A Forrester Consulting
Thought Leadership Paper
Commissioned By Red Hat

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Maximize Container Benefits With A Top-Down Approach

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Executive Summary

With the growth in interactive systems of engagement and Agile-based product development, customers have begun to expect extremely short product refresh cycles and almost immediate availability of new features. This places unprecedented pressure on development and operations professionals to respond quickly, frequently, and accurately to business requirements. Containers offer significant opportunities to improve the speed and quality of development, testing, and deployment, but just how easy is it for organizations to maximize their capabilities?

In January 2015, Red Hat commissioned Forrester Consulting to evaluate the use of and challenges with Linux containers in application development and IT operations environments. To further explore this trend, Forrester developed a hypothesis that tested the assertion that containers will change the way organizations deliver applications, but that this process is hindered by current approaches to container management.

Containers are a key enabler of modern application and operation management approaches.

In conducting a survey of 194 IT operations, application development, and architecture professionals at enterprises in the US, the UK, Germany, China, and India, as well as three in-depth interviews from the same population, Forrester found that these companies with top-down container management strategies that foster clear policies and practices regarding container use were more confident in their use of containers and did not share major challenges with other firms as they expanded container use. Furthermore, Forrester found that organizations that employ advanced container management tools considered themselves more skilled in container use and were much more likely to align themselves with DevOps organizational structure and Agile development methodology.

KEY FINDINGS

Forrester's study yielded three key findings:

- **Containers enable organizations to deliver better business results, faster.** The demands of modern application development and IT operations can't be addressed through old methodologies. Containers simplify application deployment, reducing the friction between development and operations while accelerating delivery cycles and delivering value to customers faster. Survey respondents confirmed a wide range of container benefits. Across 13 benefits described, an average of 69% of respondents rated each as very or critically important to their organizations.
- **Undirected approaches to container adoption and management don't yield ideal results.** Containers are being adopted haphazardly at many organizations, with one enterprise architect we spoke to admitting a great deal of "shadow IT" around containers by individuals seeking to maximize their efficiency in the absence of formal policies. This leads to results that fall short of expectations and potential; while our study only included respondents working with containers in some capacity or planning to do so shortly, a mere 45% considered their organizations to be highly skilled in container usage.
- **Container use needs to be properly defined and managed as an enterprise standard in alignment with modern application and operations management approaches.** The survey respondents who benefited the most from their containers were those who had adopted comprehensive management and orchestration capabilities on top of standard offerings. These firms cited well above average levels of expertise with container usage and below average levels of concern around key considerations for container expansion. Additionally, these firms are more likely to leverage modern application development methodologies and organizational structures (such as Agile and DevOps), which encourage collaboration.

Increased Business Demands Drive Widespread And Diverse Container Adoption

The age of the customer — an era in which companies are expected to deliver value anytime, anywhere, at the time of need — has increased customer expectations and put pressure on application delivery professionals to deliver more software than ever before, more quickly than ever before. Recently, container technology has become an important contributing technology for meeting these demands without sacrificing quality.

Container technology makes it possible to provision and configure virtual development, testing, or deployment environments quickly. This, in turn, makes application delivery faster and more reliable. Issues are quickly identified and remediated and changes are easily tracked and managed, resulting in delivery cycle times reduced from months and weeks to weeks and days.

Containers are easy to use and convenient, and they preserve the integrity of units of work as they are moved between environments. Individuals and small teams are able to provision, use, and decommission the environment they need within minutes, from their own desktops and with minimal involvement from other groups. It is also much easier to ensure compliance with enterprise technology standards, as containers are configured according to standard images and infrastructure specifications.

Virtualization can certainly improve efficiency and responsiveness, but it would be difficult to achieve all the promises of virtualization without containers.

