EMA Research Report: Enterprise Data Center Network Transformation

REPORT SUMMARY

ENTERPRISE MANAGEMENT ASSOCIATES® (EMA™) Research Report
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Executive Summary

Today's enterprises increasingly require data center networks that are more agile, higher performing, more resilient, and more automated. To meet these requirements, IT organizations are adopting new network technologies, including software-defined networks, network virtualization, network orchestration and automation software, disaggregated switches, and much more. This end-user research report is based on a survey of 200 IT professionals directly involved in data center network transformation projects. It identifies the technologies and strategies they use and the challenges that enterprises face with such transformation initiatives. It also identifies some emerging best practices.

Introduction

Today enterprises need data center networks that are dynamic, programmable, automated, and resilient. In fits and starts the networking world has tried to keep up, introducing leaf-and-spine architectures based on equal-cost multi-pathing (ECMP). Later, we saw the emergence of software-defined networking (SDN), network virtualization, and much more.

To varying degrees, many enterprises are transforming their data center networks, but a definitive roadmap for success remains elusive. EMA set out to understand how enterprises are tackling data center network transformation. This research report investigates the drivers of change in enterprise data center networks, the challenges organizations face with these changes, and the technology decisions they are making. EMA surveyed 200 enterprise IT professionals who are directly involved in data center network transformation initiatives.

To provide context for this research, EMA presented participants with the following definition:

data center network transformation

An initiative that leverages new technologies, design practices, and processes to make data center networks more agile, programmable, scalable, efficient, high-performing, and reliable. These transformation initiatives can involve the implementation of a completely new network or the use of new technologies that transform a legacy network or information system.

Examples of transformative network technologies include leaf-and-spine network fabrics, software-defined networking (SDN) solutions, network automation and orchestration software, network virtualization, disaggregated switches (e.g., white-box or bare-metal switches) and private cloud frameworks (e.g., OpenStack).

Only IT professionals who were directly involved in such a transformation initiative were allowed to participate in this survey.

Overview of Research Participants

This research is based on a survey of 200 IT professionals based in North America. Most of them held senior IT positions: 34% were IT managers, 35% were IT directors, 7% were vice presidents, and 22% were CIOs or CTOs. Just 2% were IT specialists, such as engineers or architects.

All participants in this research worked in midmarket or large enterprises. For the purposes of this project, EMA defined a "midmarket enterprise" as an organization with 1,000 to 4,999 global employees. We defined "large enterprises" as organizations with 5,000 or more employees worldwide. Forty percent (40%) of participants worked in midmarket companies, and 60% worked for large enterprises, including 24% who worked in organizations with 20,000 or more employees.

Nearly half of the organizations represented in this research had already completed a data center network transformation initiative. As **Figure 1** shows well over one-third said they were in the midst of their transformation implementation, while 15% said they were starting implementation within the next year.

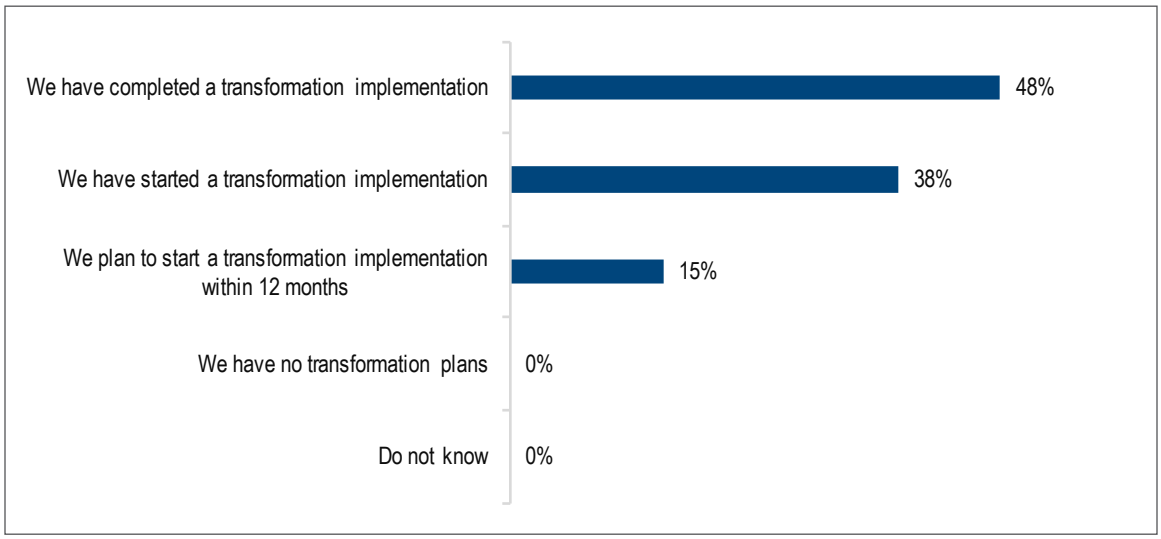

Figure 1. The current stage of these data center network transformation initiatives

These IT professionals were involved in multiple aspects of data center networking, with a majority participating in the following tasks: researching network solutions, procuring solutions, planning and designing networks, deploying networks, managing performance, managing capacity, and even managing for cost efficiencies.

Forces of Change

Data center network transformation does not happen in a vacuum. There are specific drivers for why enterprises pursue this change. And those drivers often shape the technical and business requirements that organizations establish for these projects.

Big data analytics (42% of respondents) is the most common driver of network transformation.

EMA asked research participants to identify the technology initiatives that are most responsible for driving their data center network transformation efforts. Four initiatives emerged as particularly influential, as **Figure 2** shows. Big data analytics (42% of respondents) is the most common driver of network transformation. Big data technologies can create tremendous bursts of traffic in the data center. For our 2015 research study "Big Data Impacts on IT Infrastructure and Management," EMA asked adopters of big data solutions to identify how the technology was most affecting their IT environments. Forty-five percent (45%) reported increased network traffic loads due to big data collection, and 46% reported increased network traffic loads from backups of big data repositories.

Other leading drivers of network transformation included hybrid cloud or multicloud architecture (32%), server virtualization (32%), and the Internet of Things (31%). Midmarket companies were particularly driven by hybrid cloud and multicloud projects (44%), in contrast to 23% of large enterprises.

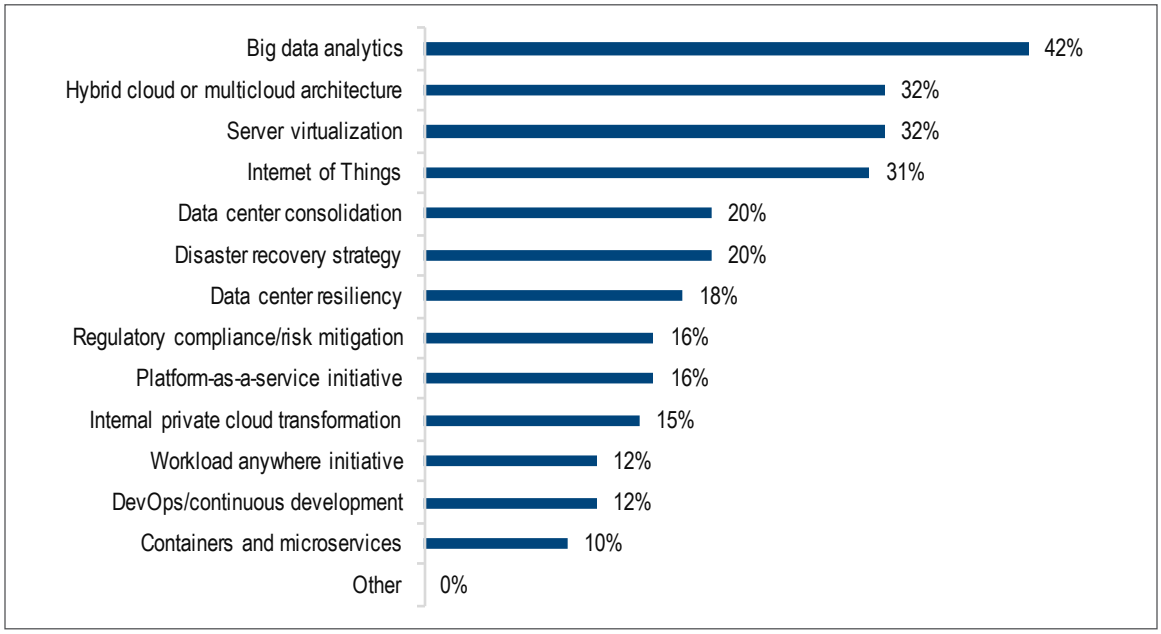

Figure 2. Primary drivers of data center network transformation

Technology Choices for Data Center Network Transformation

Leaf-and-Spine Network Fabrics

Leaf-and-spine fabrics appear to be a foundational element of data center network transformation. An alternative to legacy fat-tree network architecture, leaf-and-spine networks provide any-to-any connectivity between any two servers in a data center. A leaf-and-spine topology is two-tiered, with a layer of leaf switches, usually top-of-rack or end-of-row devices, that serve as the server access layer. Leaf switches mesh into the spine layer of switches via specialized Layer 2 protocols or an Equal Cost Multi-Pathing (ECMP) Layer 3 routing scheme. Then the spine layer of switches provide interconnections between different leaf switches. Leaf-and-spine topologies can scale out by adding more switches to the spine layer.

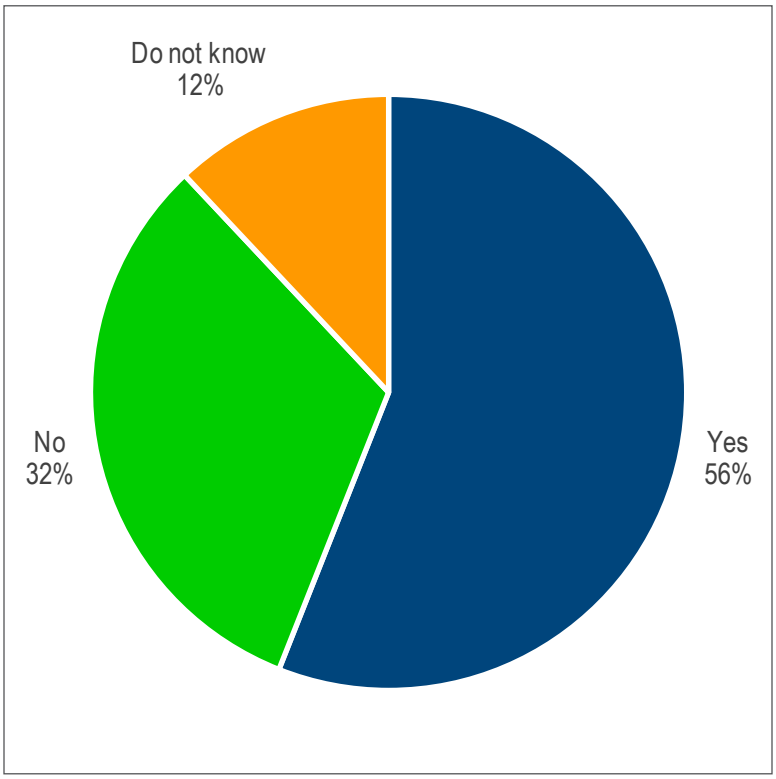

Figure 3. Adoption of leaf-and-spine network fabric in data centers

SDN Is Central to Data Center Network Transformation

Ninety-eight percent (98%) of the enterprises represented in this research are adopting SDN in their data centers. **Figure 4** reveals that more than one-third of them had already completed a product deployment, while the rest were either in deployment or were planning to deploy within 12 months.

