



REPORT

2019 CONTAINER ADOPTION BENCHMARK SURVEY

EXECUTIVE SUMMARY

Enterprise adoption of containers and Kubernetes continues to grow rapidly in 2019, transforming how applications are created, deployed, and managed. Enterprises are turning to containers to increase efficiency, facilitate application portability, and enable multi-cloud IT operations.

Last year, in our inaugural Container Adoption Benchmark Survey we found that enterprises were still early in the container journey, but already demonstrating a strong preference for open source in the container stack, resulting in a strong trend from proprietary VM-based solutions to containers.

This year we once again surveyed more than 500 IT leaders, and the results reinforce last year's findings, providing strong evidence that container technology is quickly entering the enterprise mainstream. The use of bare-metal containers is increasing as a way to reduce infrastructure complexity, deliver the full performance and efficiency benefits of the technology, and reduce costs by eliminating VMware licensing.

Enterprises are focusing on a range of container use cases beyond cloud-native applications as they explore containerizing legacy applications and add support for big data and other workloads.

Key Findings:

- Cloud-native applications remain the number one container use case for 2019, according to 33 percent of respondents.
- The database use case has moved up to a close second, chosen by 32 percent of respondents.
- Respondents are running containers in multiple environments: on premises (45 percent), private cloud (29 percent), and public cloud (up to 37 percent).
- Almost 56 percent who run containers on bare metal do so for higher performance; 36 percent choose bare metal to reduce costs.
- Management complexity is the biggest bare-metal adoption challenge (36 percent) followed by time-to-deploy and keeping software up to date (both 22 percent).
- For enterprises investing \$100k or more on containers, seventy percent are entering production in 2019, and more than one-third (34 percent) are running containers on bare metal.
- For enterprises investing \$100k or more on containers, 43 percent plan to move some workloads to containers, while 26 percent intend to move most workloads to containers.

KEY FINDINGS

[01] THE CURRENT STATE OF CONTAINER ADOPTION

In comparison to last year, we see clear signs that containers are entering the enterprise IT mainstream. The decision makers are changing, investment is increasing, and use cases are expanding. As a result, the challenges for running containers in production are changing, and the container skills shortage has become an increasingly pressing challenge.

[02] BARE METAL: OPPORTUNITIES AND CHALLENGES

The move to bare-metal container deployments has accelerated in 2019. Organizations are turning to bare-metal to increase performance and decrease costs, even as they grapple with management complexity, deployment time, and updating open-source software.

[03] EXPANDING USE CASES

Container use cases are moving beyond cloud-native applications. Respondents are exploring a wide range of use cases—everything from modernizing legacy applications to big data analytics—and increasingly deploying containers in multi-cloud environments. Databases have emerged as a critical container use case for the enterprise.

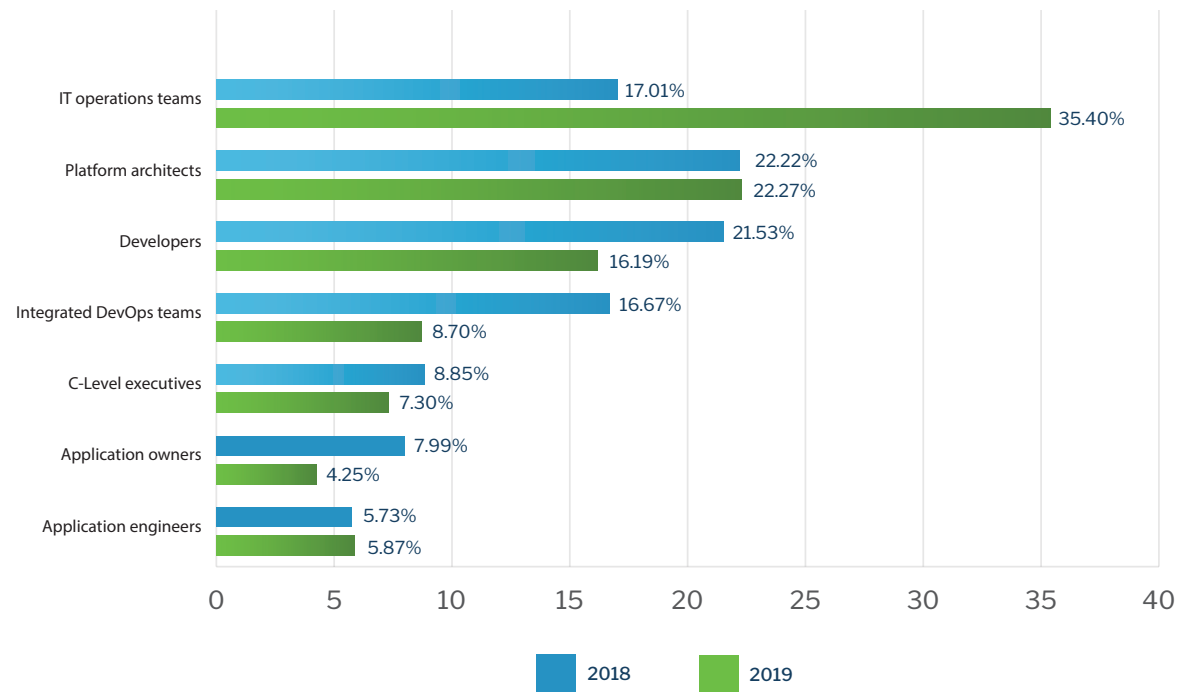
01

THE CURRENT STATE OF CONTAINER ADOPTION

OUR 2018 SURVEY found that the state of enterprise container adoption was still in the early stages, with many enterprises just starting to move containers into production. This year, the approach to containers in the enterprise is clearly maturing.