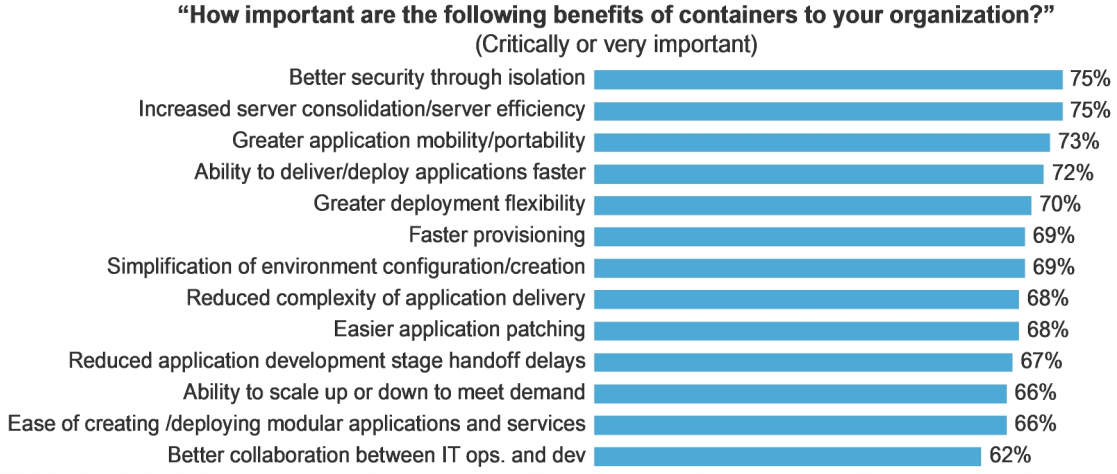
Among the key factors identified by our survey of application development and operations are:

- **Containers satisfy many needs.** An average of 69% of respondents rated any one of the 13 container benefits on which we surveyed as "critically important" or "very important" to their organizations, and the variance of such designations across the 13 benefits is notably small. Additionally, an average of only 3% rated any one of these benefits as "not important" (see Figure 1).

  "Developers like [containers] because they can keep their standard platform and spin up containers of what our normal image looks like. The infrastructure folks like it because it's baked into [our framework]," said an enterprise architect in the healthcare industry.

- **Release frequency is on the rise.** 82% of survey respondents reported an increase in the frequency at

FIGURE 1
Containers Address Major Priorities Of Today's Organizations

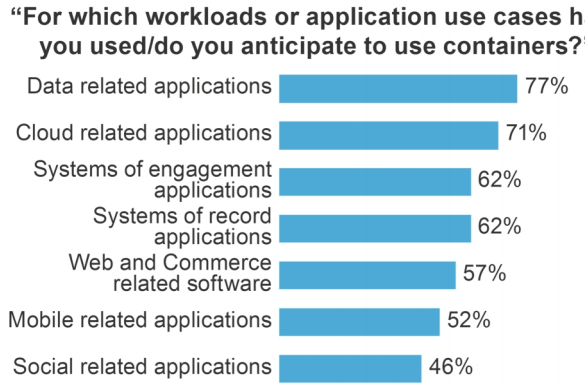


Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

which their organizations release applications over the past two years. Among those that reported an increase, 43% classified it as major.

FIGURE 2

Containers Are Used In A Variety Of Use Cases



Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America

Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

› **Container adoption is surging in response.** Less than a fifth (19%) of survey respondents have been using containers for more than three years. Nearly half (46%) have been using them for less than two years.