98% of the enterprises represented in this research are adopting SDN in their data centers.

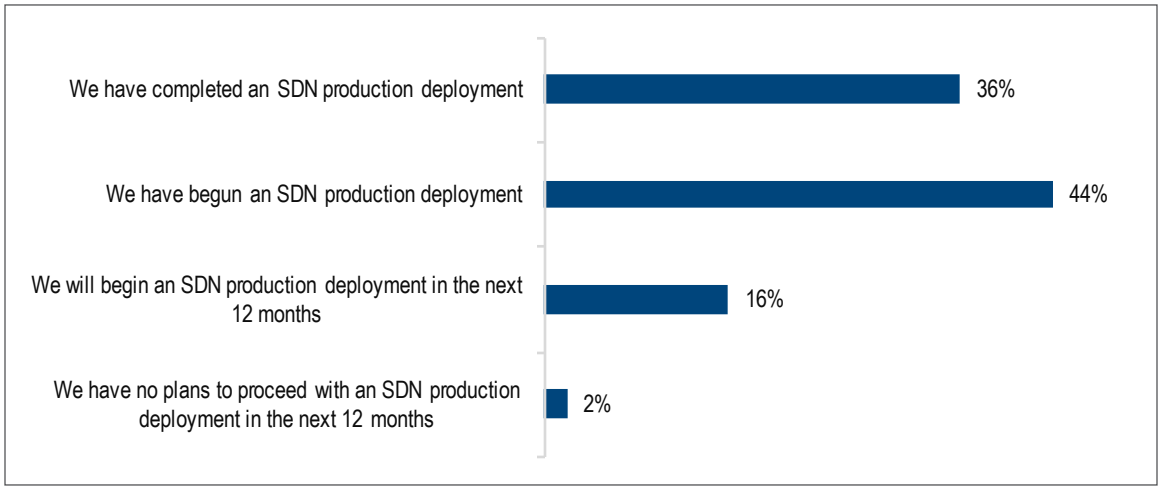

Figure 4. SDN activity as part of a data center network transformation initiative

SDN Choice: Underlays Versus Overlays

Enterprises generally have two classes of SDN technologies available to them in their data centers: hardware underlays in which switches are programmed by a controller or controller-like function and virtual software overlays, which create a layer of abstraction over an existing hardware network. While it is generally assumed that most enterprises will choose one or the other variety of SDN, EMA is aware of anecdotal examples of enterprises that have deployed both an underlay and an overlay in the same environment to address different use cases or administrative requirements.

EMA asked participants in this study which class of SDN technology they have adopted or are planning to adopt in their data centers. **Figure 5** reveals some unusual results. Overlays (43%) are most popular, which is not terribly surprising since they are often deployable without a hardware refresh, reducing potential disruption in a data center. One-third (33%) have chosen a hardware underlay. However, nearly one in four (24%) says they use both an overlay and an underlay in the same environment. EMA believes this final statistic is inflated, given that we have only seen anecdotal examples of dual adoption in the market.

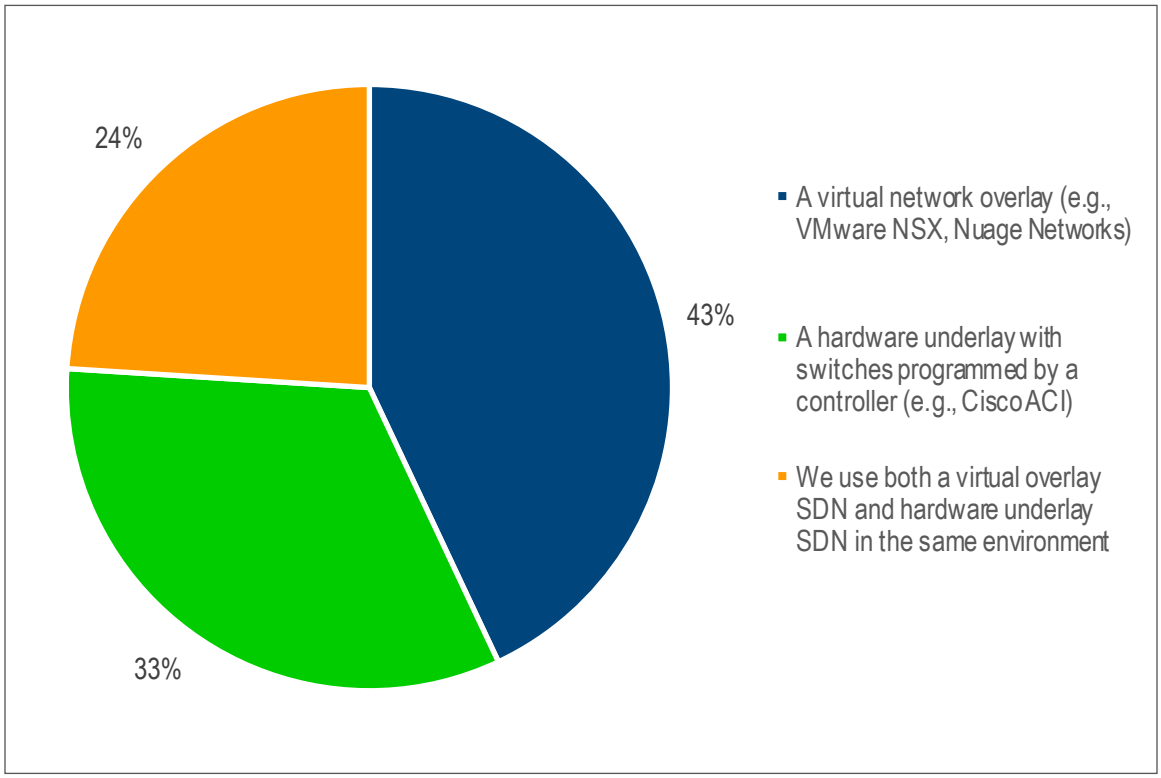

Figure 5. Class of SDN technology chosen for data center network transformation

More than half (53%) of organizations that told us they are adopting both classes of SDN technology also reported that their data center network transformation initiatives involve four or more data centers. We suspect that many of these individuals misread the question and that they have adopted an overlay in one subset of their data centers and an underlay in another subset of them.

Data Center SDN Use Cases

In this section we review the SDN use cases that are most important to data center network transformation initiatives. **Figure 6** reveals that organizations are targeting two primary SDN use cases: network virtualization and disaster recovery. SDN-based network virtualization enables network teams to create multitenant environments, whether those tenants are business units, application development teams, or customers. With SDN network teams can slice up the network logically for each tenant.

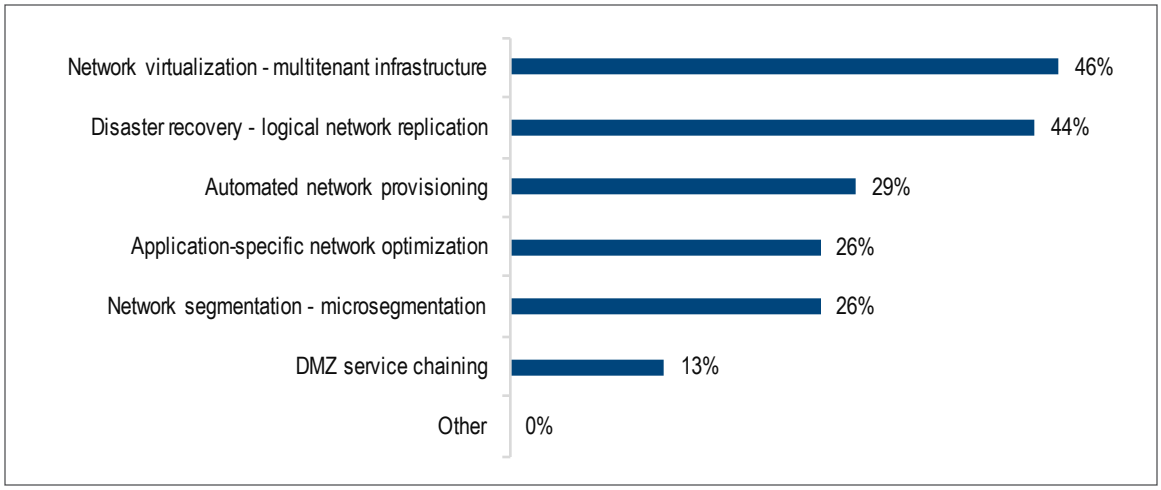

Figure 6. The SDN use cases most important to data center network transformation

SDN also supports disaster recovery by simplifying the process of logically replicating a network to a disaster recovery site. The middling importance of micro-segmentation is somewhat surprising because several SDN vendors identified it as an important initial use case for many early adopters. These numbers suggest that organizations recognize that other use cases may become more important as they mature their SDN implementations.

Data Center SDN Challenges

Figure 7 reveals the top technical challenges of SDN that organizations experience during data center network transformation.