One of the clearest signs that containers and Kubernetes technology are entering the mainstream is a dramatic shift in who's in the driver's seat. In 2018, just 17 percent said that IT operations teams were driving container adoption; a year later that number has jumped to more than 35 percent. IT operations is assuming responsibility for containers from DevOps teams, developers, and application owners in many organizations.

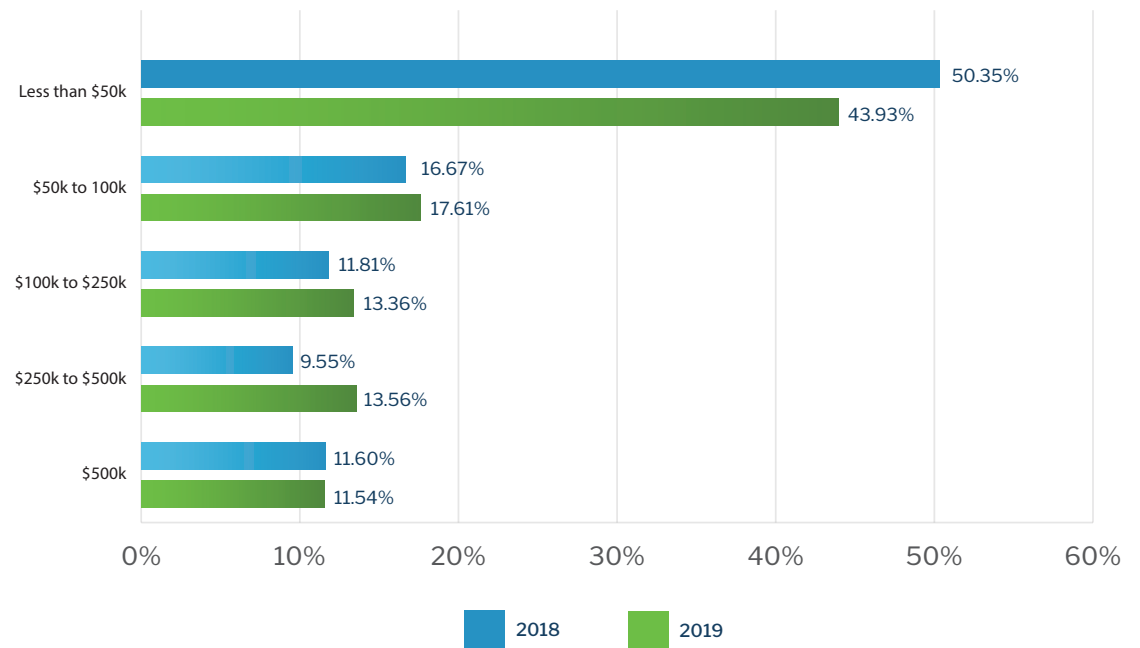
WHO DRIVES CONTAINER ADOPTION IN YOUR ORGANIZATION?



WE'RE SEEING AN INCREASE in investment in 2019, with 38 percent of organizations spending in excess of \$100K on container technologies, up from 33 percent in 2018. More than 25 percent are investing more than \$250K.

While \$100,000 may not seem like a large sum, it's important to remember that over 70 percent of most IT budgets is spent just keeping the lights on. Containers justify the investments you make in them by enabling your IT organization to become more agile while reducing the total cost of computing.

HOW MUCH MONEY IS YOUR ORGANIZATION LIKELY TO INVEST IN CONTAINER TECHNOLOGIES?



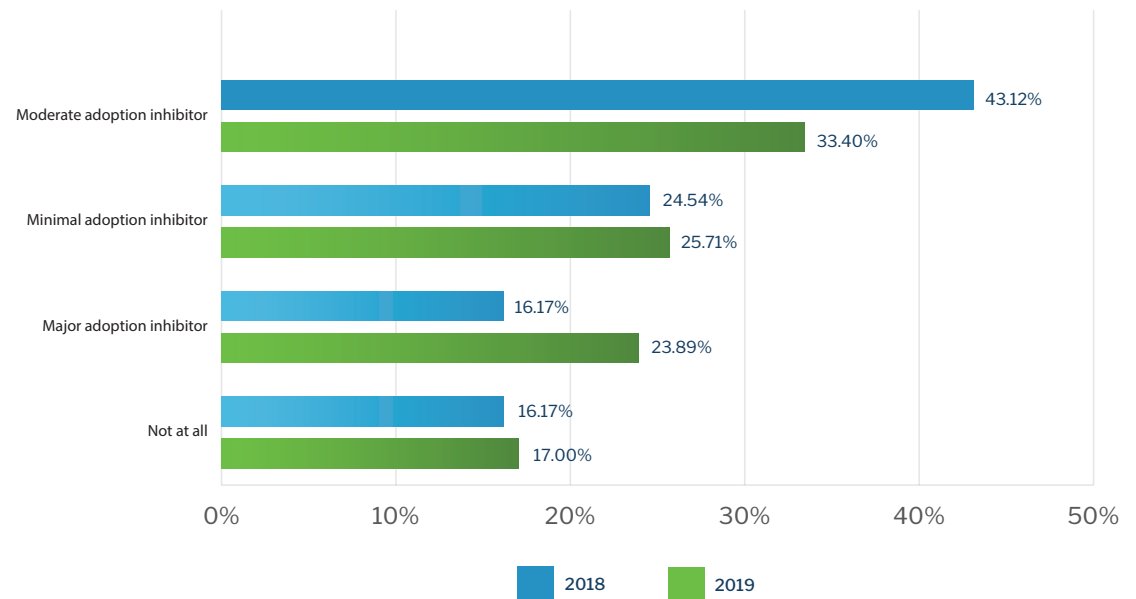
A SHORTAGE OF SKILLED professionals is affecting all areas of IT, with infrastructure skills like containers and DevOps in high demand.

