



DZONE'S 2019 GUIDE TO

Containers

ORCHESTRATION AND BEYOND



RESEARCH PARTNER SPOTLIGHT



Key Research Findings

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Demographics

For the 2019 DZone Guide to Containers, we surveyed 559 developers, with a 79% completion rating. Below, we've given a quick demographic breakdown of these respondents.

- Respondents live in three main geographical areas:
 - 35% reside in Europe
 - 26% live in the USA
 - 14% call South Central Asia home
- Respondents, on average, have 18 years of experience in the software/IT industry.
- Most respondents work for enterprise-level organizations:
 - 23% work for organizations with 100-999 employees
 - 22% work for organizations with 1,000-9,999 employees
 - 22% work for organizations with 10,000+ employees
- Respondents reported three main job roles:
 - 29% work as developers/engineers
 - 25% are architects
 - 20% make their living as developer team leads

- Survey-takers reported working on three main types of software development projects:
 - 84% are currently developing web applications/services
 - 52% are working on developing enterprise business applications
 - 30% are developing native mobile apps

How Orgs Use Containers

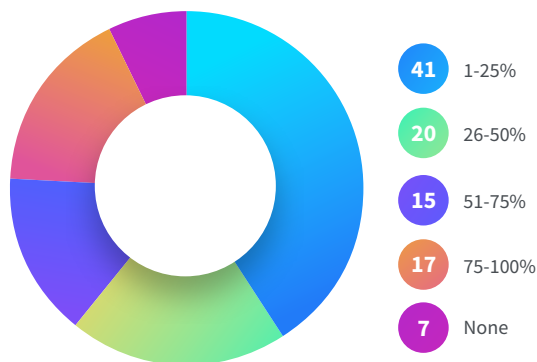
To set a baseline for the rest of the report, let's begin by examining the organizational use of containers, and how it has changed over time. When we asked respondents if their organization currently uses container technologies, 70% answered yes. This is a rather astounding number, as last year, in our 2018 Containers Guide Survey, only 45% of respondents reported that their organization used containers. Additionally, that percentage of respondents who told us that their organizations are not using containers fell from 25% in 2018 to 10% in this year's survey.

Taking a more granular look at these statistics, we find that every department within a typical software company's organizational structure witnessed large increases in container adoption. Among development teams, container adoption rates rose from 83% in 2018 to 89% in 2019; container use among DevOps teams grew from 77% to 82%; QA/Testing teams' adoption of containers went from 46% to 60%; and operations teams' container adoption rates climbed from 38% to 60%. These statistics represent a dramatic shift in the ways in which containers and container technologies are used throughout the SDLC.

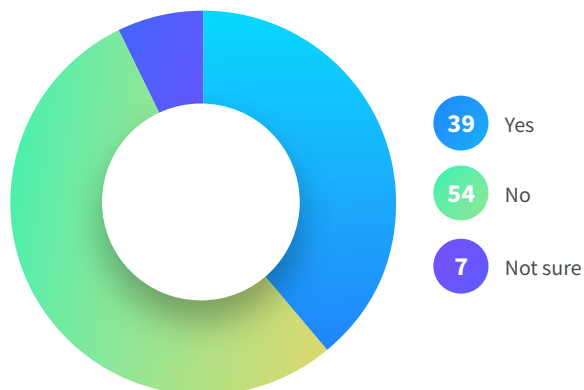
If we zoom in even farther, going from the departmental level to the environmental level, we see the same pattern occurring. In 2018, 87% of respondents reported using containers in development environments; this year, this number rose to 90%. Production/deployment environments saw a 7% percent increase

SURVEY RESPONSES

What percentage of your organization's workload is containerized?



Do you believe your organization has achieved Continuous Delivery?



in container use over the past year, with 80% of this year's survey-takers using containers in production/deployment. The containerization rates of QA/Testing environments jumped from 63% in 2018 to 79% in 2019; and staging environments witnessed a similar growth in containerization rates, going from 54% in 2018 to 71% this year.