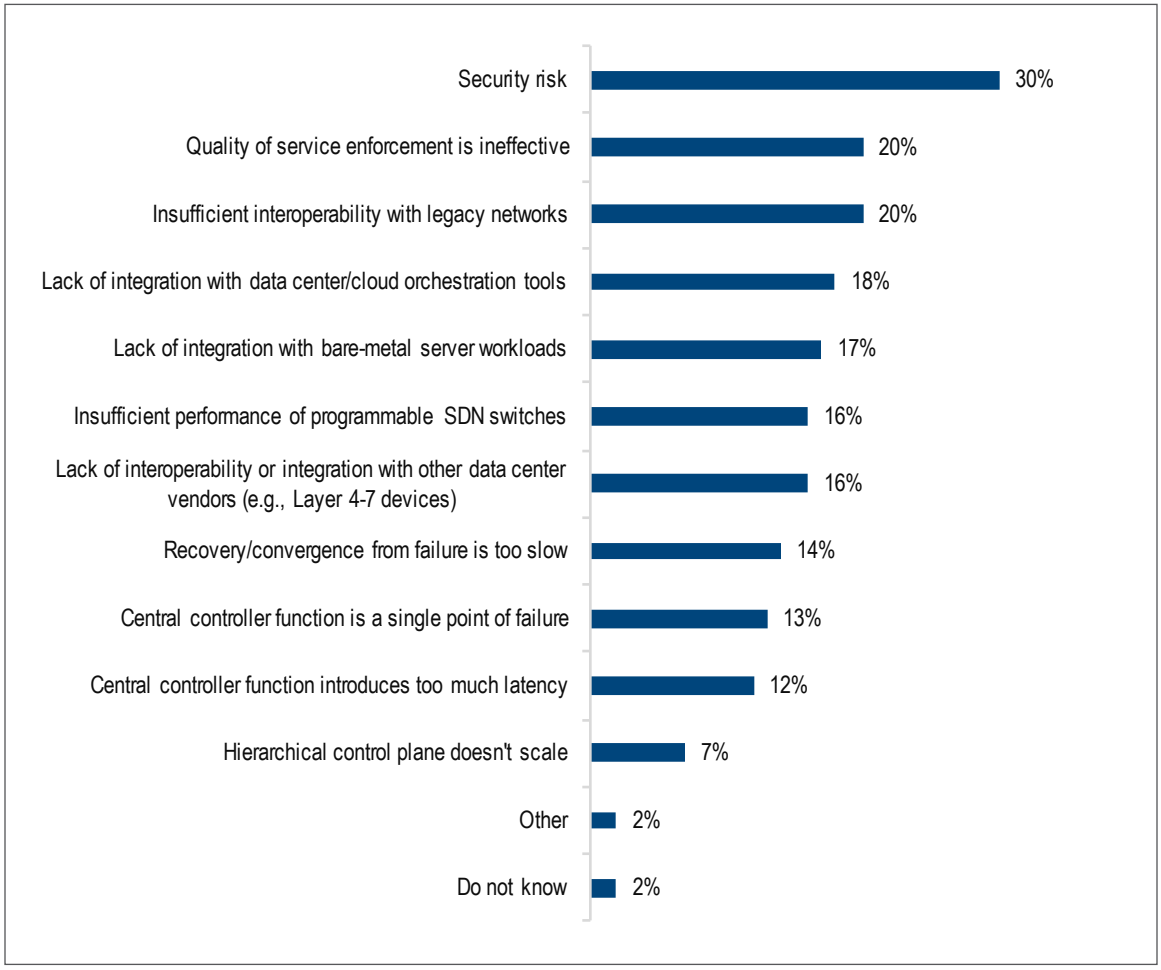

Figure 7. The top technical challenges to SDN adoption

"Security risk" stands out as the number one technical challenge today. Enterprises are struggling to understand just how secure SDN solutions are. Ineffective enforcement of quality of service (QoS) and insufficient interoperability with legacy networks are the leading secondary challenges, followed closely by lack of integration with data center and cloud orchestration tools.

Figure 8 details the top business-related challenges of SDN adoption in data center networks. Here organizations are most concerned that their network teams lack sufficient skills and expertise with SDN (32%).

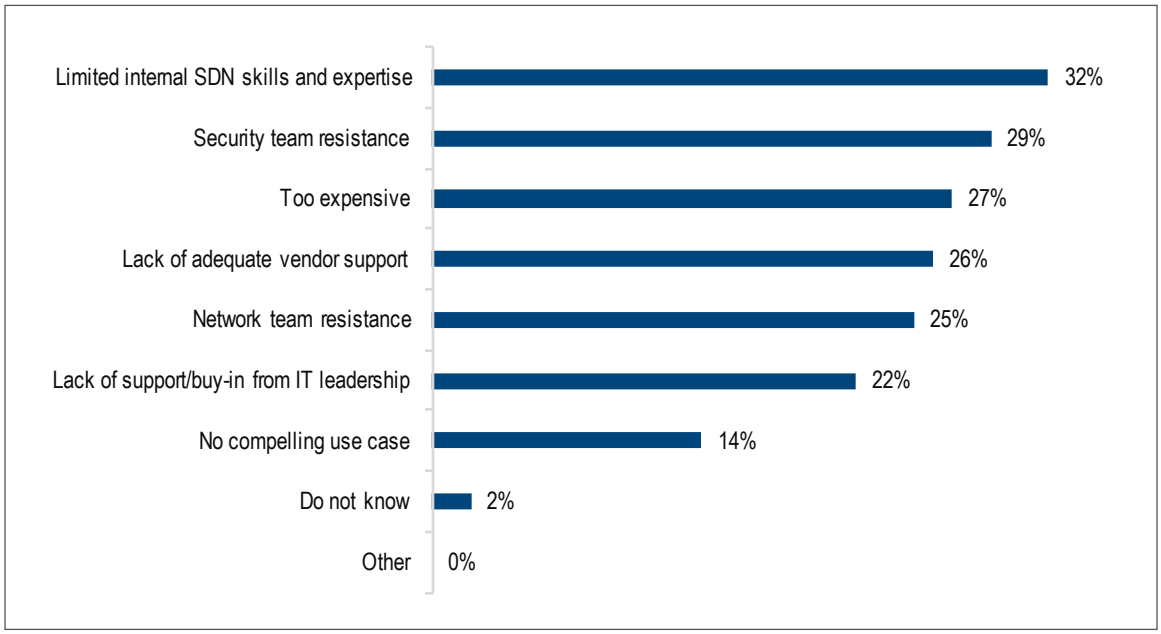

Figure 8. Top business-related challenges to SDN adoption

The other major business challenge identified was "security team resistance." The network team is hitting a roadblock with the security team, which makes it even more critical for them to address the technical security issues we highlighted above.

The days of enterprises complaining that they see no compelling use case for SDN appear to be ending, and this issue sits at the bottom of the list of business-related complaints with only 14% of organizations selecting it. "Too expensive," "lack of adequate vendor support," "network team resistance," and "lack of support/buy-in from IT leadership" are all secondary challenges.

Disaggregated Switching Is Common in Network Transformation

Like SDN, disaggregated network switching has enjoyed a wave of hype in recent years, but the industry has also reacted with an equal measure of skepticism. Known also as "bare-metal switches" and "white-box switches," disaggregated switches are an alternative to the fully integrated hardware and software products traditionally offered by network vendors. As the term implies, these solutions disaggregate network hardware from the operating system software that runs on them.

Forty-five percent (45%) of organizations in this study have installed disaggregated network switches. Another 41% said they were considering it.

These numbers are higher than expected, even among this group of 200 enterprises involved in data center network transformation. Keep in mind that we only asked whether organizations had installed the devices. We did not ask them to elaborate on the nature of these installations. Many of them are probably proofs of concept, pilot projects, etc. This finding may be more indicative of enterprises' willingness to explore disaggregated switching as an option when they are transforming their data center networks.

The Benefits and Challenges of Disaggregated Switching

While cost reduction and technology flexibility are often mentioned as compelling benefits of switch disaggregation, this research reveals that enterprises see a broad set of potential benefits, particularly with the unification of network teams and systems teams. EMA asked all participants in this research, regardless of whether they were currently using them, to identify what they saw as the primary benefits of disaggregated data center switches. **Figure 9** reveals that integrating network and server operations is the most anticipated benefit, followed very closely by integration of network provisioning and server provisioning. We observed almost no variation in response between those that had already installed disaggregated switches and those that hadn't.

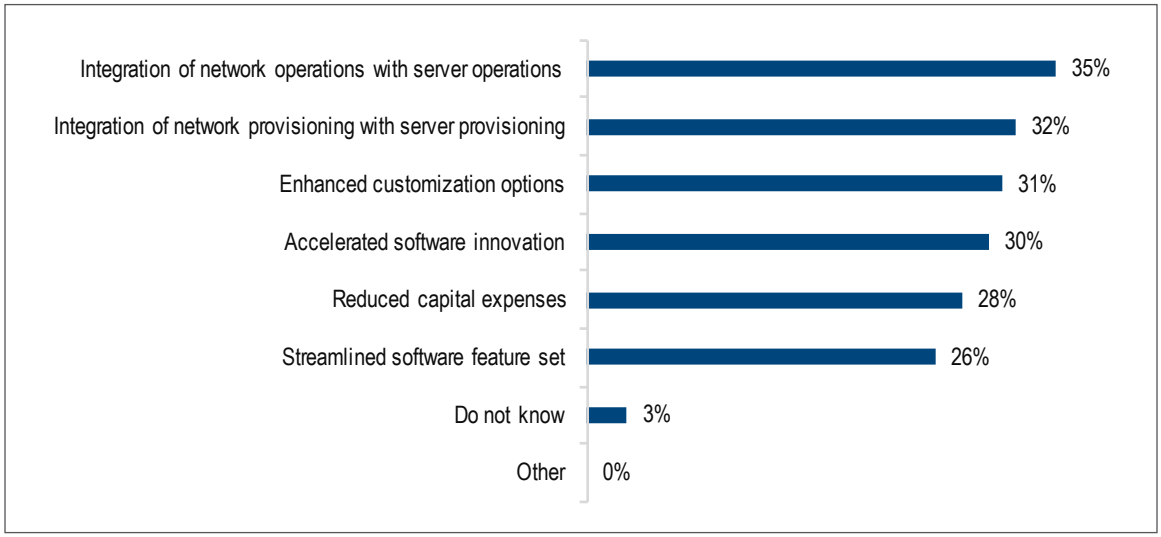

Figure 9. Primary perceived benefits of using disaggregated switches in a data center

The other two leading benefits were "enhanced customization" and "accelerated software innovation." Reduced capital expenses and streamlined software feature sets were the lowest priorities for organizations overall, but even they weren't that far from the top of the list.

EMA also asked all research participants, regardless of whether their organization had adopted switch disaggregation, to identify the top barriers to installing these systems. Again we saw very little variation in the responses of organizations that had installed network disaggregation and those that hadn't. **Figure 10** shows that risk was the top reported challenge, with 38% saying their security and compliance teams object to switch disaggregation. Second, these organizations were concerned with the divided support model that some of these disaggregated systems introduce.