Another clear sign that containers are entering the mainstream is that this year the number of people reporting that the skills shortage was a major adoption inhibitor jumped from 15 percent to almost 25 percent.

Many of those reporting that the skills shortage had no impact fall in the low investment category (investing less than \$50K). If we filter them out, almost 65 percent rate the skills shortage as a moderate or major adoption inhibitor.

The significance of this shortage will continue to grow as container use expands further.

HOW WILL THE SHORTAGE OF PEOPLE WITH THE NECESSARY SKILLS AFFECT ADOPTION?



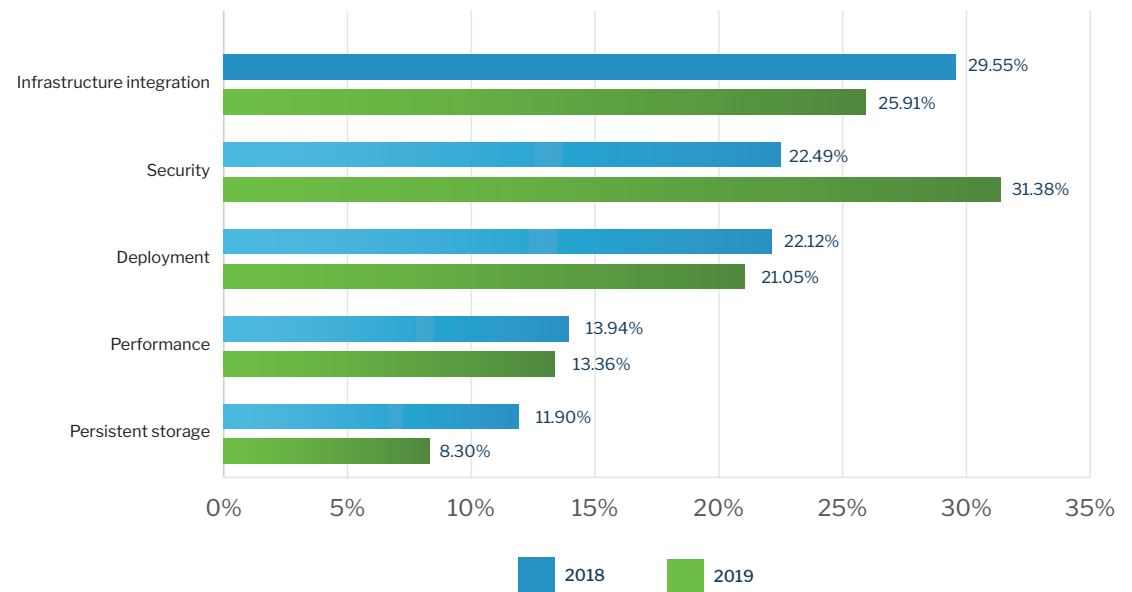
THE SKILLS SHORTAGE exacerbates the challenges of new technology adoption. In IT terms, containers and Kubernetes are extremely young technologies. Kubernetes only became available as open source in 2014.

This year, survey respondents continue to cite infrastructure integration (26 percent) and deployment (21 percent) among their most significant challenges. Getting a container environment up and working with the infrastructure you already have still requires significant expertise.

The biggest shift from last year is in the area of security, chosen by more than 30 percent of respondents as their biggest challenge, an increase of almost 10 percent from last year. This is another indicator that enterprises are moving more containers into production.

The good news is that security has been a primary consideration since the inception of Kubernetes, and it remains an active area of development. In addition, an ecosystem of security vendors is emerging to help address the security needs of enterprises adopting containers.

IF YOU'RE RUNNING CONTAINERS IN PRODUCTION, WHAT IS YOUR BIGGEST OVERALL CHALLENGE?



Containers in the enterprise are becoming mainstream and investments are increasing, but expertise is limited, and challenges are mounting as containers enter production. Smart companies are building skills internally, looking for partners that can help catalyze success, and choosing more integrated solutions that accelerate deployments and simplify the container environment.

