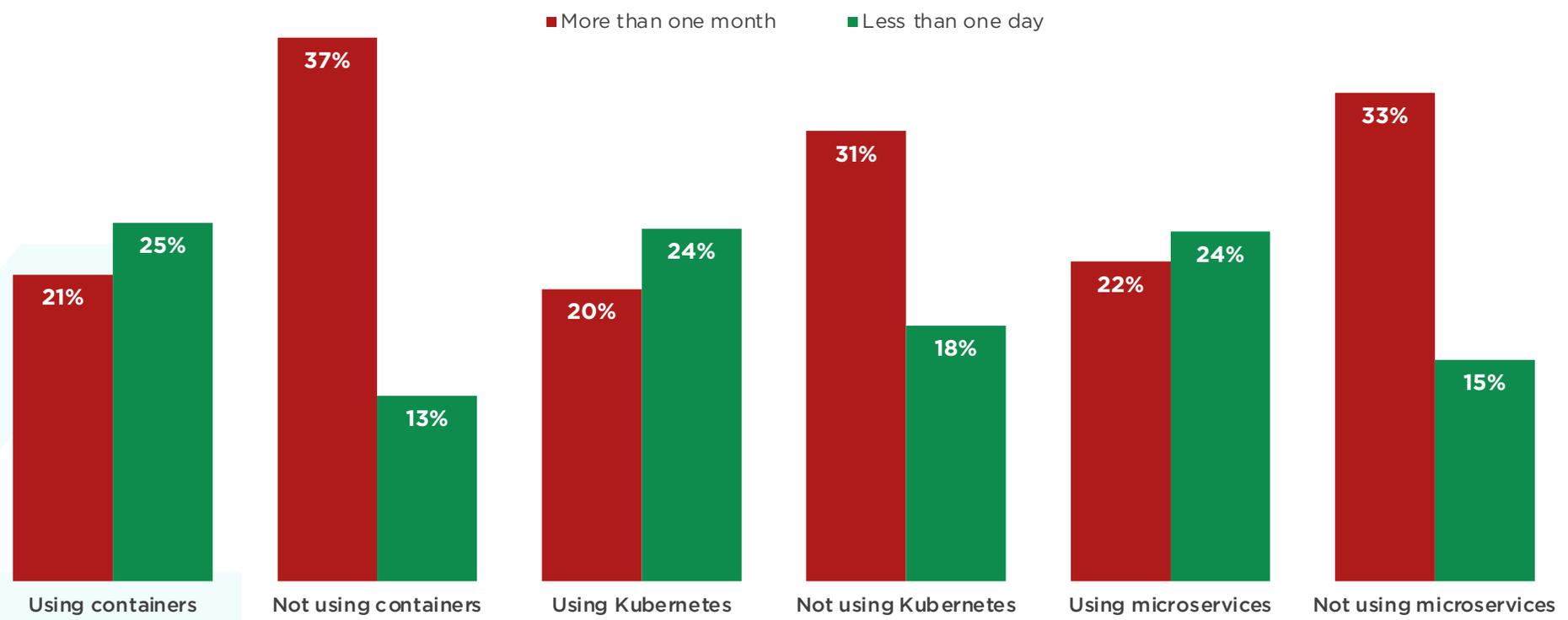
However, we see a very different picture regarding deployment frequency. Those who use each of these technologies are less likely to be in the low performing group than non-users. However, they are also around half as likely to be in the top-performing group. Hence, these technologies appear to coalesce developers around middling performance for delivery frequency. Although these technologies allow developers to change code quickly, fix issues efficiently, and operate at an increasing scale, they also add an additional layer of technology for DevOps teams to manage. Applications built on such technologies are likely subjected to the same release cycles and challenges of getting it through a release pipeline. At present, developers who don't use these technologies are, in fact, more productive – they are about twice as likely to be top-performers, deploying multiple times per day. With only 53% of DevOps practitioners that work in backend development using microservices, there is still a significant way to go to convince developers that switching to cloud-native practices will make them more productive.