All this is to say that container adoption has increased dramatically over the past year. This growth was not only reflected in the number of organizations, teams, and projects adopting container technologies but also the number of containers being run by those organizations. In last year's survey, 61% of respondents reported that their organizations ran 1-100 containers in production; this year, 46% of respondents reported thusly. Interestingly, the growth in larger containerized environments in production was spread out rather evenly among the different sizes. As this type of statistical breakdown does not lend itself to compelling prose, here are the numbers reflecting the year-over-year changes our respondents reported in terms of the number of containers their organization uses in production:

- 2018:
 - 1-100: 61%
 - 101-250: 13%
 - 251-500: 6%
 - 501-1,000: 2%
 - 1,001-5,000: 3%
 - 5,000+: 1%
- 2019:
 - 1-100: 46%
 - 101-250: 16%
 - 251-500: 9%
 - 501-1,000: 6%
 - 1,001-5,000: 4%
 - 5,000+: 4%

Containers as a DevOps Tool

Not much has changed over the past year in terms of the tools that developers use in their containerization efforts; the field is still dominated by Docker (and its other products like Docker Swarm, Docker Enterprise, and Docker Hub) and Kubernetes. Thus, rather than belabor the point of Docker's and Kubernetes's astronomical adoption rates, in this section, we'll evaluate the role that containers play as a means to achieve a more streamlined development process.

MICROSERVICES ADOPTION

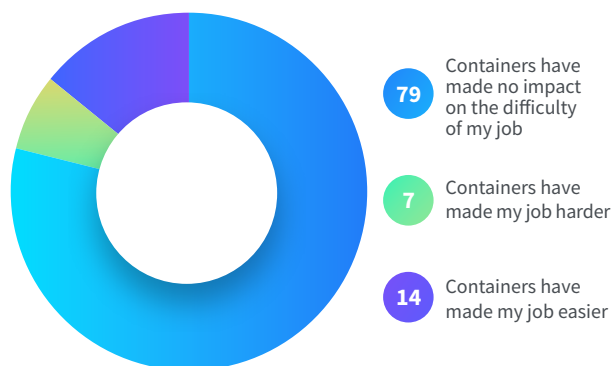
As noted in [DZone's Guide to DevOps: Implementing Cultural Change](#), microservices have become an important facet of DevOps-based development — so much, in fact, that 58% of respondents to our 2019 DevOps survey reported using microservices in some capacity (either in production or development). In this year's containers survey, we also found a widespread adoption of microservices among respondents. When we asked survey-takers if their organizations have adopted microservices, 70% responded yes. This was a rather large year-over-year change from our 2018 Containers Guide survey, in which 57% of the respondents reported that their organization had adopted microservices. When we compare this year's data on microservices adoption to those organizations that are currently using containers, we find that the two are a popular pairing. Among those respondents who work for organizations that use container technology, 60% have adopted microservices. Additionally, only 10% of survey-takers who reported using microservices have not adopted container technologies.

CI/CD

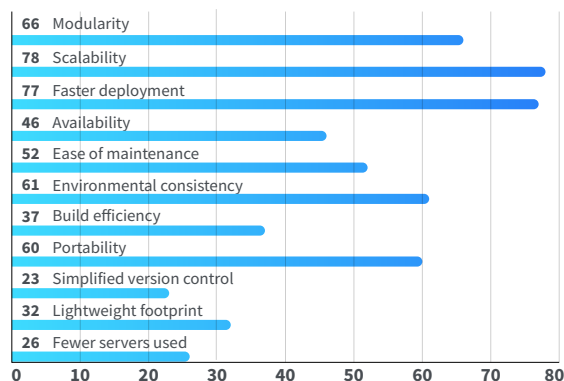
Continuous integration and continuous delivery constitute possibly the most well-known DevOps concepts, and thus seems like a good barometer with which to measure containers' effects on the DevOps process. When we asked survey takers whether

SURVEY RESPONSES

Have containers made your job easier or harder?



What benefits do container technologies offer your organization?



they believe their organization has achieved continuous delivery, 54% said no and 39% responded yes. Interestingly, when we correspond this data to the data on organizational container adoption, we get a different story. Among those respondents whose organizations are using container technologies, 33% reported that their organization has achieved continuous delivery and another 33% reported that their organization has not. Thus, while containers are not the silver bullet for achieving CD, it seems they may alleviate some of the roadblocks along the way.

In terms of continuous integration, we see a similar story. 62% of respondents said that they believe their organization has achieved CI, while 32% told us they have not. Comparing these numbers to our data on organizations that currently use container technologies, we find that the rate of organizations both achieving and not achieving continuous integration fall. Among respondents who work for organizations that use containers, 50% believe their organization has achieved CI, while 16% say they have not achieved CI. Thus, much like in the case of continuous delivery, containers seem to act more as an impediment remover to the CI process than an active agent in CI's success.