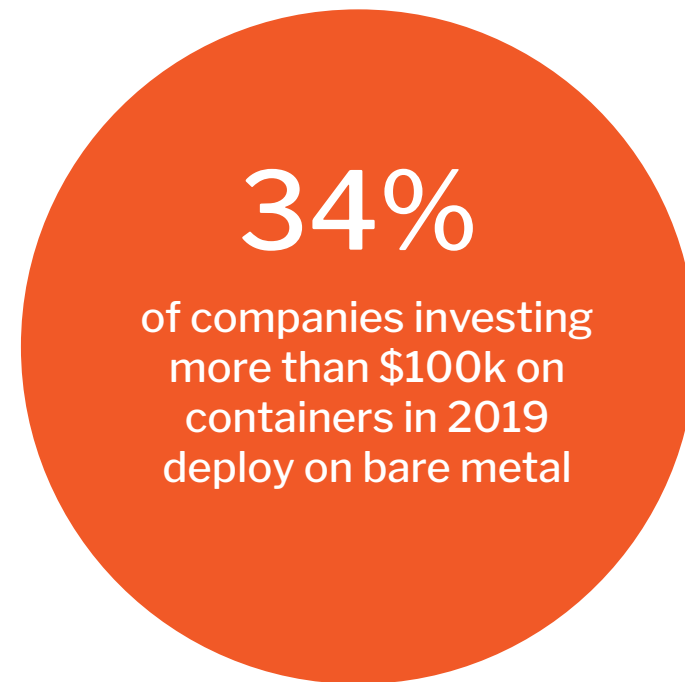
02

BARE METAL:
OPPORTUNITIES AND CHALLENGES

THE 2018 SURVEY FOUND that respondents expressed some eagerness to reduce the “VM tax” by running containers on bare metal rather than inside virtual machines. In many cases, containers are deployed on top of a hypervisor largely because organizations initially lack the tools and processes to run containers on bare-metal servers. This year’s survey suggests that enterprises are accelerating the adoption of bare-metal as a way to optimize their container deployments.

In 2019, more than 21 percent of respondents report running containers on bare metal. That number jumps to 34 percent when we exclude the companies that are investing less than \$100K on containers.

In this year’s survey, we looked at the issue of containers on bare metal a bit more closely to understand why organizations choose bare metal and what challenges they face with bare-metal deployments.

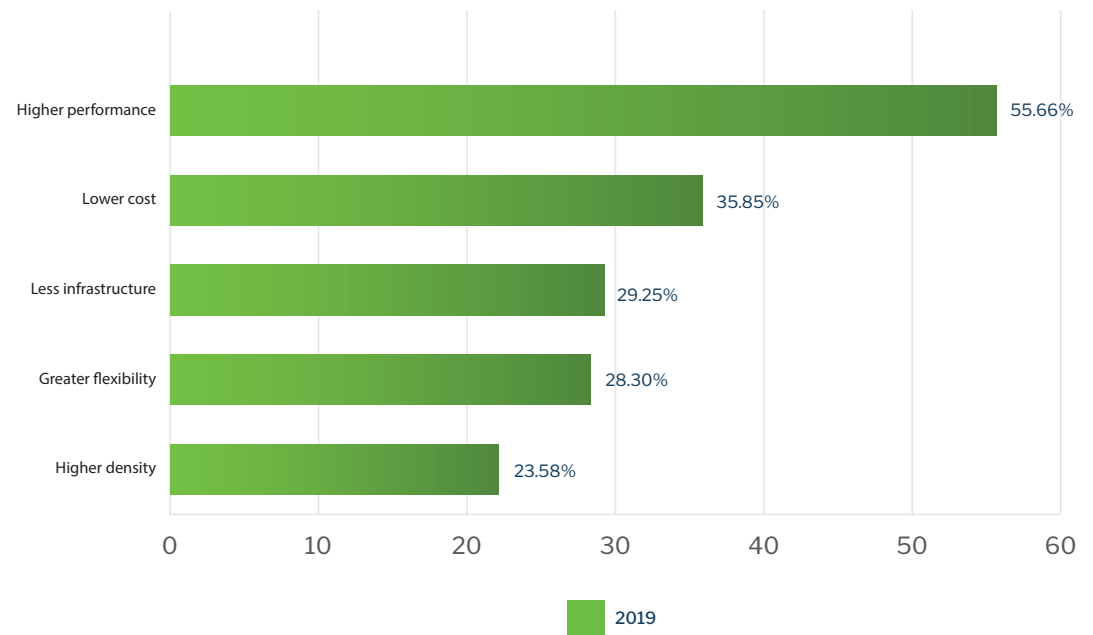


WHEN WE ASKED companies running containers on bare metal their reasons, the answers were multifold:

PERFORMANCE. The biggest response by far was performance. Almost 56 percent cited higher performance as the reason they run on bare metal. Many applications are I/O bound, and bare metal does a better job of delivering I/O to containers. If VMs have an Achilles' heel, it's I/O performance.

COST. The next biggest reason for running on bare metal is lower cost, chosen by 36 percent of respondents. Many organizations start with containers on VMs. While this makes sense for initial experimentation, there's little reason to stay on this path from a technology or cost standpoint as your container environment grows and enters production. Virtualization licensing costs add significantly to the overall cost of a container environment.

WHY ARE YOU RUNNING CONTAINERS ON BARE-METAL SERVERS INSTEAD OF VIRTUAL MACHINES?