4. What drives software delivery performance?

Developers using containers are twice as likely as non-users to be top performers in lead time for code changes

% of DevOps practitioners involved in backend development and using each technology that are top and low performers in lead time for code changes (Q1 2022 Using containers n=3,255 | Using Kubernetes n=1,898 | Using microservices n=2,844 | Not using containers n=1,833 | Not using Kubernetes n=3,144 | Not using microservices n=2,201)

Software delivery performance (lead time for code changes) by technology

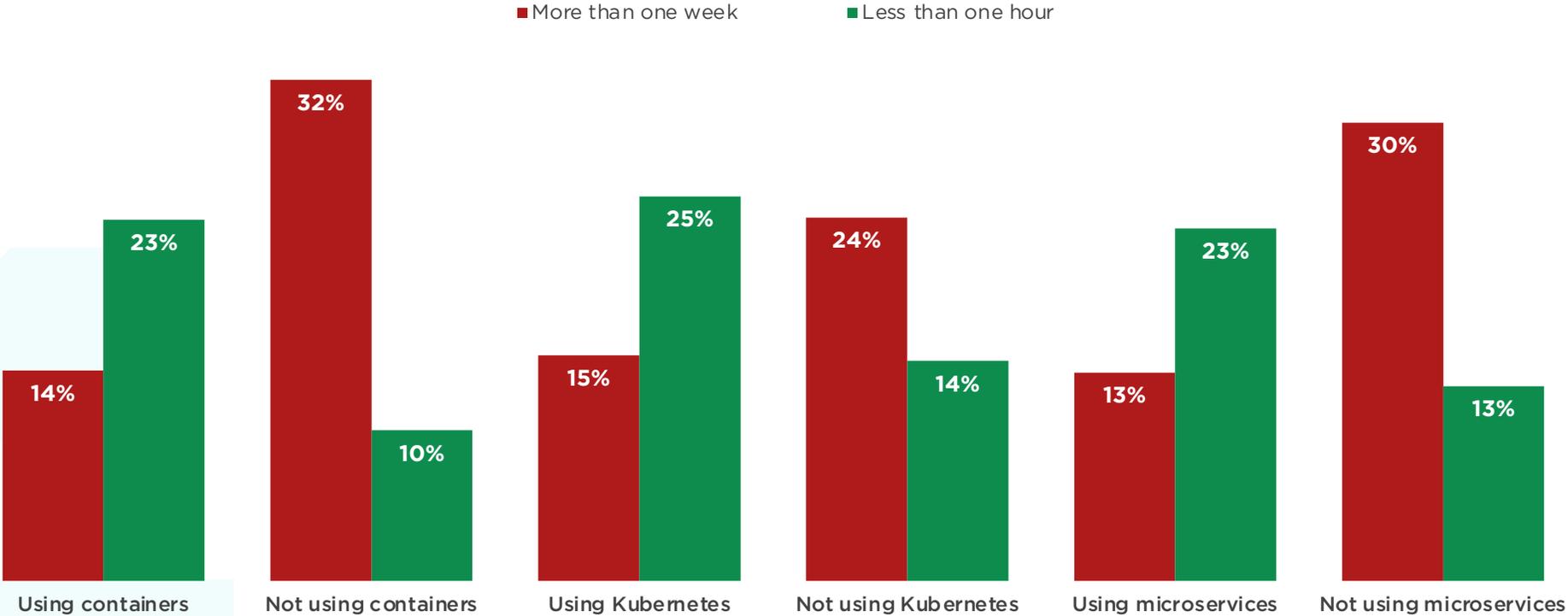


4. What drives software delivery performance?

Developers not using microservices are more than twice as likely to be low performers in time to restore service

% of DevOps practitioners involved in backend development and using each technology that are top and low performers in time to restore service (Q1 2022 Using containers n=3,042 | Using Kubernetes n=1,817 | Using microservices n=2,688 | Not using containers n=1,676 | Not using Kubernetes n=2,859 | Not using microservices n=1,991)