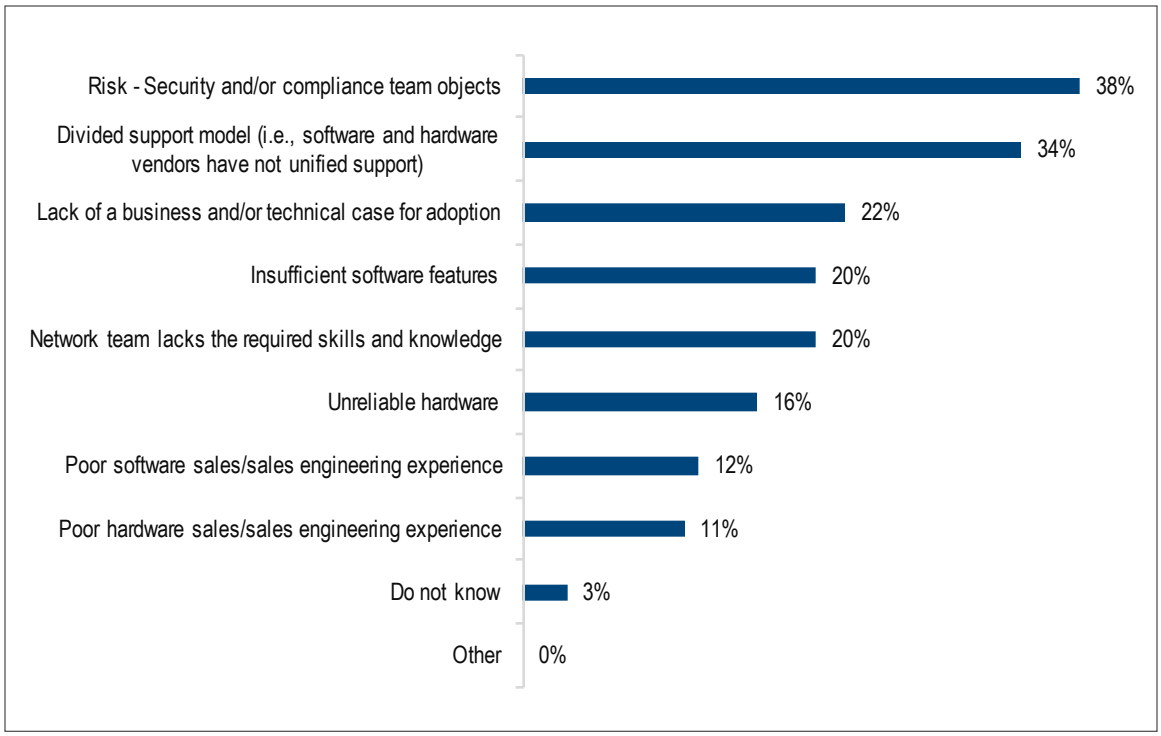

Figure 10. The biggest barriers to adopting disaggregated data center switches

Hardware reliability appears to be a relatively minor issue. And very few were concerned about the sales and sales engineering experience offered by disaggregated software and hardware vendors.

Load Balancing and Application Delivery Controllers

As today's enterprises virtualize their infrastructure and move applications to public and private cloud environments, large ADC appliances no longer fit every use case. Organizations need ADCs that are flexible, lightweight, capable of migrating with workloads, and integrated with orchestration frameworks. As a result, many organizations are virtualizing load balancers and ADCs.

Figure 11 shows that 70% of data center network transformation projects lead to the virtualization of ADCs and load balancers.

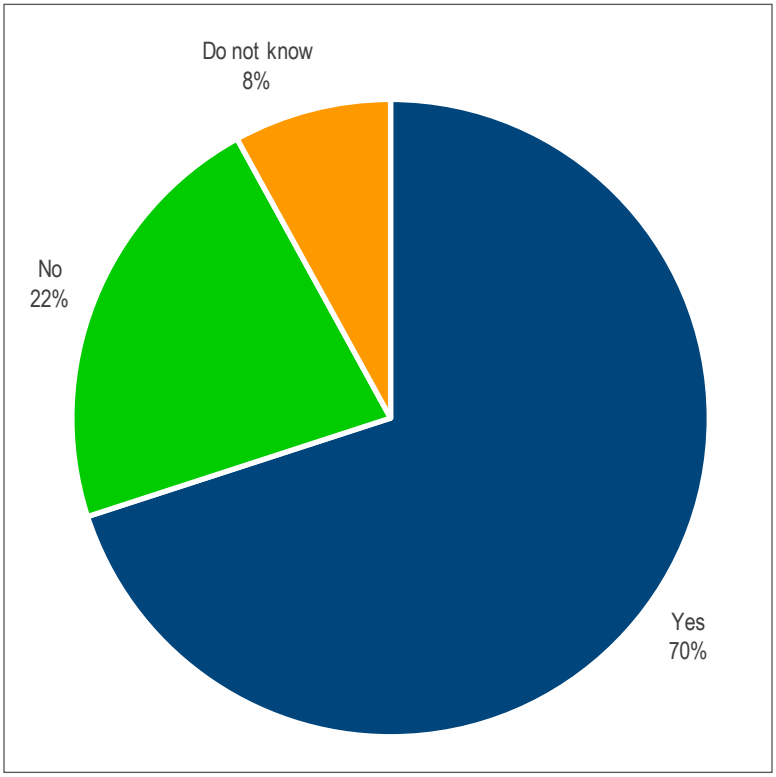

Figure 11. Responses to the question: As part of your data center network transformation, are you virtualizing application delivery controllers (ADCs) and/or load balancers?

To understand how extensive ADC virtualization is in these organizations, EMA asked respondents to estimate what percentage of their workloads would be served by virtual ADCs after their data center network transformation initiatives were complete. These organizations reported an average of 58% of their application workloads ultimately being served by virtual ADCs.

The transition from ADC appliances to virtual ADCs will naturally present some difficulty. **Figure 12** reveals that enterprises struggle primarily with three issues during these transitions. Their most pressing problem is that their virtual ADCs are incompatible with their cloud or network orchestration tools (42%). This finding suggests that their chosen vendors have inadequate plugins for SDN frameworks or OpenStack and comparable cloud software platforms.

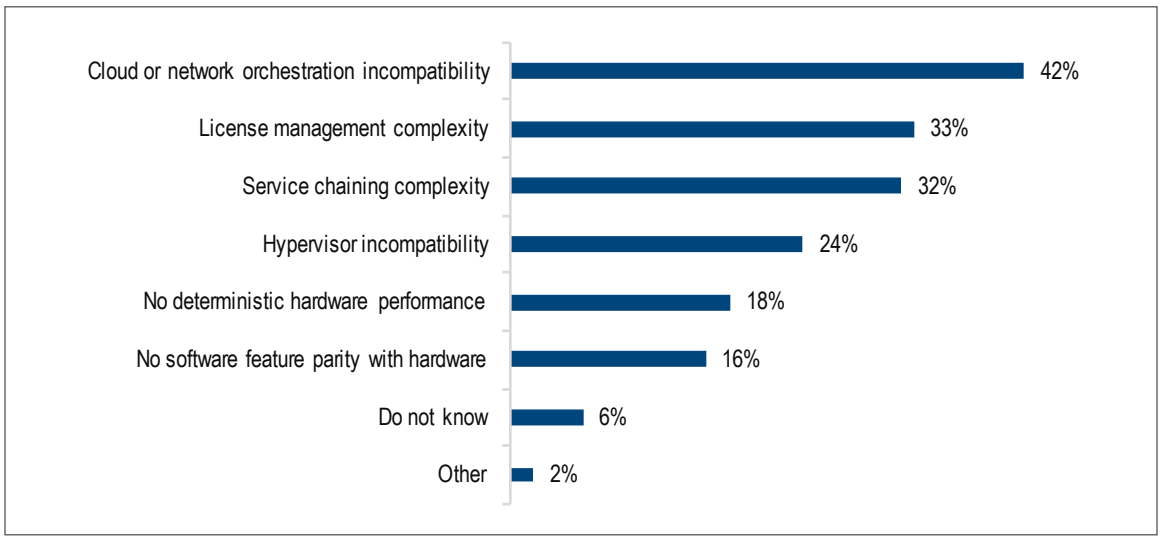

Figure 12. Top challenges to successful virtualization of ADCs and load balancers

License management complexity (32%) is also a significant challenge. ADC vendors vary in how they license virtual ADCs. Also, many offer native platform management systems designed to manage licenses for hardware appliances. Many ADC vendors are still evolving their licensing models and license management capabilities to be friendlier to a virtual world.

Finally, service chaining complexity is also a major problem. Virtual ADCs offer the flexibility to apply very specialized ADC instances to applications. One application might need Layer 7 load balancing and another might only need Layer 4 load balancing. One might need SSL acceleration and the other will need SSL offloading. Where should a data center operator apply all these application-specific service chains? Enterprises will need guidance with this issue.

Hypervisor incompatibility is a problem for nearly one-quarter of organizations surveyed. However, this problem will probably fade over time as ADC vendors expand the number of hypervisors they support. Finally, the two issues that network engineers may have fretted about when organizations first started virtualizing ADCs seem to actually be minor problems in practice. Very few organizations reported struggling with a lack of deterministic hardware performance, and even fewer said that they lack software feature parity with hardware ADCs.

The Ideal ADC for the Transformed Data Center

Figure 13 charts the importance of ADC product features in relation to data center network transformation. Traditional load balancing (Layer 4 and Layer 7 load balancing and round robin) are the least important ADC features in these data centers. Instead, the top features for these organizations are integrated security (web application firewalls, denial of service protection), identity and access management, data compression, SSL acceleration, and global load balancing.

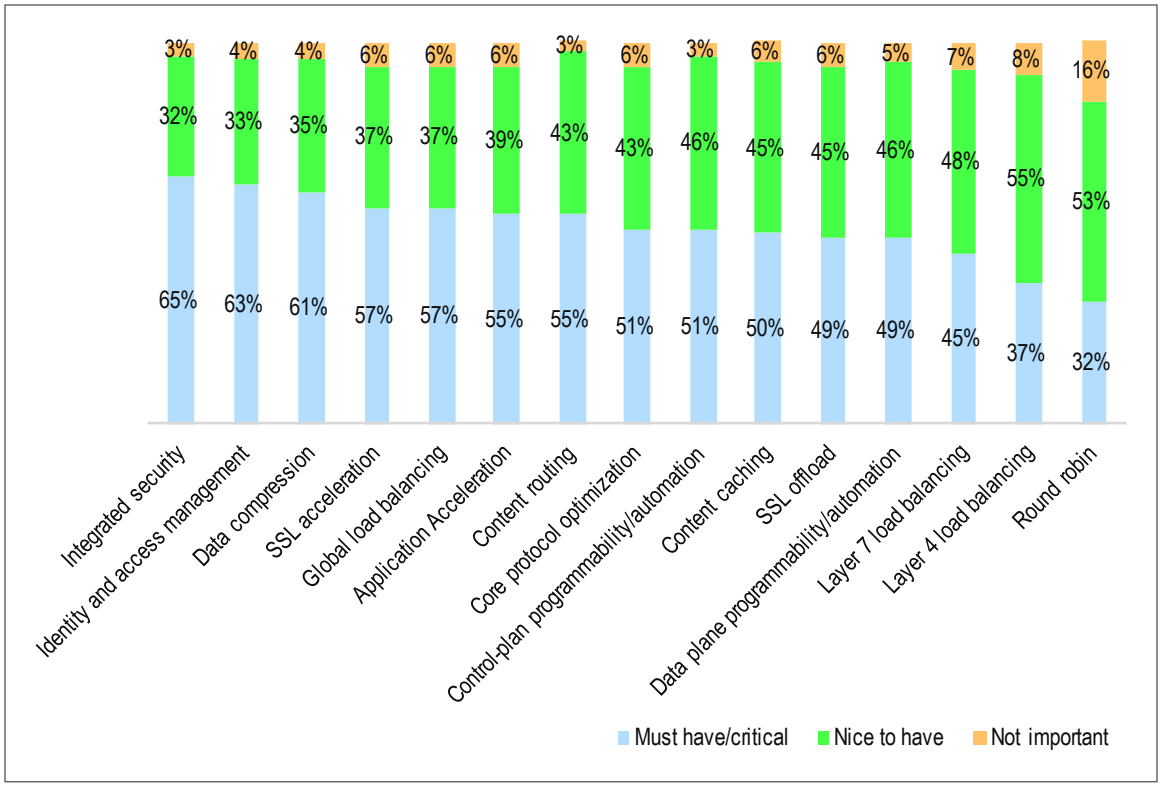

Figure 13. The relative importance of ADC product features

A majority of research participants also identified application acceleration, content routing, core protocol optimization and control plane programmability as critical features. Data plane programmability was slightly less important.