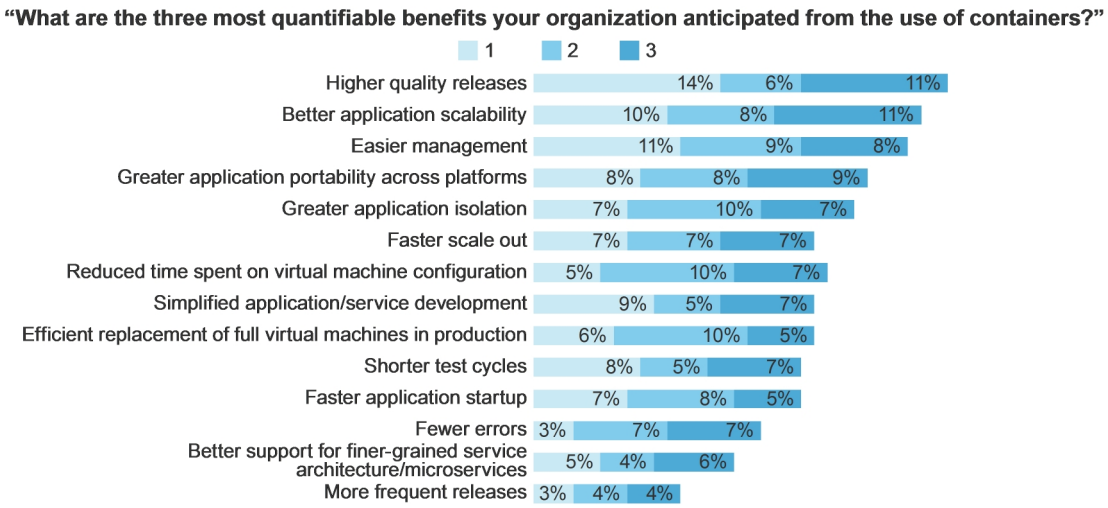
› **Containers help in many contexts.** The benefits of containers are not limited to one or two types of application or architecture. Rather, containers are being used to support almost every modern application development trend, including big data, cloud, web development, mobile apps, systems of engagement, and social networking. In fact, the majority of respondents use containers for six of the seven use cases we asked about, led by data-related, cloud-related, and systems of engagement applications, respectively (see Figure 2).

› **The benefits of containers are tangible and varied.** The top three most quantifiable container benefits are higher-quality releases, better application scalability, and easier management, cited by 31%, 29%, and 28% of respondents, respectively (see Figure 3). That the top benefits cited are so spread out is a testament to the broad appeal of containers to businesses with varying objectives. Our interviewees had similar sentiments:

"We had limited flexibility before [containers]. Checkpointing was hard, memory usage was not very

FIGURE 3

Containers Enhance The Application Development Life Cycle



Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America

Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

good, how the applications interacted with the Kernel was limited . . . [containers] help us in deployment, management, distribution, etc.," noted a lead software engineer at a major telecommunications company.

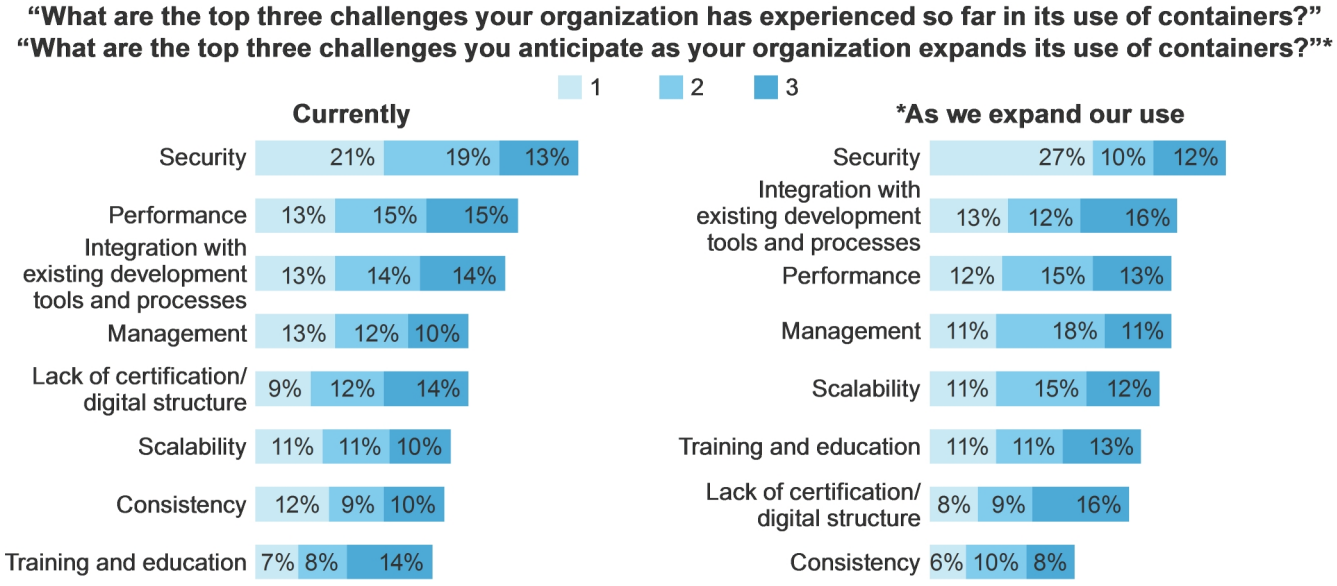
"Our understanding of the drivers of [container adoption] has changed. Initially, it was a cost-saving measure. But now we're realizing that the early adopters are being driven by business requirements," explained an IT operations engineer in financial services. A lead software engineer at a major telecommunications company concurred: "We started container use as a cost-saving thing, but we found it had other benefits for productivity, workflow, etc."