Software delivery performance (time to restore service) by technology

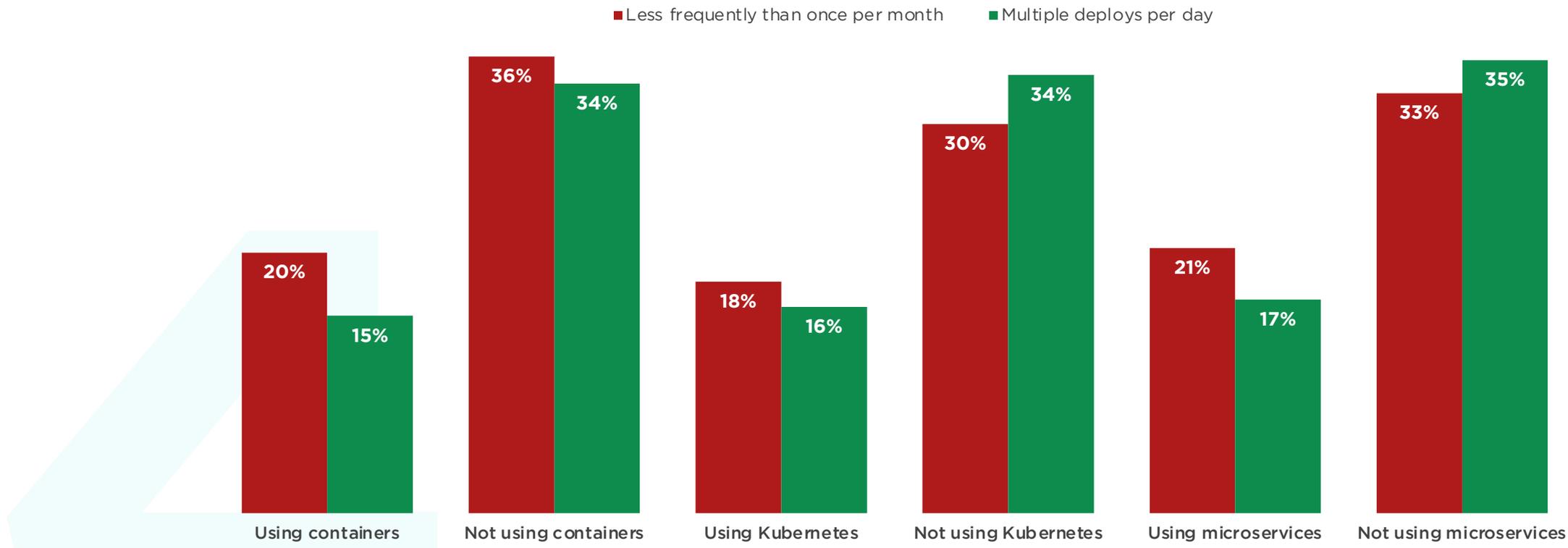


4. What drives software delivery performance?

Users of microservice and container technologies are less likely to be top performers or low performers in deployment frequency

% of DevOps practitioners involved in backend development and using each technology that are top and low performers in deployment frequency (Q1 2022 Using containers n=3,257 | Using Kubernetes n=1,927 | Using microservices n=2,859 | Not using containers n=1,762 | Not using Kubernetes n=3,053 | Not using microservices n=2,122)

Software delivery performance (deployment frequency) by technology



4. What drives software delivery performance?

In our survey, we capture information on a broad range of DevOps-related technologies that developers use, ranging from tools for managing source code to tools for monitoring application performance. The average number of technologies that DevOps practitioners use, of those listed, has risen from 4.0 in Q3 2021 to 4.6 in Q1 2022. We see significant growth in the adoption of technologies such as managed CI/CD services (up 6 percentage points to 26% adoption) and Infrastructure as Code (up 6 percentage points to 27% adoption).

Next, we analyse whether the number of these DevOps technologies used by developers correlates with improved software delivery performance. Our motivation is to examine whether having developers with a greater breadth of exposure to different aspects of DevOps and technologies to support them helps to collectively drive performance or whether performance benefits from developers each having a narrow and specific focus or responsibility and fewer tools or technologies to manage.

The results of this analysis point, resoundingly, to a strong correlation between the breadth of developers' involvement with DevOps technologies and their likelihood of being among the top performers in terms of lead time for code changes, deployment frequency, and time to restore service. That is to say, the more DevOps technologies a developer uses, the more likely they are to report improved delivery performance.

44% of practitioners using only a single technology belong to the low performing groups for lead time for code changes and deployment frequency and 47% are low performers for time to restore service. For both code changes and deployment frequency, those who use ten or more of the technologies that we list become more likely to be among the top performers than low performers. Performance continues to improve further with an even greater breadth of technology adoption.

While we do not currently measure whether DevOps and CI/CD competencies are purposefully shared within development teams or allocated to dedicated experts/specialists, our results indicate that having developers with a broad range of skills, as indicated by the technologies they use, helps with overall delivery performance.