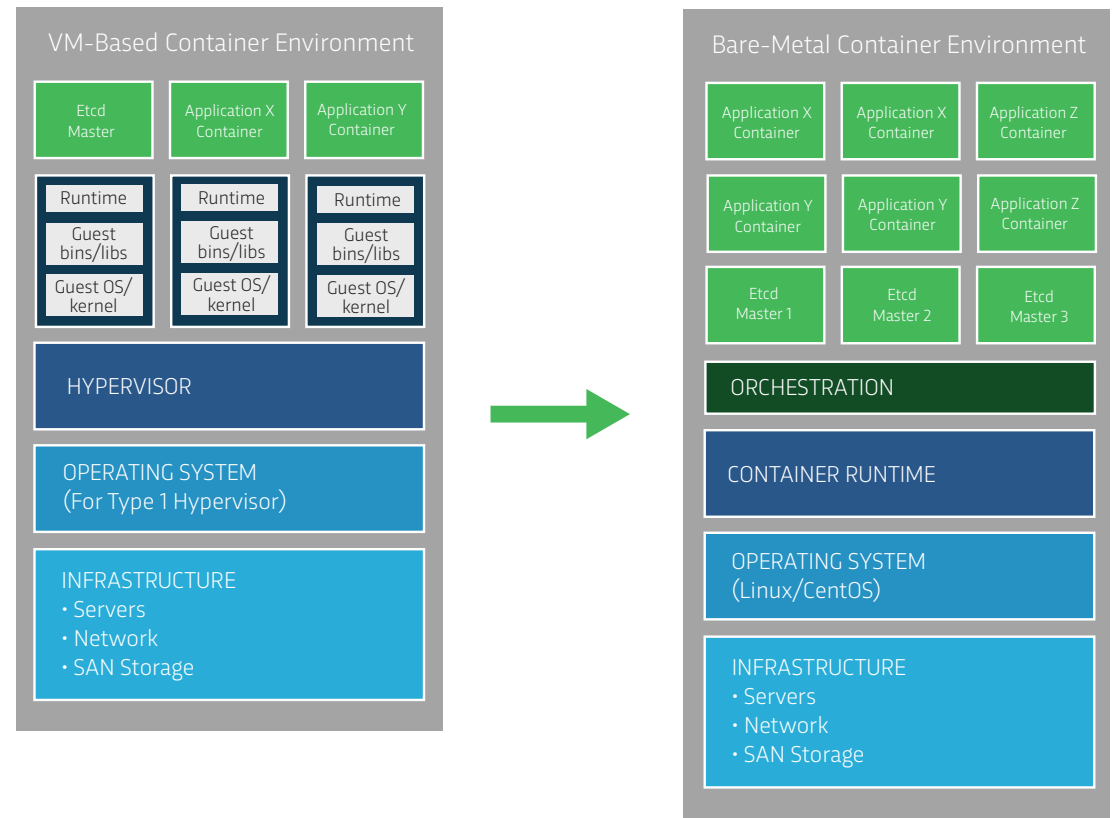


COMPLEXITY. Almost 30 percent of respondents cited the fact that bare-metal container environments are less complex. Bare-metal containers reduce the number of infrastructure layers to manage and maintain versus VM-based containers. Because bare metal is more efficient, you also need less total hardware, so there's less to manage.

FLEXIBILITY. Greater flexibility was named as a reason for bare-metal containers by 28 percent of those surveyed. A bare-metal environment gives you more flexibility to choose your networking, storage, and software ecosystem.

INFRASTRUCTURE DENSITY. Last on the list, but still significant at almost 24 percent of respondents is density—the number of containers you can run on a single server. VM-based containers can require up to 5x the infrastructure to support the same workload. Having multiple different application containers contending for a VM's limited CPU, memory, and I/O resources introduces noisy neighbor problems that limit the density you can achieve.

Learn more in the white paper [Five Reasons You Should Run Containers on Bare Metal, Not VMs](#).



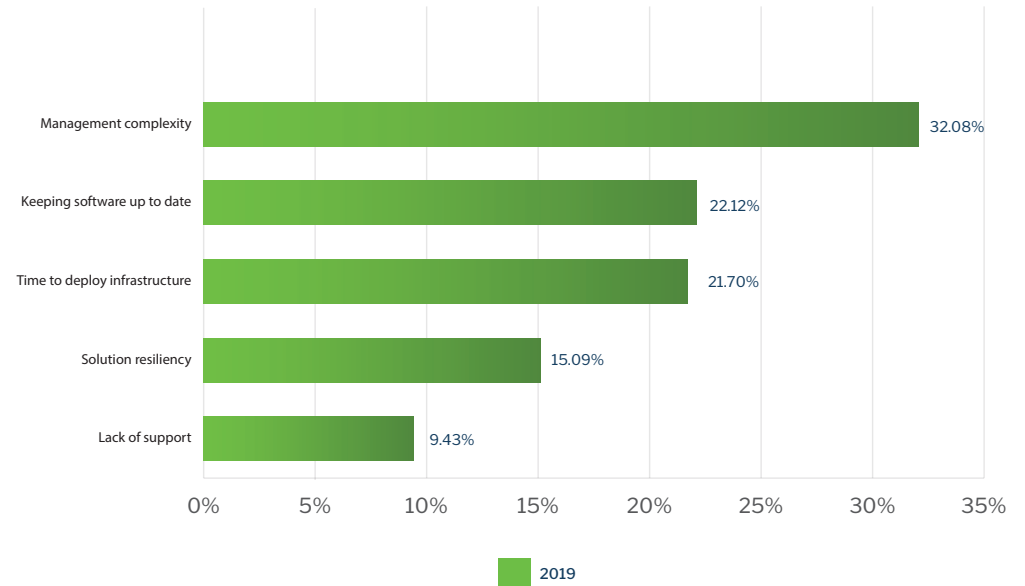
Due to noisy neighbor problems and networking complications, VM-based container environments support far fewer containers per physical server.