Container Adoption Is Not Without Its Speed Bumps

Despite the overwhelming benefits containers bring to teams with stretched resources and collaborative needs, the rollout across enterprises hasn't been without its headaches. The problems with container adoption have little to do with the technology itself, however. Rather, they relate to organizational aspects that haven't caught up to the technology. Key among these issues are:

- **There are significant challenges with current container use.** We asked respondents whether they have experienced eight specific container use challenges so far. No fewer than 29% of respondents counted each one of them among their top three current container use challenges. Security leads the pack, with more than half (53%) citing this as a concern, including more than a fifth (21%) who consider it their top challenge. Rounding out the top five current challenges are performance, integration with existing development tools and processes, management, and lack of certification or digital signature (see Figure 4).
- **Concerns mount as container use expands.** In addition to current roadblocks around implementation, the professionals we surveyed anticipate increased levels of challenge with as they expand container use. For example, the percentage of respondents ranking security as their No. 1 container-related challenge grows from 21% currently to 27% as firms expand use (see Figure 4). As one IT operations engineer in financial services explained: "Governance, as it pertains to container capabilities, will be a key focus for us before we can really

FIGURE 4
Companies Anticipate Considerable Challenges As They Expand Container Use



Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

take advantage of containers."

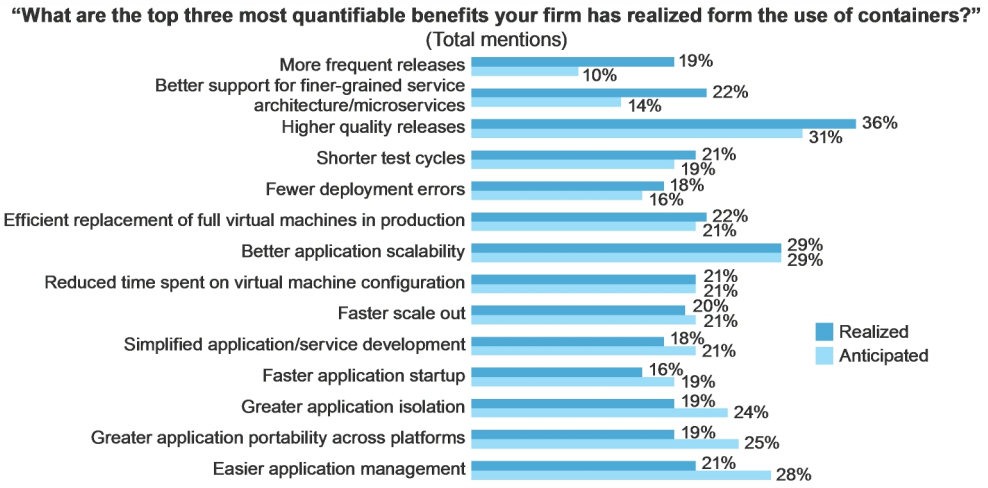
Levels of anxiety regarding integration with existing development tools also become higher in the future, rising from the No. 3 concern to No. 2. Performance and management issues also retain their status as top issues. Indeed, in the absence of companywide container standards, such concerns are likely to persist. Skills and competency vary across teams, and controls external to container technology curb its effectiveness.