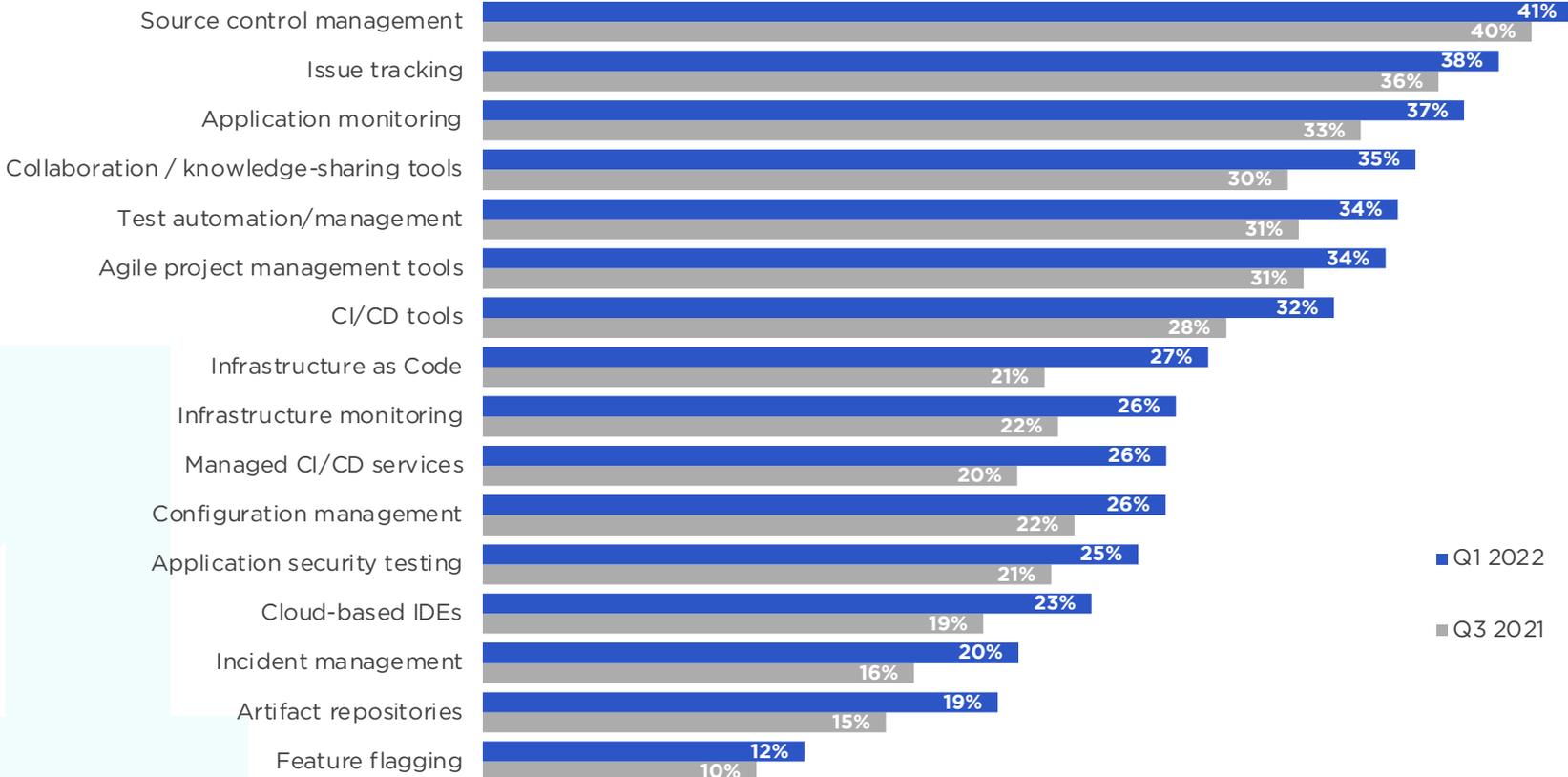
Of course, certain technologies contribute more significantly to improved performance than others. For example, users of CI/CD tools are more likely to be top performers in lead time for code changes (22% of CI/CD tool users are top performers vs. 16% average for other technologies) and time to restore service (21% of CI/CD tool users are top performers vs. 13% average for other technologies). Feature flagging – a technique for switching code paths at runtime – is associated with better performance for deployment frequency (16% using feature flagging are top performers vs. 13% average for other technologies).