WHILE IT'S CLEAR that survey respondents find many reasons to prefer a bare-metal container environment, no matter what environment you choose, challenges remain. Containers and Kubernetes are still young technologies. Three challenges rise to the top in this year's survey.

MANAGEMENT. Management complexity tops the list, chosen by almost a third of respondents. The container environment is still new to most teams, technologies are evolving quickly, and management tools are relatively immature.

To be fair, this is a challenge that applies to all container environments. While the familiarity of your VM environment may feel reassuring, building your container environment on top of it creates the requirement to manage two layers of application orchestration.

WHAT'S YOUR BIGGEST CHALLENGE WITH BARE-METAL CONTAINERS?

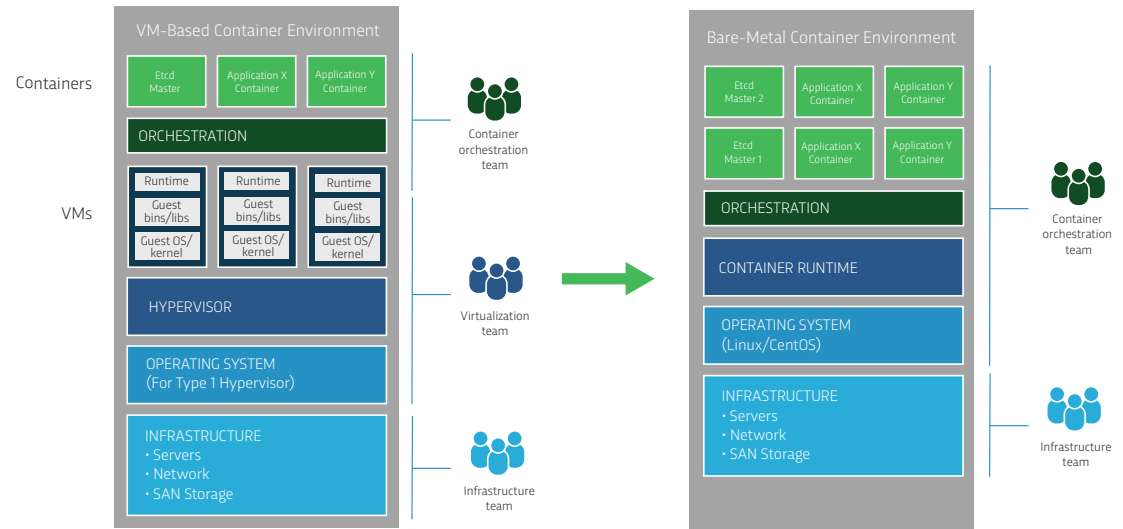


Bare metal has clear performance, cost, and flexibility advantages. However, making hardware and software choices and integrating a solution is time consuming. That doesn't mean you shouldn't do it, just make sure you've done your homework and understand the alternatives. Integrated solutions and experienced partners can accelerate your path to production and help ensure success.

TIME TO DEPLOY. Almost 22 percent of respondents chose “time to deploy infrastructure” as their biggest challenge. Deploying a bare-metal container environment from scratch is a significant undertaking.

UPDATES. Keeping software up to date was cited as the biggest challenge by another 22 percent of respondents. The open source ecosystem may be unfamiliar to your team, and keeping up with developments, making deployment decisions, and installing updated software versions can be a daunting undertaking.

Learn more in the white paper [Choosing the Right Container Infrastructure for Your Organization](#).