- **Security challenges are of particular concern.** Not only are security challenges cited most often across the board by the container users we surveyed, but they are done so with good reason. A recent vulnerability allowed malicious code to break out of its container and execute arbitrary code on the underlying Linux system.[1] Containers alone are not inherently secure and, indeed, can be less secure than the virtual machines typically used to isolate application environments.
- **Some anticipated container benefits aren't being realized.** Across six of the 14 container benefits on which we surveyed, respondents reported that there was less improvement than they anticipated. Discrepancies between expected and realized benefits were greatest for easier application management, greater application portability across platforms, and greater application isolation, respectively (see Figure 5).
- **Containers are used inconsistently across organizations.** Container adoption has not been a carefully planned and executed technology adoption driven by companywide understanding and belief in its virtues. Instead, individuals or small teams of developers have started using containers because they are fast and convenient, enabling them to respond to the increased pressure for quick turnaround coming from their business units and thus making their jobs easier. Unfortunately, this results in not just inconsistent adoption, but also inconsistent benefits.

"Officially, we have about four operations people and eight developers using Docker, but there are tons of other folks running Docker on their workstations. There's a bunch of shadow IT around this," noted an enterprise architect in the healthcare industry. "Various development groups here use different technologies for building, provisioning, etc. I think there's a fair amount of interest in Docker so that it'll all merge together, but that hasn't played out yet."

Compounding this haphazard approach, the types of projects on which containers are used are also varied

FIGURE 5
Firms See Varying Levels Of Impact From Containers Across Metrics



Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

across the organizations we surveyed. Only 42% of respondents use containers for both new and existing projects. Additionally, while levels of use are relatively consistent for development (73%) and testing (71%) stages, use is a full 10 or more percentage points lower for production (61%).

Manage And Orchestrate Containers From The Top Down For Maximum Benefits

Even though containers are a critical tool for modern application development and operations staff, the potential benefits will not be fully realized while container adoption continues to be driven by individuals or small teams. Organizations wishing to exploit the full potential of containers will need to view them as a component of a broader strategy for managing applications and infrastructure throughout the life cycle, achieved by:

1. Formally defining the role of containers as an integral part of enterprise standard practices and architectures.
2. Adding comprehensive management and orchestration capabilities on top of tools like Docker.

Firms that embark on these two initiatives stand to reap more benefits from containers than their counterparts, such as:

› **Fewer concerns about expansion risks.** The percentage of firms citing security as their No. 1 concern as they expand container use drops from 54% among respondents without any tools to 23% among those with cluster and configuration tools. Management concerns rank in the top three concerns around expanded use for firms with no tools or Docker only, but fall precipitously in ranking for firms with comprehensive tools. Scalability jumps in ranking of concern for firms with Docker only as they expand container use, but remains low for firms with comprehensive tools. In each of these categories, those with the most comprehensive, top-down approach to container management and orchestration noted such concerns less frequently than their counterparts (see Table 1).

"Our tools need to do a better job around monitoring and orchestration," explained an enterprise architect in the healthcare industry, "[We] currently lack that functionality. If that doesn't happen, we'll be in the mindset that this isn't for anything but strict development, and we won't be able to use containers elsewhere."