4. What drives software delivery performance?

DevOps practitioners are using even more technologies now than in Q3 2021

% of DevOps practitioners (Q1 2022 n=14,176 | Q3 2021 n=13,205)

DevOps technologies used (in the past 12 months)

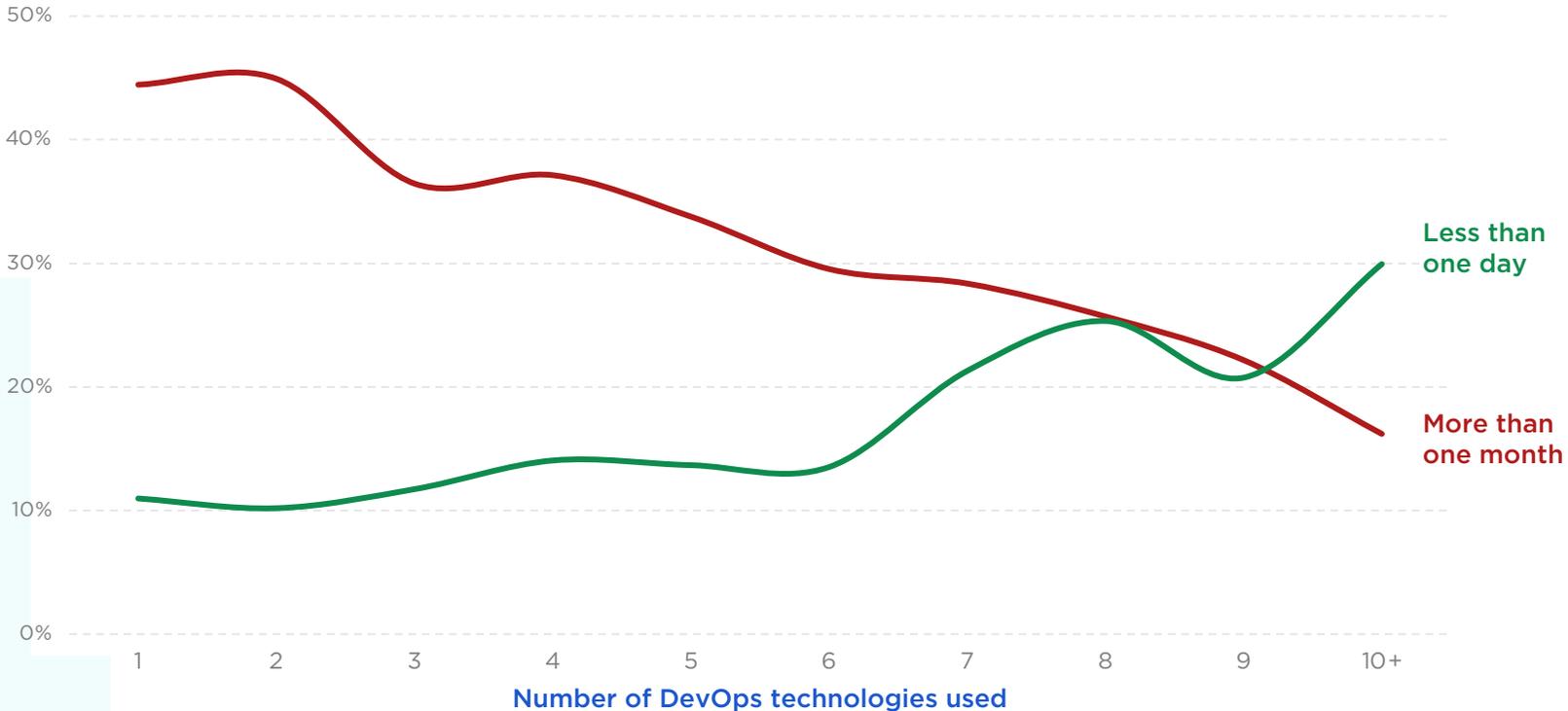


4. What drives software delivery performance?

Those using more DevOps technologies are increasingly likely to be top performers in lead time for code changes

% of top and low performers in lead time for code changes among DevOps practitioners using each number of DevOps technologies (Q1 2022 n=9,258)

Software delivery performance (lead time for code changes) by number of DevOps technologies used