03

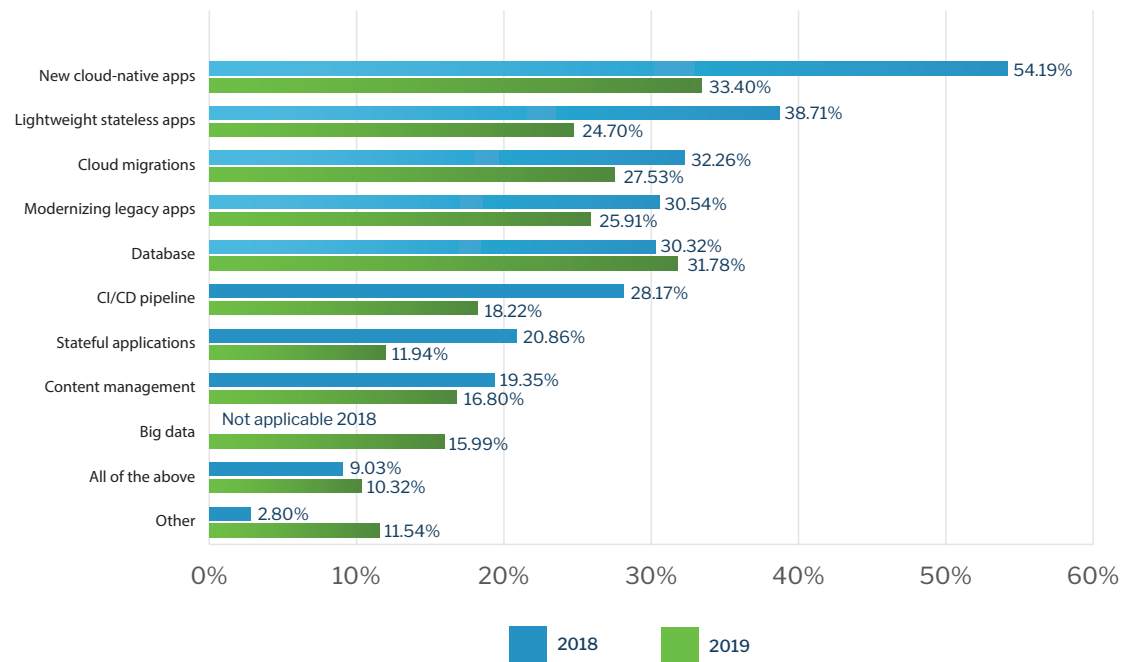
EXPANDING USE CASES

A FURTHER SIGN that containers are entering the mainstream is that we're seeing some shifts in use cases since 2018. The first thing you notice when you look at the figure on the right is significant drops in the percentage of respondents selecting "cloud-native apps" and "lightweight stateless apps"—declines of 21 percent and 14 percent respectively.

We don't believe this implies that people are losing interest in building cloud-native apps and deploying them on containers, rather we think it demonstrates that respondents are now interested in a broader variety of use cases—some of which clearly don't appear in the list of choices we provided.

This is borne out by the fact that the percentage of respondents choosing "other" increased threefold, and the percentage choosing "all of the above" increased modestly. Fifteen percent of respondents chose "big data," which was a new option for 2019.

IN WHAT USE CASES WILL YOUR CONTAINERS BE EMPLOYED?

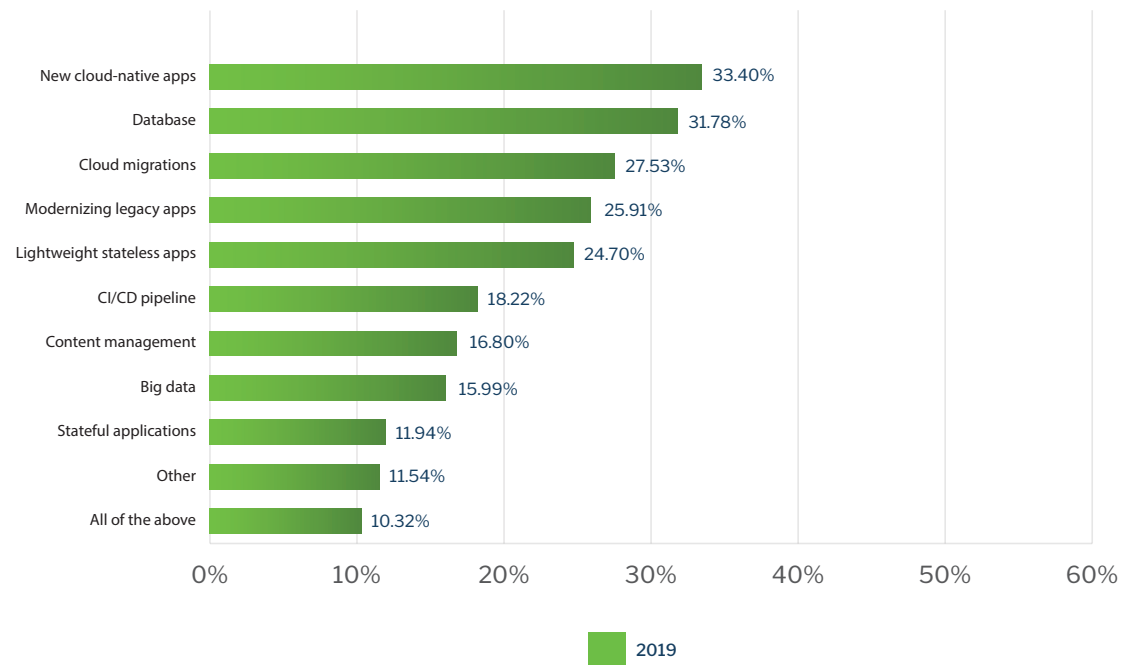


DATABASES ARE a critical element of any enterprise IT environment. A significant percentage of your IT budget probably goes to pay licensing fees for proprietary, closed source databases such as Oracle and Microsoft SQL Server.

In 2019, databases were essentially in a dead heat with cloud-native apps as the most popular container use case; 32 percent of respondents selected databases while cloud-native apps came in at 33 percent.

Databases are likely to be the “killer app” in container environments in 2019, as enterprises seize the opportunity to move away from expensive, closed-source database platforms in favor of databases such as MariaDB, MongoDB, PostgreSQL, YugaByte, and other options suited to container environments. New options scale faster, guarantee service levels—and cost less.