Figure 14 reveals that scalability is top of mind for most organizations. Of course, scalability takes on a different meaning when so many organizations are leveraging virtual ADCs. Vendors need to provide products that can scale in software rather than hardware. And that leads to the second most important product characteristic: resource efficiency. Network teams want ADCs with feature sets that are tuned to specific application requirements. This reduces the amount of resources a virtual ADC will consume on a hypervisor host. It may also affect the scalability of individual ADC instances and the license cost.

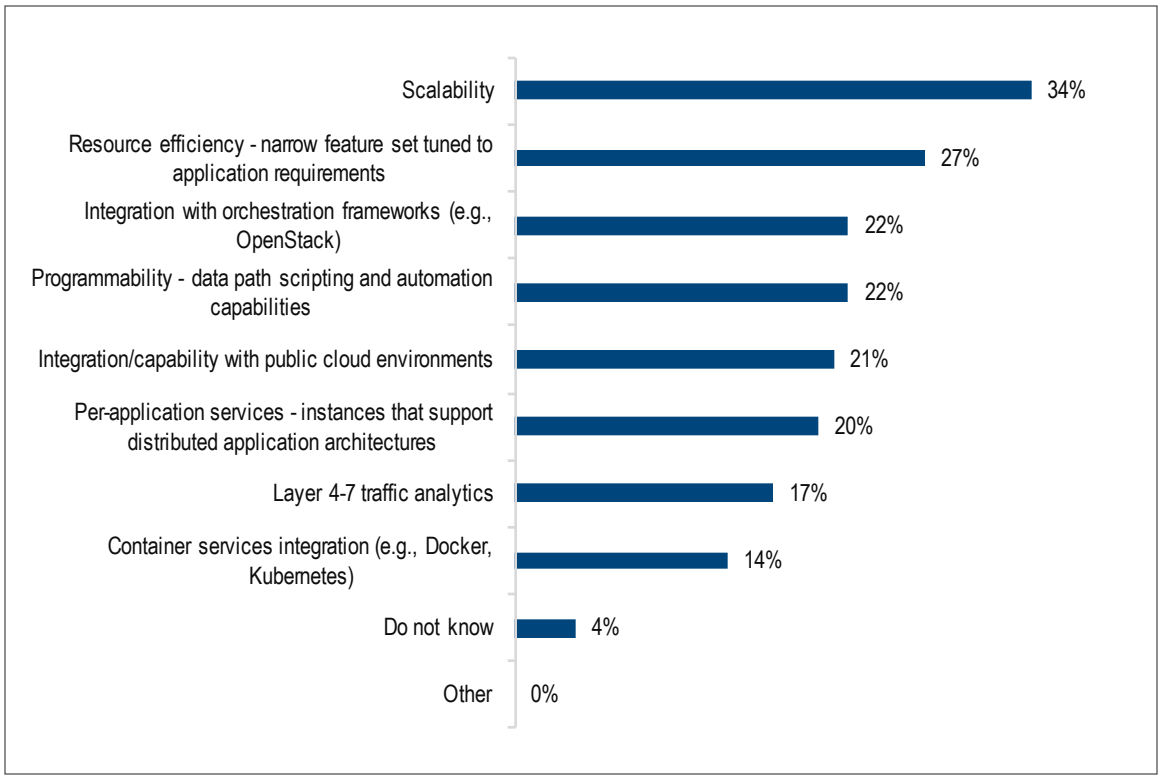

Figure 14. ADC characteristics most important to data center network transformation

Transforming Data Center Network Engineering and Operations

Automating the Data Center Network

Automation is an essential piece of data center network transformation. This research found that 98% of organizations automate at least one aspect of their data center networks as a result of these projects. In fact, the average transformative network team automates three aspects of their network. **Figure 15** reveals that network security is a major automation priority. The majority of organizations in this research were automating security incident detection and, to a slightly lesser extent, security incident response.

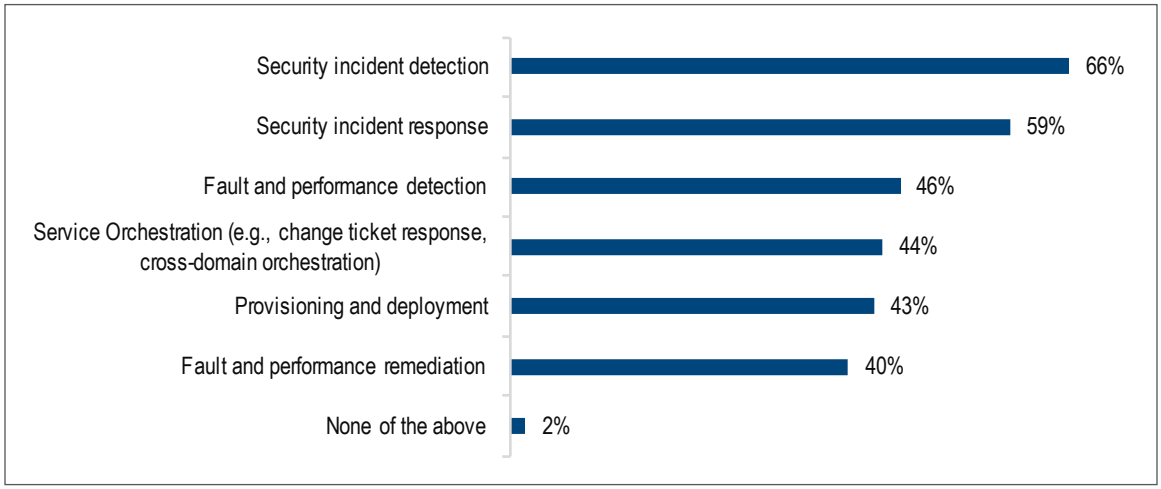

Figure 15. Aspects of data center networking automated by transformation projects

All other networking tasks are secondary targets for automation, with "fault and performance *detection*" being the most popular and "fault and performance *remediation*" the least popular.

Figure 16 reveals the technologies that organizations use to automate their transformed data center networks. "IT automation/ DevOps software" was the most popular class of tools. This finding is somewhat surprising given that research participants identified DevOps as the second least influential technology initiative driving data center network transformation decisions. While DevOps isn't driving network transformation it is certainly facilitating it. Network teams identify DevOps and IT automation tools as an important means of network automation for these projects.

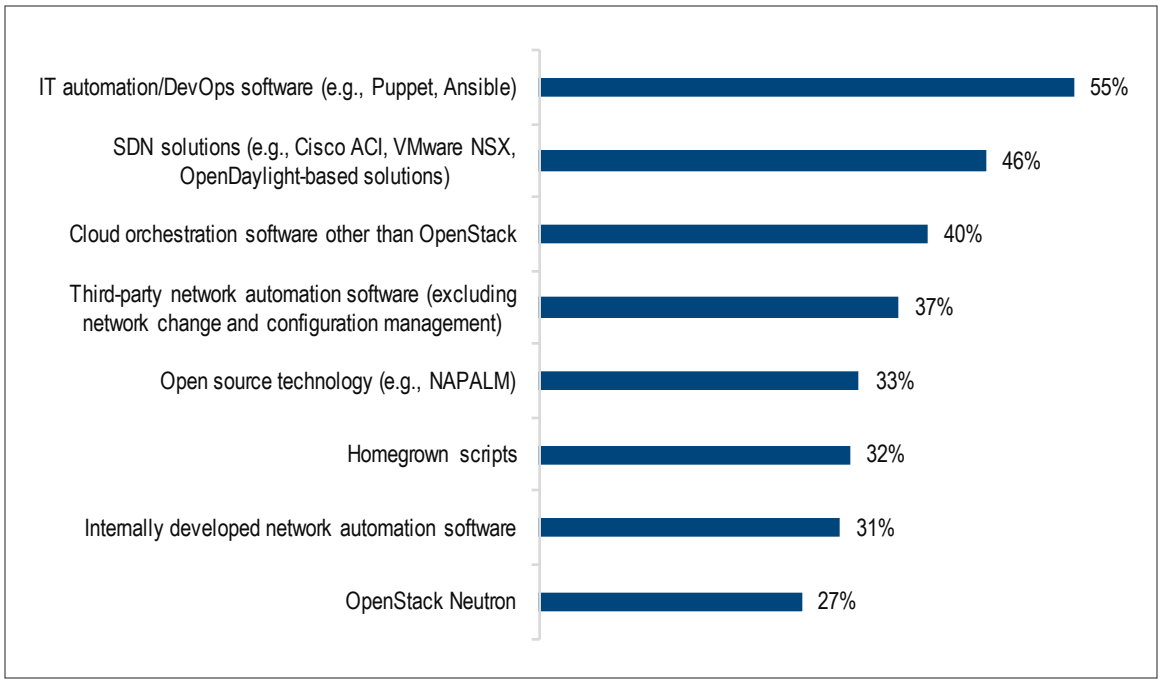

Figure 16. Technologies used to automate data center networks

SDN is the second most popular technology for automating networks.

Overall, OpenStack Neutron is the least popular option for network automation among these enterprises, cloud orchestration software other than OpenStack is a popular secondary choice automation, which suggests that many enterprises prefer commercial software to open source. Third-party network automation software is another popular automation tool.

Network Managers Want More From Their Hardware Vendors

Open APIs on Data Center Switches

In this research, 55% of organizations required their vendors to provide open APIs for infrastructure programmability on data center switches, and 38% said they don't require them but they are nice to have (see **Figure 17**). Only 3% said they had no need for such APIs.