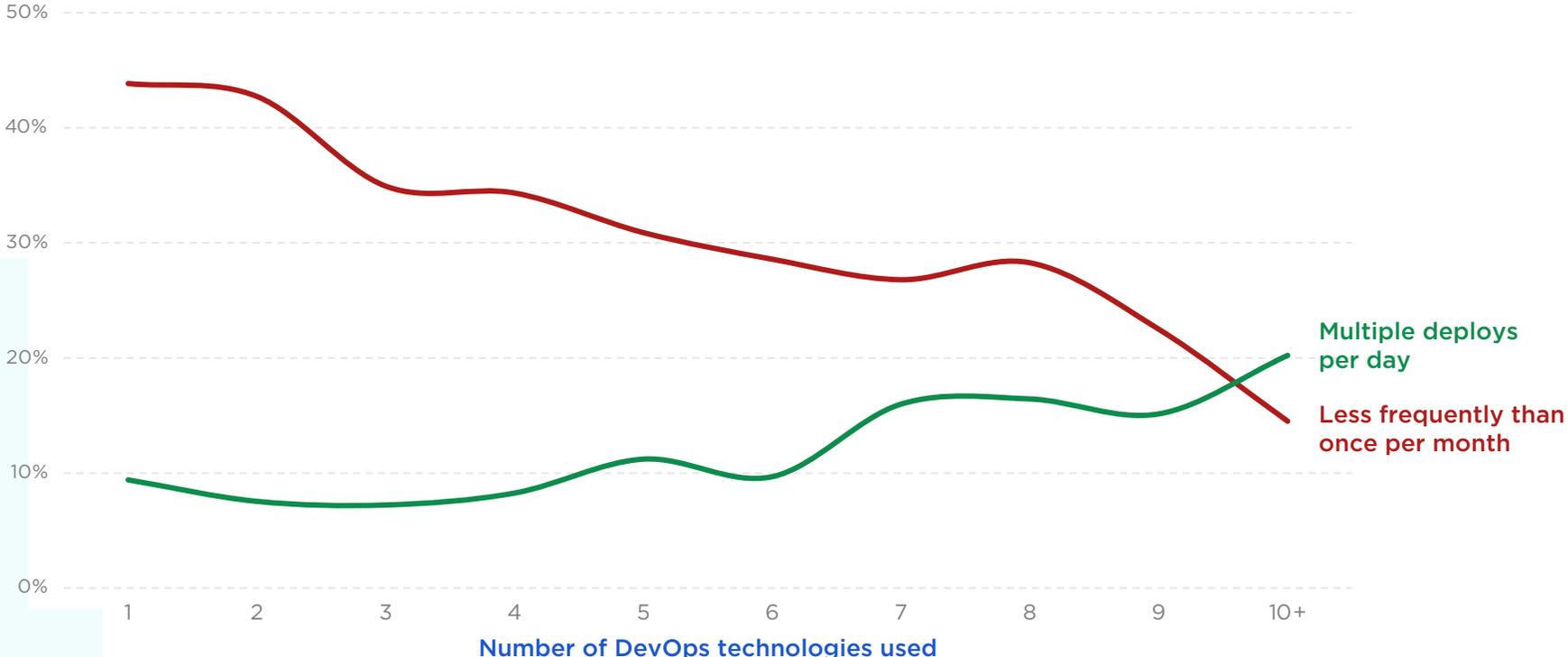


4. What drives software delivery performance?

Practitioners using a greater number of DevOps technologies are less likely to be low performers in deployment frequency

% of top and low performers in deployment frequency among DevOps practitioners using each number of DevOps technologies (Q1 2022 n=9,164)

Software delivery performance (deployment frequency) by number of DevOps technologies used