DATABASES EMERGED AS A TOP USE CASE FOR 2019

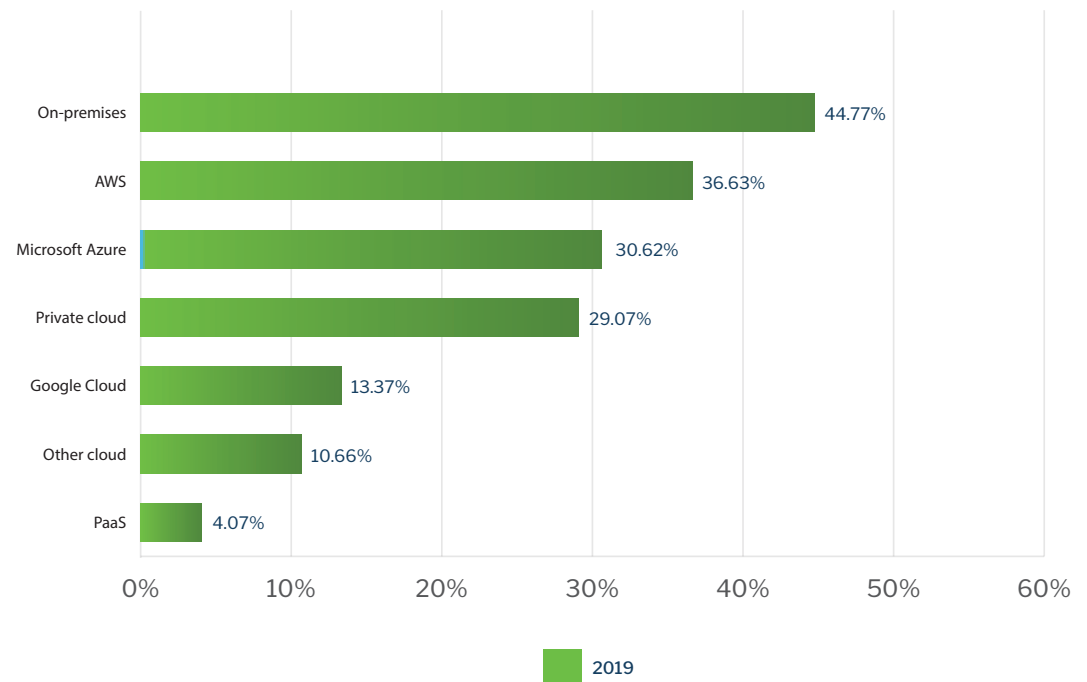


Modernizing your approach to databases can make your database operations much more agile, enabling database as a service (DBaaS). With a containerized database, developers and line-of-business teams can deploy a new database quickly without time-consuming hardware configuration, software installation, and tuning.

Most enterprises want to run containers on premises for lower cost and greater control, but with the ability to easily move or expand operations to the cloud. The promise of easier application portability across environments is a hallmark of containers and Kubernetes.

We wanted to understand more about where people are running containers, so we expanded the choices to break out the major public cloud providers this year. This makes it impossible to show an apples-to-apples comparison versus 2018. The only environment that shows clear declines from 2018 is PaaS, which has dropped from 14 percent of respondents down to just 4 percent.

MULTI-CLOUD HAS BECOME A CRITICAL CONSIDERATION ACROSS ALL CONTAINER USE CASES



Among public cloud providers, AWS has the greatest share among those deploying containers (37% of respondents), followed closely by Microsoft Azure (31% of respondents).

It's clear that respondents are already running containers in multiple environments: on premises (45 percent), private cloud (29 percent), and public cloud (up to 37 percent). Enterprises have clearly learned that they can run containers and Kubernetes on premises and in the public cloud; each of the three major public cloud providers support a conformant version of Kubernetes.

However, this is an area where you still need to exercise caution to avoid lock-in, especially if you're doing development in the cloud.

The big cloud providers are in business to make money, so they have a vested interest in locking you into solutions that may make it difficult to move applications later. While containers and Kubernetes may conform to open source APIs, the same can't necessarily be said for other services and tools in a given cloud environment.

CONCLUSION

The need to deliver new digital services more quickly is driving enterprises to pivot to containers and Kubernetes, both on-premises and in the cloud. Flexible, multi-cloud and hybrid cloud environments built on containers and Kubernetes are supplementing and even replacing conventional IT. Containers are one of the most disruptive—and most beneficial—technologies ever to hit enterprise IT.

Developers benefit because they can access the resources they need, when they need them. Cloud-native development and microservices enable development teams to work more efficiently and innovate faster. Operators appreciate the container environment because it increases infrastructure utilization, enabling them to accomplish more with less while managing critical applications at unprecedented scale.

Since our 2018 survey, we have seen significant indications that containers are entering the IT mainstream. Decision-making has shifted to IT operations teams, investment is increasing, and use cases are expanding. Enterprises are using containers for everything from modernizing legacy applications to big data analytics.

Enterprise applications, whether cloud-native or traditional, need databases to store and manage persistent data. Databases have emerged this year as a high-priority container use case for the

enterprise. IT teams are moving away from expensive, closed-source database platforms in favor of open-source databases that integrate easily into container environments. New options scale faster, guarantee service levels—and cost less.

Your existing IT infrastructure has been optimized over many years for virtualized business applications and may not efficiently support containers. As your organization navigates the transition to containers, you'll need infrastructure that addresses the unique needs of the container environment to avoid bottlenecks.

This year's survey shows that organizations are turning to bare-metal container environments to increase performance and decrease costs. Over 34% of companies investing more than \$100K on container technology choose bare-metal as the best way to decrease infrastructure complexity, achieve greater density, and build a more flexible operating environment.

However, making hardware and software choices and integrating a bare-metal solution can be time consuming. You may face significant headwinds in the transition from VMs to containers, including a shortage of expertise and significant technical debt. The wrong choices today will lock you into solutions that could limit your choices in the future. Integrated solutions and experienced partners can accelerate your path to production and help ensure success.