EXPECTATIONS VS. REALITY

Containers have received a fair amount of hype over the past several years. In an attempt to peer through the buzz, in this section, we'll be using the data we collected from developers on what they expected from containers and what they've actually found working with containers to be like.

We began by simply asking respondents what benefits they were expecting container technologies to offer their organization. The top answers were as follows: scalability (72%), faster deployment (69%), ease of maintenance (54%), environmental consistency (51%), modularity (48%), and portability (42%). Out of all these potential benefits, ease of maintenance (52%) was the only one where expected and actual benefits (more or less) matched up.

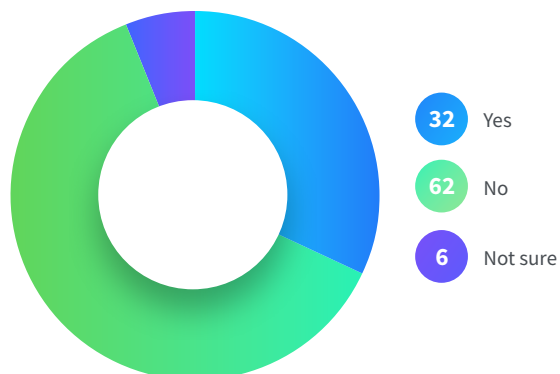
When we asked respondents what benefits containers actually brought to their organization, all the other factors enumerated above exceeded expectations (and, in some cases, by quite a wide margin). The benefits of containers that survey-takers reported actually witnessing in their organization were as follows: scalability (77%), faster deployment (77%), modularity (66%), environmental consistency (61%), and portability (60%). Modularity and portability seem to be the most unforeseen benefits offered by containers, with each garnering an 18% difference between expected and actual benefits.

When it comes to the expected versus actual challenges of containers, we saw equally interesting results. Unlike the potential benefits listed above, respondents only reported four main concerns regarding container adoption: lack of developer experience (80%, up from 71% in 2018), refactoring/re-architecting legacy applications (70%), ensuring application and network security (43%), and application performance monitoring (31%, down from 38% in 2018). Again, much like we saw with the benefits of containers, only one of these challenges actually matched respondents' expectations, with ensuring application and network security reported as a real challenge faced by 46% of respondents. The other three potential challenges proved less daunting than feared. 63% of respondents told us refactoring/re-architecting legacy applications was an obstacle, 58% reported challenges with a lack of developer experience, and 41% said application performance monitoring proved a challenge (up from 33% in 2018). Out of these four main road blocks, however, only two were reported as a primary reason why organizations opted against container adoption: lack of developer (41%) experience and refactoring/re-architecting legacy applications (21%).

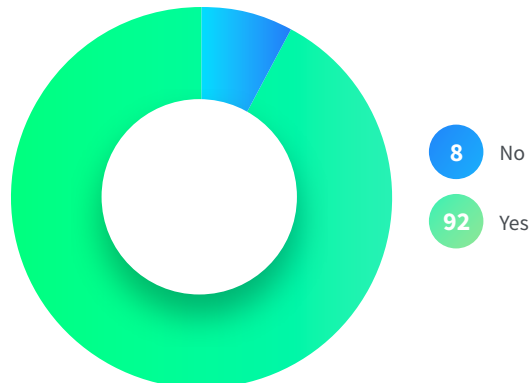
All in all, the benefits of container adoption seem to outweigh the negatives, as 79% of respondents told us they feel containers have made their jobs easier (up from 75% in 2018).

SURVEY RESPONSES

Do you believe your organization has achieved Continuous Integration?



Is your organization planning to increase the number of containers they use?



Diving Deeper Into Containers

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Books

The Docker Book: Containerization Is the New Virtualization

Dive into how to install, deploy, manage, and extend Docker, as well as how to use Docker to build containers and services for your specific needs.

Microservices and Containers

Get an analysis of how Docker containers plus microservices can aid in agile and scalable app development and deployment.

Kubernetes Cookbook: Building Cloud-Native Applications

Learn about successfully using Kubernetes to automate the deployment, scaling, and management of containerized applications.