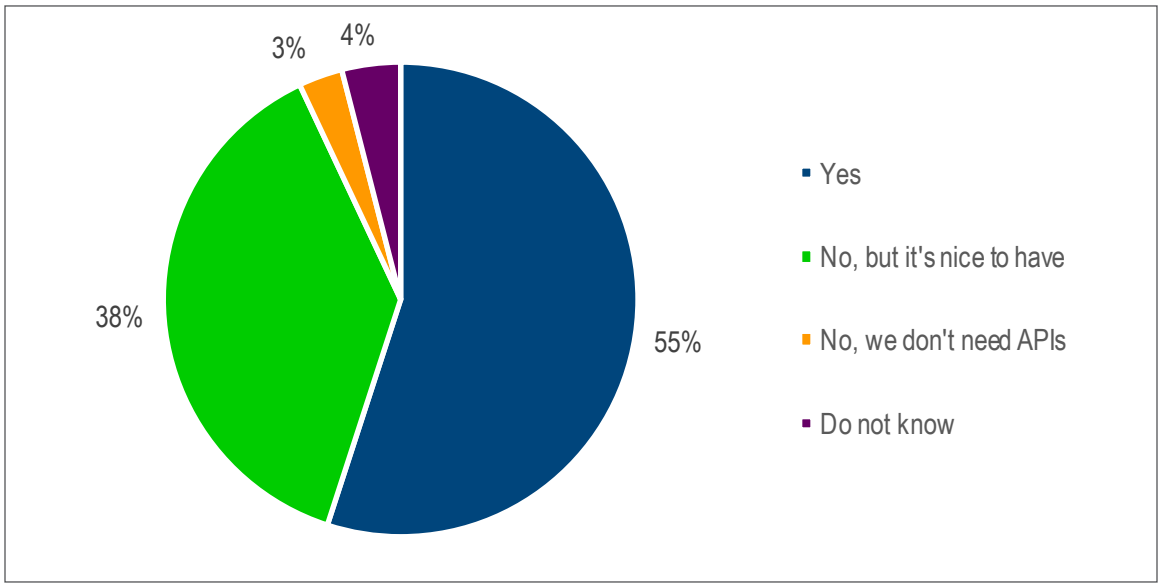

Figure 17. Respondents were asked, "Do you require your vendors to provide open APIs on data center switches to enable infrastructure programmability?"

Although open APIs are becoming a standard requirement in these data centers, CLI, the traditional means of writing changes to and extracting data from network hardware, isn't going away. Eighty-two percent (82%) of organizations that require APIs or say they are nice to have intend to maintain both API and CLI access on their switches.

Figure 18 reveals that security is a major driver for open APIs in the transformed data center network. Network teams are leveraging these interfaces to integrate network switches with their security architecture. For instance, this integration could enable switches to act as network security sensors or control points.

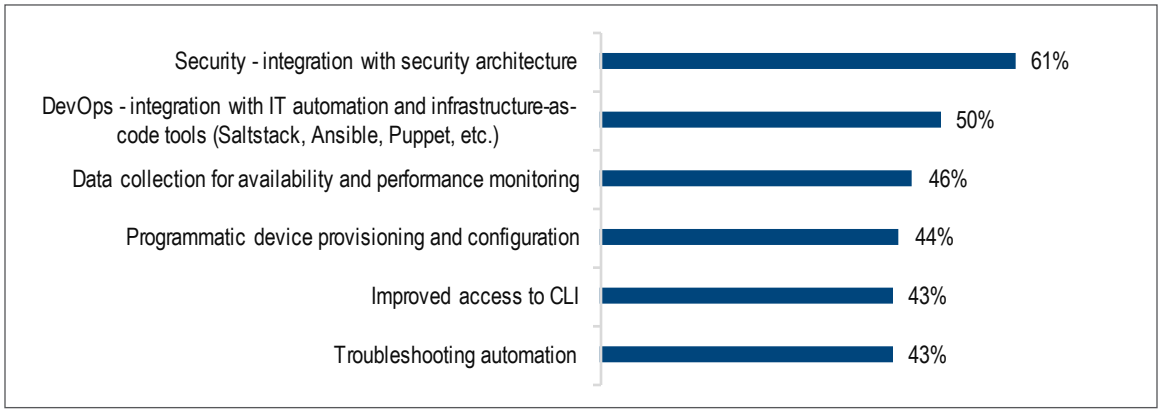

Figure 18. How organizations use open APIs on data center switches

The Rise of Streaming Network Telemetry

Streaming network telemetry is a concept in which network devices can stream data about the network continuously and efficiently to network management systems.

This research found that streaming telemetry will be critical to data center network transformation. More than half of the enterprises represented are streaming telemetry from their network devices today, as shown in **Figure 19.** Nearly all the others were planning to use streaming telemetry in the future.

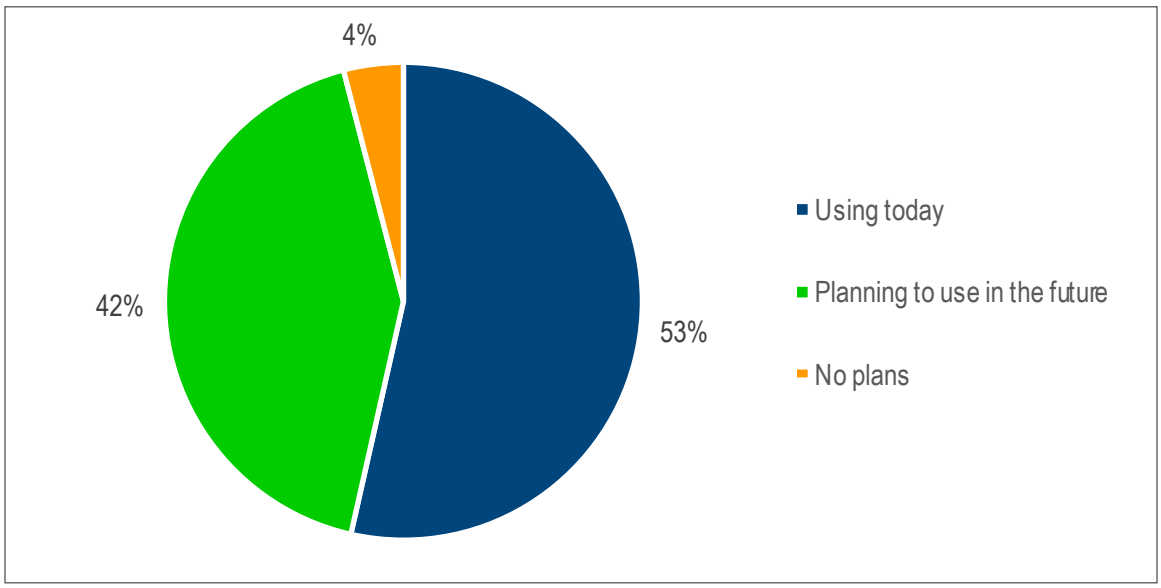

Figure 19. Most transformed data center networks use streaming telemetry from their network devices today.

EMA believes that streaming telemetry will be an essential technology for SDN in the future. Efficient and continuous network telemetry streams can combine with the programmatic control enabled by SDN to give network managers the ability to manage their networks more effectively.

The most important use cases for streaming telemetry technology are security related, as **Figure 20** reveals. More than one-third of organizations that were using or planning to use streaming telemetry reported applying it to enhanced security monitoring and automated security response.

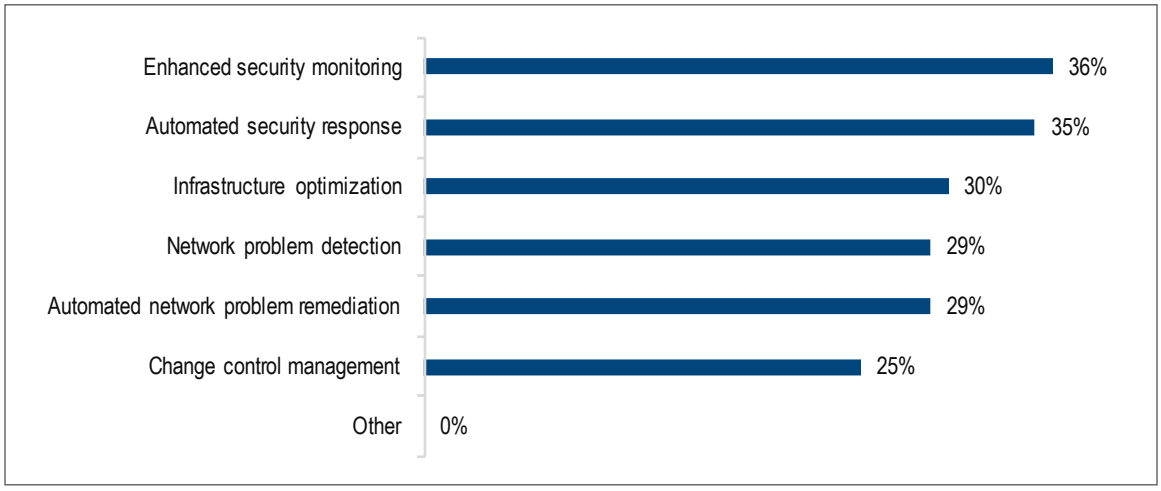

Figure 20. Most important use cases for embedded streaming telemetry and analytics

Organizational Factors of Data Center Network Transformation

Networking Life in the Transformed Data Center

Network Team Skills for the New Data Center Network

Data center network transformation will require network teams to acquire a diverse set of skills. Cloud expertise is a major need, as **Figure 21** reveals. Cloud software such as OpenStack is the top training priority, but not far down the list is expertise with public cloud environments like Amazon Web Services and Microsoft Azure. Server virtualization and cybersecurity round out the top four training priorities.

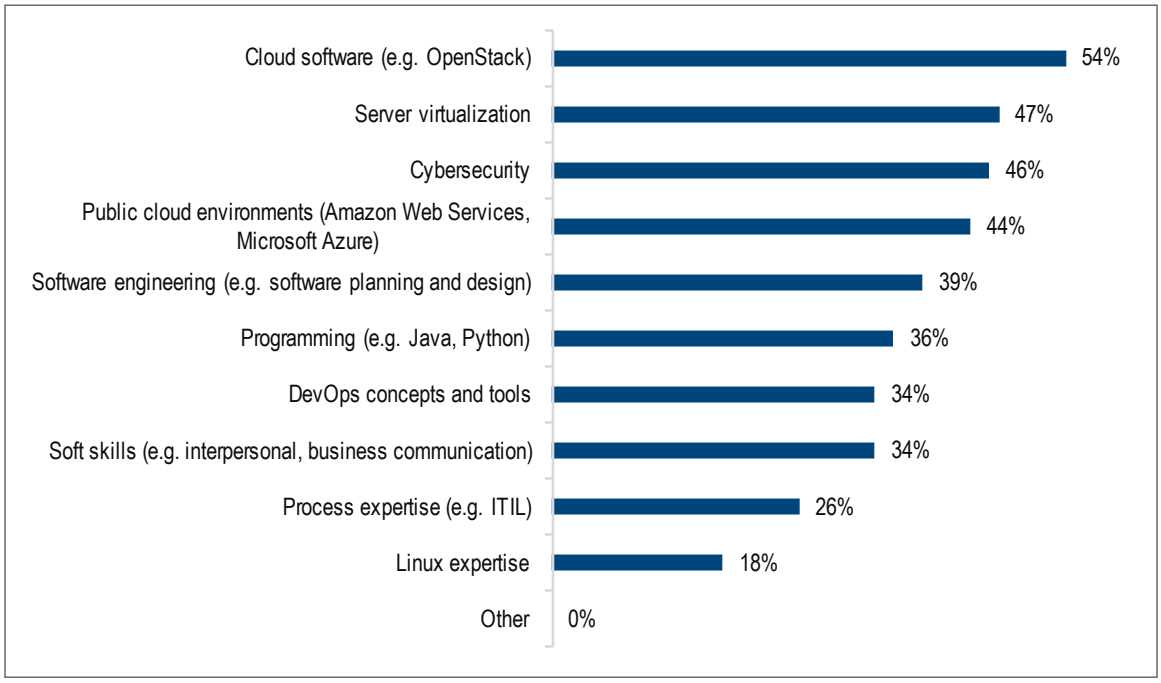

Figure 21. Data center network transformation requires network professionals to require these new skills and knowledge

Secondarily, many networking pros are learning software engineering, programming, and DevOps concepts and tools. Equally important are so-called soft skills (interpersonal skills, business communication, etc.). Process expertise (e.g. ITIL) and Linux skills are low priorities.