As container use expands, users should also be aware of the benefits of container certification, such as via digital signatures. Those firms that already leverage cluster and configuration management tools, and are therefore more likely to have larger deployments, indicated that certification was a top concern twice as often as more

TABLE 1

Firms With Comprehensive Management And Orchestration Capabilities Are More Confident In Security, Management, And Scalability

"What are the top three challenges you anticipate as your organization expands its use of containers?"
(Total mentions)

	Security	Management	Scalability
Containers with Docker and cluster/configuration management	47%	34%	31%
Containers with Docker alone	48%	44%	46%
Containers with no tools	58%	51%	43%

Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

novice users. Certification adds safety by confirming who created a container and for what purpose and providing a mechanism for verifying its contents.

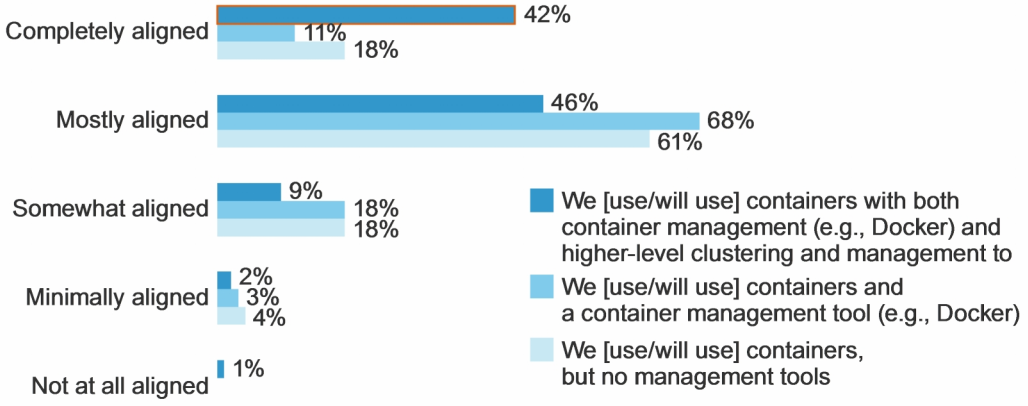
- **Better preparation for Agile methodologies.** More firms with comprehensive tools describe themselves as employing Agile methodology than their counterparts. 43% of these firms are agile, versus 34% that use Docker alone. Organizations using Agile-based product management cycles benefit hugely from containers since they need to develop and release functionality within days or weeks. This results in frequent releases, which could be disruptive if not well managed.
- **Easier path to implementing DevOps.** DevOps, defined as a software development methodology that stresses communication, collaboration, and integration between software developers and IT operations professionals with the aim of enabling rapid production of software products and services, is a naturally ideal environment for container-utilizing organizations. True DevOps is still rare, with mostly nascent examples across industries. Yet organizations with configuration and cluster management tools have a leg up on breaking down silos within the software development life cycle. An average of 15% of container-using organizations that utilize either no management tools or Docker alone classify themselves as "completely aligned" with our definition of DevOps, but that figure nearly triples to 42% among firms with higher-level clustering and management tools (see Figure 6).
- **Increased organizational expertise of container use.** Only 18% of container-using organizations with no management tools consider themselves as "highly skilled" in the use of containers, and that figure rises to 47% among organizations using Docker alone. Yet organizations with higher-level clustering and management tools are the only group in which a majority (58%) see themselves as highly skilled. This group is also the only one in which no one rated themselves as less than "moderately skilled" (see Figure 7).

  Added an enterprise architect in the healthcare industry: "There are people in the development and operations groups who, once they recognize the technology, would use it more if it became formalized."
- **Focus on business objectives rather than siloed performance.** Without proper governance, individual contributors are too focused on matching their own performance to what is demanded of them. Comprehensive orchestration and management from the top down replaces this sentiment with one of achieving