Zones

Cloud [dzone.com/cloud](#)

The Cloud Zone covers the host of providers and utilities that make cloud computing possible and push the limits (and savings) with which we can deploy, store, and host applications in a flexible, elastic manner. The Cloud Zone focuses on PaaS, infrastructures, security, scalability, and hosting servers

Microservices [dzone.com/microservices](#)

The Microservices Zone will take you through breaking down the monolith step-by-step and designing microservices architecture from scratch. It covers everything from scalability to patterns and anti-patterns. It digs deeper than just containers to give you practical applications and business use cases.

DevOps [dzone.com/devops](#)

DevOps is a cultural movement, supported by exciting new tools, that is aimed at encouraging close cooperation within cross-disciplinary teams of developers and IT operations. The DevOps Zone is your hot spot for news and resources about Continuous Delivery, Puppet, Chef, Jenkins, and much more.

Refcardz

CI/CD for Containers

Containers and orchestration tools have often been cited as ways to facilitate continuous delivery and continuous integration. Download this Refcard to learn about the challenges and solutions to utilizing containers in your DevOps pipeline.

Java Containerization

This Refcard focuses on the design, deployment, service discovery, and management of Java applications on the open-source project called Docker so that you can get your Java application up and running inside a Docker-deployed Linux container.

Persistent Container Storage

Containers are great for building applications with ephemeral data. But what if you need your data to persist? Download this Refcard to learn what you need for container storage, discover the benefits of cloud-native storage.

Podcasts

Containerization and Why Everyone Loves Docker So Much

Learn about what containerization is, containerization software solutions, what the appeal of containers is, and how containerization is used.

Tom's Tech Notes: What You Need to Know About Containers

Get advice from nine industry experts on what you need to know about containers for modern application development.

Pod as a Service: Containerization & Container Orchestration

Learn about prominent container technologies and their benefits, considerations, orchestration, and management.

Why Containers Are an Existential Threat to VMware

VMware has dominated the virtualization space since it introduced the technology 19 years ago. But experts now cite the rise of containers as an existential risk to VMware. The Docker container format, popularized by developers, is taking the datacenter by storm as enterprises move containers into production.

But what's driving this transformation? Pressure to modernize applications and accelerate time-to-market is greater than ever. That means more frequent releases, straining the old ways of deploying software and putting the monolithic application stack under siege. In contrast, many of today's most advanced distributed systems are built using frameworks that are deployed as containers and designed to run on clusters of bare-metal servers — without virtual machines.

However, this runs contrary to VMware CEO Pat Gelsinger's recent keynote speech at VMworld. In it he stated that virtual machines are still the best place to run Kubernetes and containers.

What should we make of this? In short, it's self-serving and customers know better. VMware's acquisition of Heptio for \$550 million suggests VMware is eager to build IP around containers, and to figure out how to reduce the risk of virtual machine obsolescence.

Here's why VMware should be on the defensive: VMs require excessive overhead, because inside each VM you have to boot up an OS. So when you run containers on a VM, you're running a VM and an OS and a container. Running each container on a VM also introduces two layers of orchestration — one to manage the virtualization environment, and Kubernetes to manage the container environment. That means two layers of networking topology to architect, and two layers of storage to manage.

Many cloud-native apps are not meant to run on VMs, they're meant to run on bare metal. Most are I/O bound when it comes to performance. And with VMs, I/O performance — and more importantly TPS (transactions per second) — suffers.

If containers replace virtual machines and the enterprise data-center standardizes on Kubernetes, what will the net impact be on the vendor ecosystem? We're on the cusp of a revolution much like VM revolution two decades ago. But at the time, no one knew how to operate VMs. No one knew how to optimize storage or manage networks so VMs would work efficiently. It was all new, and it was all far from optimal.

If containers replace virtual machines and the enterprise datacenter standardizes on Kubernetes, what will the net impact be on the vendor ecosystem?

Today, the first attempts at containerized infrastructure from the hyperconverged players have largely been about trying to squeeze containers into an obsolete virtualization model. But next-generation infrastructure vendors like Diamanti are focused on deploying Kubernetes and containers on bare metal without VMs — lessons learned from the most sophisticated container production environments in the world.



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Container Infrastructure in 15 Minutes

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- 100µs latency across cluster



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- Easy to scale



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- 70% lower capex
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CONTROL

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- Predictable performance
- Container-granular QOS

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