Removing CLI From Network Engineering and Operations

Figure 22 shows that 82% of network teams represented in this study were using programmatic tools and interfaces like REST APIs to reduce their reliance on CLI workflows for network management.

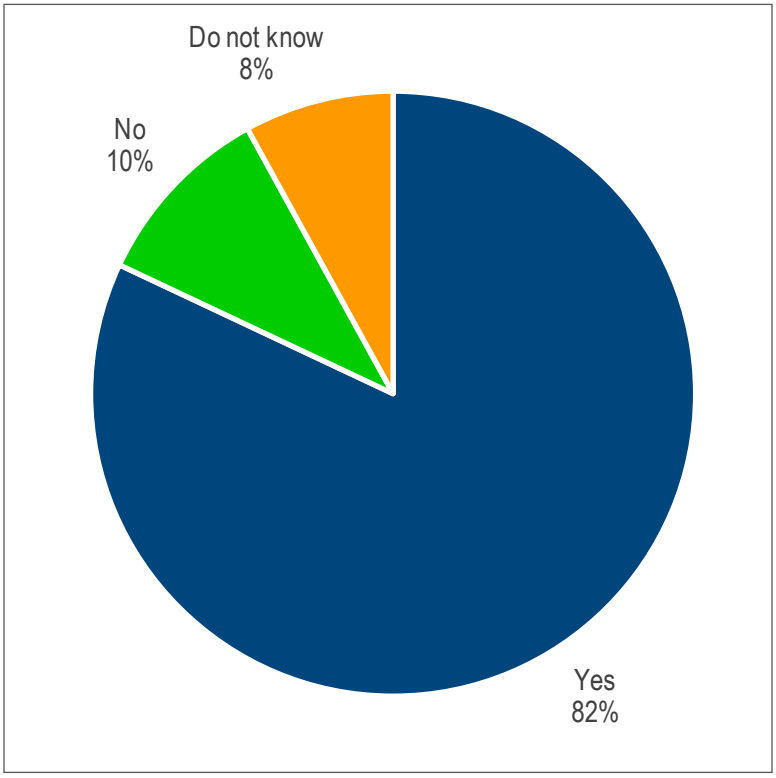

Figure 22. Research participants were asked, "Does your data center networking team use programmatic tools and interfaces such as REST APIs to reduce reliance on CLI for network device configuration and management?"

The primary driver for reducing CLI use in the data center network is increased network agility, as **Figure 23** shows. To truly realize the benefits of technologies like SDN and network automation software, the networking team needs to spend less time on CLI and more time with programmatic tools. Nearly one-third of respondents chose agility as their number one driver.

The primary driver for reducing CLI use in the data center network is increased network agility

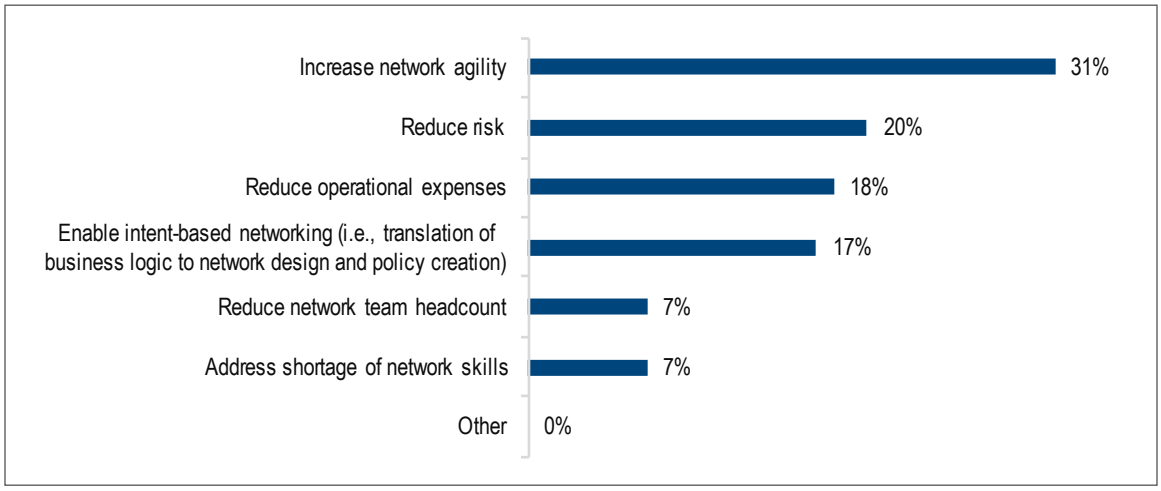

Figure 23. Research participants identified their primary business driver for reducing reliance on CLI

Risk reduction is the second most popular driver. CLI is by its very nature a manual process, which opens opportunities for mistakes. Programmatic tools remove many of those opportunities for error. In a near tie with risk reduction is operational expense reduction. The less time networking pros spend on CLI, the more time they have for more productive tasks.

The fourth most popular driver is enablement of intent-based networking, a relatively new concept being promulgated by several incumbent networking vendors and emerging startups. Definitions vary from vendor to vendor, but simply put, intent-based networking involves the translation of business logic to administrative and engineering tasks like network design, policy creation, and change controls. Programmatic tools are emerging that allow a network administrator to express intent directly on a graphical user interface, such as "only users in the accounting department can access financial management applications" or "this critical application must have a top QoS priority." An intent-based network interface will then reconfigure the entire network to facilitate that expressed intent.

Conclusion

With this research, EMA wanted to identify how forward-thinking IT organizations are reinventing the data center network. Our snapshot view of 200 data center network transformation initiatives gives us a look at what the future holds. There is a path toward success, and it is likely to involve some combination of leaf-and-spine fabrics, SDN, ADC virtualization, and, for some, switch disaggregation.

The future data center network will also require network automation technologies, open APIs on devices, streaming telemetry technologies, and much more. Finally, the networking team must develop a new set of skills to complement the valuable expertise they already have. That new skillset begins with private and public cloud expertise, but it may also require cybersecurity skills, software engineering, and much more. This report should serve as an early guide to IT leaders who are preparing for their own network transformation journey. EMA will continue to conduct research in this area, so keep an eye on our research libarary.