FIGURE 6
Firms With Comprehensive Tools Are More Aligned With DevOps

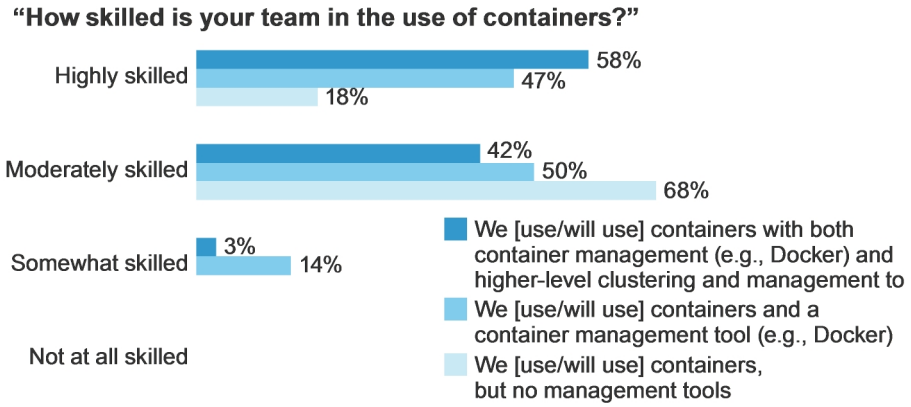
DevOps is a software development method that stresses communication, collaboration, and integration between software developers and IT operations professionals with the aim of enabling rapid production of software products and services.

"How closely do your organization's processes align with this definition?"



Base: 171 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

FIGURE 7
Comprehensive Tools Enhance Container Use Skills



Base: 171 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

company objectives through the enabling of sound business technology in the context of a standardized approach that drives efficiency.

Key Recommendations

Forrester's in-depth survey and interviews of application development and IT operations professionals yielded several important recommendations for organizations seeking to optimize their use of containers:

- **Assess the current use of containers within your organization.** Most organizations are already using containers for multiple use cases. Before setting an enterprise approach, policy, or standard, it is important to know current practices. Starting with existing practices will make it easier and quicker to define the enterprise position, and it will also detect any gaps in the utilization of these practices, such as poor security procedures. In addition, this approach will identify the potential impact on current practices of defining a central policy or standard.
- **Prioritize key projects.** The use of containers is not just a technical matter. Container adoption reflects a shift in culture, along with the emergence of new ways of working and new development methodologies. Some of these will be formal initiatives, but most tend to be informal, grassroots patterns of behavior. As such, trying to define an enterprise approach for all teams for all use cases at the same time is not a wise plan. Rather, target key teams and key projects to develop an enterprise approach.
- **Don't rely on a bottom-up approach; define and implement container governance.** Although most of the work will be based on the current grassroots work, organizations need to balance the autonomy of developers with safeguards to ensure security breaches are not introduced. It is important to define a high-level management framework so that the approach is defined and implemented consistently throughout the organization. This framework should consist of key roles, practices, processes, and tools, and it should be integrated into the organization's development and operations processes, standards, and policies.
- **Start integrating build/run cycles for key projects and products.** Although containers can be used in any development approach, they come into their own in modern approaches such as Agile or DevOps. Older approaches and architectures will not be as open to container adoption, so it makes sense to do two things: Firstly, integrate container adoption into your DevOps projects. Secondly, migrate older approaches to more modern ones.
- **Integrate management processes and controls.** Containers alone do not automate control and management. Successful container adoption will depend on the organization's ability to integrate change and release management controls at an operational level, and service models and architecture controls at a more strategic level.

Appendix A: Methodology

In this study, Forrester conducted an online survey of 194 IT operations, application development, and architecture professionals at enterprises in the US, the UK, Germany, China, and India, as well as three in-depth interviews from the same population, to evaluate their use of, experiences with, and challenges regarding Linux containers and associated management tools in application development and operations environments. To qualify as a participant in the study, respondents must have been currently employed at an organization either currently using containers or planning to do so within one year. Questions provided to the participants asked about the prevalence of container use within respondent organizations, their plans for container use expansion, the degree to which containers have achieved intended benefits, and organizational structure. Respondents were offered a small incentive determined by their respective survey panels as a thank you for time spent on the survey. Two of the three interview contacts were furnished by Red Hat to Forrester Consulting. The study began in January 2015 and was completed in February 2015.