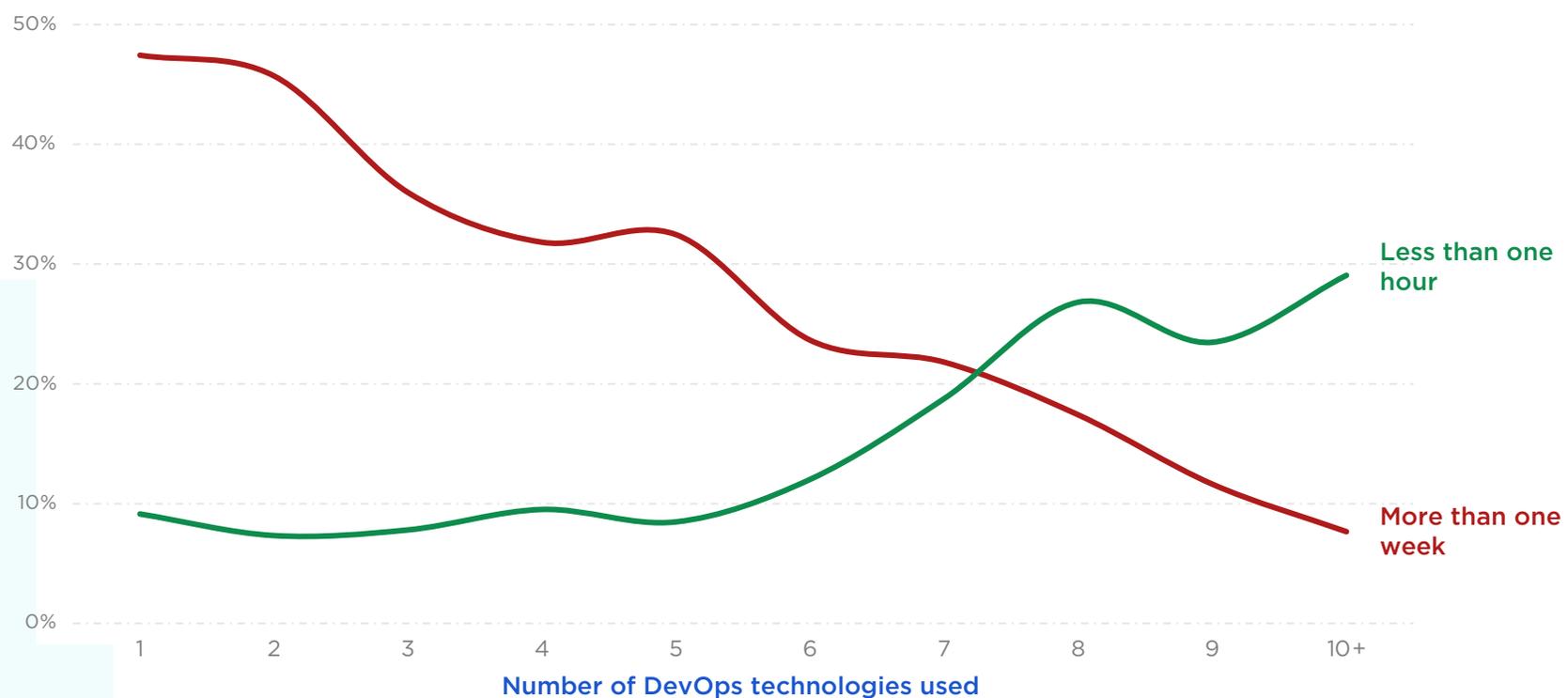


4. What drives software delivery performance?

Practitioners using seven or more DevOps technologies are half as likely to be low performers as those using a single technology

% of top and low performers in time to restore service among DevOps practitioners using each number of DevOps technologies (Q1 2022 n=8,674)

Software delivery performance (time to restore service) by number of DevOps technologies used





METHODOLOGY

The Developer Nation Survey

The 22nd edition of the Developer Nation survey reached 20,000+ respondents from 166 countries around the world. As such, the Developer Nation series of surveys continues to be the most global independent research on mobile, desktop, industrial IoT, consumer electronics, embedded, third-party app ecosystems, cloud, web, game, augmented and virtual reality, 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 December 2021 and February 2022.

Respondents to the online survey came from 166 countries, including major app and machine learning development hotspots such as the US, China, India, Israel, the UK, and Russia, even stretching all the way to Kenya, Brazil, and Jordan. The geographic reach of this survey is truly reflective of the global scale of the developer economy. The online survey was translated into eight languages in addition to English, namely simplified Chinese, traditional Chinese, Spanish, Portuguese, Vietnamese, Russian, Japanese, and Korean, and was promoted by more than 80 leading community and media partners within the software development industry.

To eliminate the effect of regional sampling biases, we first weighted to correct for over-represented individual countries within regions. We then weighted the regional distribution across nine regions by a factor that was determined by the regional distribution and growth trends identified in our Developer Nation 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>.



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.



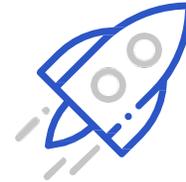
WHO DEVELOPERS ARE

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

TRUSTED BY

the leading tech platforms



OUR CLIENTS

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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