Demographics

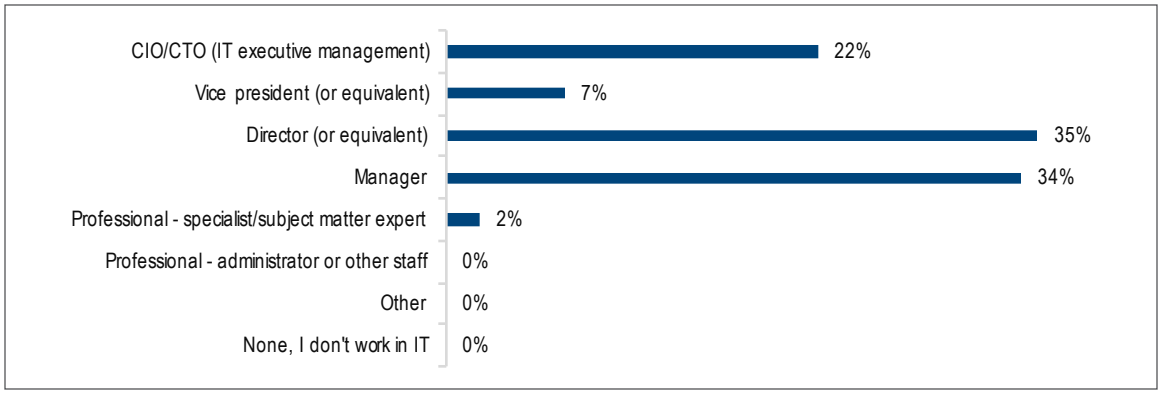

Figure A. Respondents' roles in their IT organizations

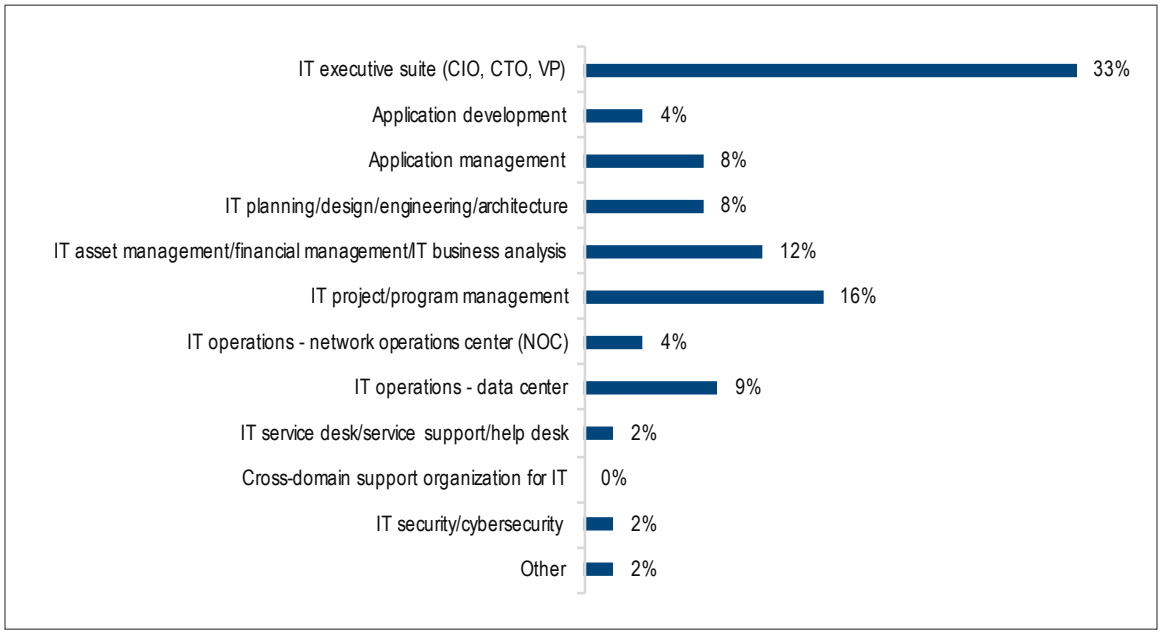

Figure B. Respondents' groups within IT

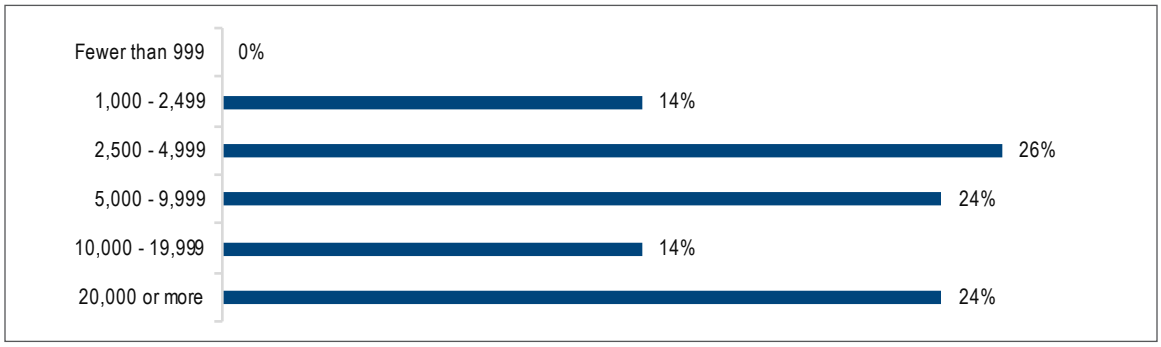

Figure C. Number of employees worldwide in company

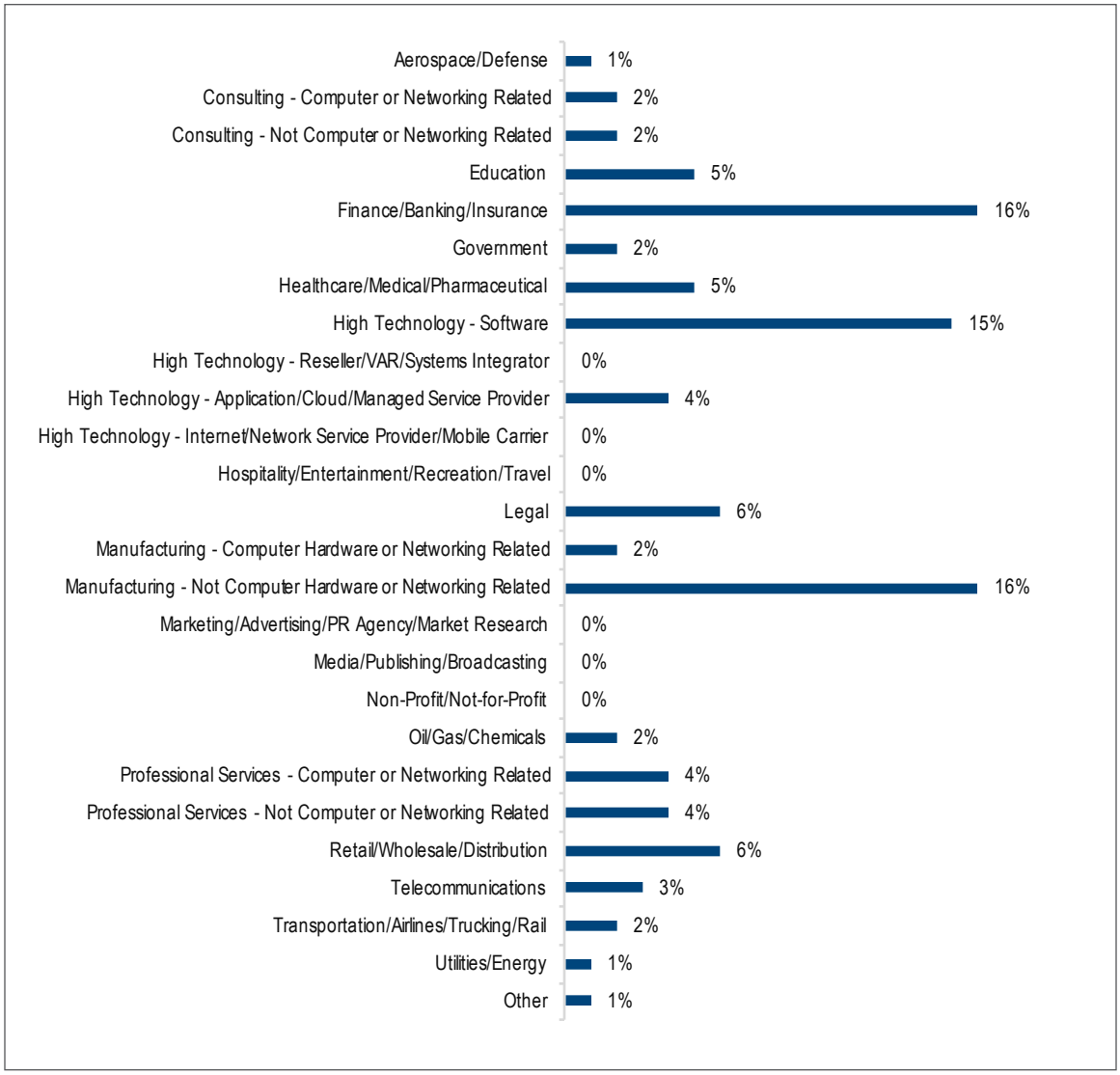

Figure D. Primary industry of company

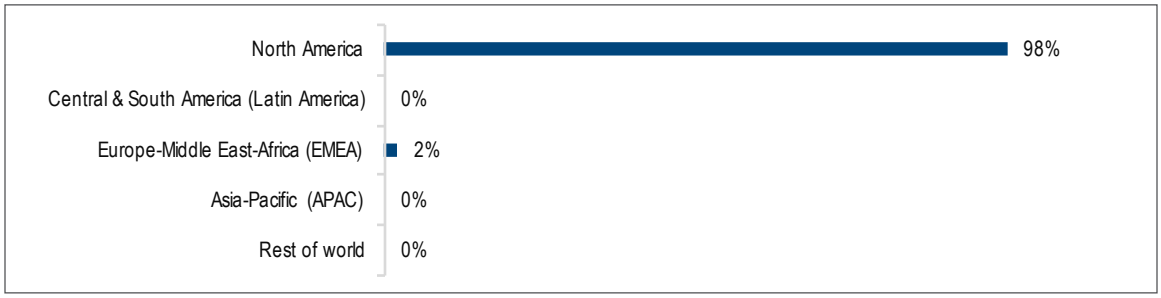

Figure E. Location of company headquarters

Figure F. Respondents' geographic location

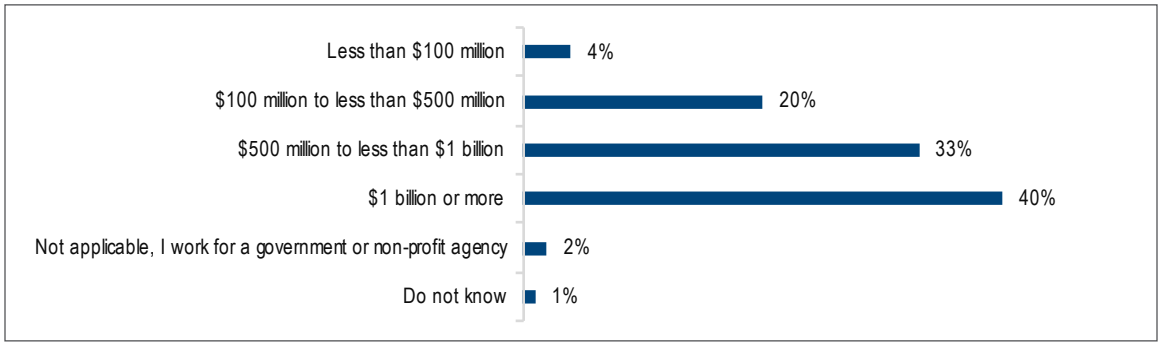

Figure G. Organizations' annual revenues

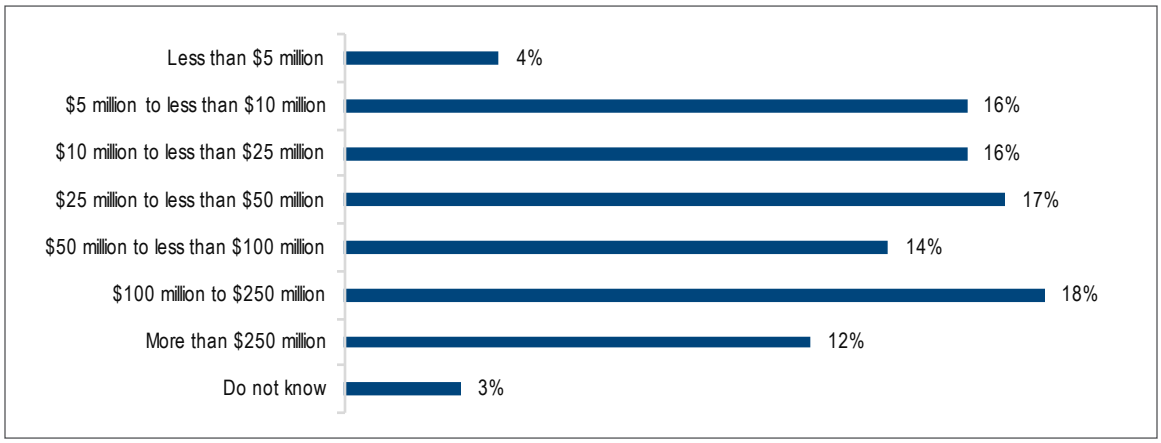

Figure H. Organizations' annual IT budgets

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Founded in 1996, Enterprise Management Associates (EMA) is a leading industry analyst firm that provides deep insight across the full spectrum of IT and data management technologies. EMA analysts leverage a unique combination of practical experience, insight into industry best practices, and in-depth knowledge of current and planned vendor solutions to help EMA's clients achieve their goals. Learn more about EMA research, analysis, and consulting services for enterprise line of business users, IT professionals, and IT vendors at www.enterprisemanagement.com or blogs.enterprisemanagement.com. You can also follow EMA on Twitter, Facebook, or LinkedIn.

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