Appendix B: Supplemental Material

RELATED FORRESTER RESEARCH

"From Application Design To Application Composition," Forrester Research, Inc., February 19, 2015

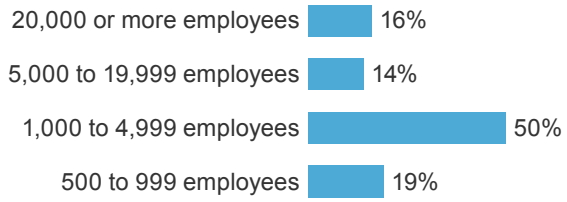
"Nine Questions To Ask About Docker," Forrester Research, Inc., March 9, 2015

"Brief: Why Docker Is All The Rage," Forrester Research, Inc., October 21, 2014

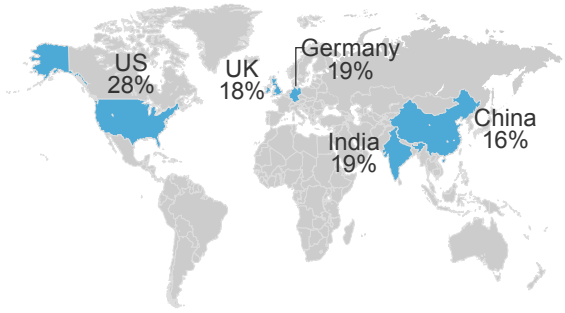
Appendix C: Demographics/Data

FIGURE 8
Respondent Demographics

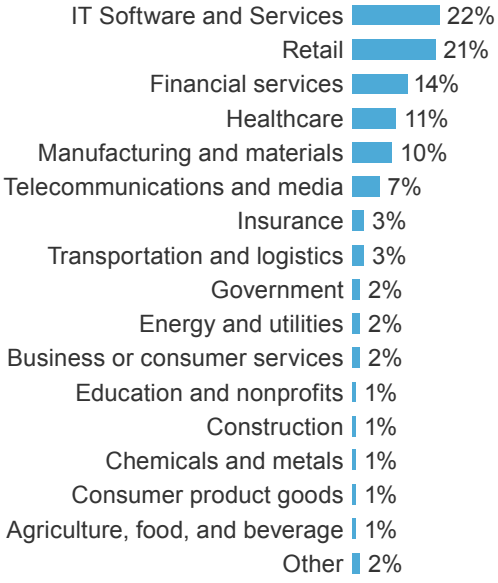
"Using your best estimate, how many employees work for your firm/organization worldwide?"



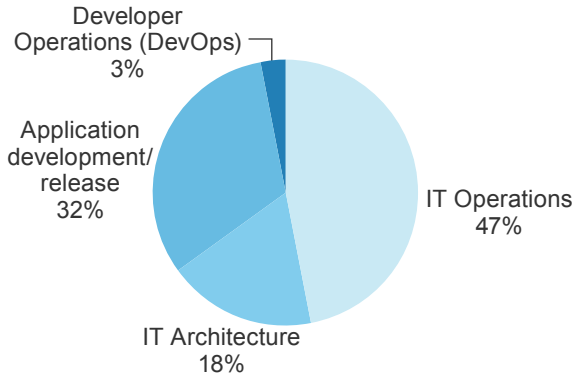
"In which country is your organization headquartered?"



"Which of the following best describes the industry to which your company belongs?"



"Which of the following best describes your primary job function?"



Base: 194 IT operations and development decision-makers at enterprises in APAC, EMEA, and North America
(percentages may not total 100 because of rounding)
Source: A commissioned study conducted by Forrester Consulting on behalf of Red Hat, January 2015

Appendix D: Endnotes

[1] Source: “Nine Questions About Docker,” Forrester Research, Inc., March 9, 2015.