THE STATE OF

# HW2SW TRANSFORMATION

*The power of workload-optimized data center infrastructure in fulfilling hardware-to-software transformational demands*


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# HW2SW TRANSFORMATION INDEX

# EXECUTIVE SUMMARY RESEARCH AT A GLANCE

*Hardware-to-Software (HW2SW) migration will play an increasingly essential role in the transformation of Communications Service Provider (CoSP) networks.*

Communications Service Providers (CoSPs) are helping drive transformational change within the communications industry and the customers they serve. But CoSPs are also undergoing significant change and transformation themselves. Emerging technologies, such as 5G, Edge Computing, the Internet of Things (IoT), and Artificial Intelligence (AI) are driving waves of new applications and customer requirements, and CoSPs recognize that they must change, adapt, and become more agile to proactively address and capitalize on these emerging opportunities. For many, this involves a shift, or migration, from a hardware-centric to software-centric infrastructure and services model.

To better understand this Hardware-to-Software (HW2SW) migration within CoSPs, Futurum Research, in partnership with Intel, completed a global research study of 465 business and technology professionals helping to shape, implement, and support these initiatives. Specifically within this report, we offer the following research insights:

1. A combination of Hardware, Applications & Data Convergence are the top strategic drivers of HW2SW Migration.

   When we talk about convergence, we are looking at a combination of three distinct technology areas: Hardware, Applications, and Data, resulting in the ever tighter blending of hardware and software systems within service provider environments. The acceleration in three-way convergence encompasses major standalone trends like software migration, virtualization, and analytics assimilation, and validates that network architects stay on top ahead of convergence demands to guide and meet their organization's strategic technology and business demands.

2. The top use case (vertical application) for HW2SW migration is Industrial IoT (but it's close).

   CoSPs view industrial IoT as the leading vertical use case today as well as up to two years from now. The focus on industrial IoT burnishes their 5G and digital ecosystem credentials, although the other top-tier use cases, such as AR/VR, banking/finance, energy.utilities, and autonomous driving barely trailed or only did so by single-digit percentages. As such, CoSPs are ready to invest heavily industrial IoT use cases, leveraging their distinct 5G/LTE assets, although they are also in a position to make solid investment bets towards the relatively more specialized, traditional verticals.

**3.** Security and Faster Access to Data Rank as the top overall selection criteria for HW2SW vendor/solution evaluation.

CoSPs are prioritizing security and faster access to data as their top selection criteria for their NFV and carrier-specific software solutions. As CoSPs hasten their HW2SW plans and move away from their early deployments to regularized digital operations, security takes on increasing paramountcy. The high prioritiy CoSPs attach to faster access to data illustrates that the "need for speed" is consistently a difference maker in their selection of networking solutions.

**4.** NFV Management/Orchestration is the leading driver of technology investments supporting HW2SW migration.

Service providers see the implementation of NFV Management and Orchestration as their top investment driver, indicating that they have graduated from testing and adopting fundamental NFV capabilities, such as VNF Management and VNF License Management, and focus more on orchestrating their essential yet increasingly complex VNF assets.

**5.** IT Units Drive Largest Bloc of Procurement Investment.

CoSPs are identifying their IT units as the leading bloc for ongoing HW2SW procurement investments, indicating the IT side of the house is driving organization-wide HW2SW migration and digital transformation. With CoSPs accelerating their NFV/SDN and hybrid service/resource management investments, the IT side is taking on increased decision-making responsibilities across the organization.

**6.** Support for Analytics is the top need addressed by NFV & Software Acceleration.

CoSPs are choosing Analytics Support as the top need for accelerating their NFV/SDN and software architecture implementations over the next two years, demonstrating that they are sifting gears from merely deploying NFV/SDN to institutionalizing it. CoSPs are progressing from kicking the tires and making SDN/NFV work on a limited bases to executing enterprise-wide implementations and manageable from a TCO and service-level perspective.

**7.** High-Performance Computing is an adjacent, related challenge.

CoSPs are facing challenges in non-traditional, yet relevant, areas. The advent and quickening adoption of 5G-IoT is obliging service providers to meet emerging HPC requirements, now increasingly less the province of academic, financial services, and life sciences. The Asia-Pacific region, in particular and where 5G deployments are the furthest along, CoSPs are encountering HPC-based challenges due to factors such as expansion of interworking with enterprise HPC platforms and exploring how they can optimize their own HPC investments and builds.

# INTRODUCTION

*An agile workload-optimized data center infrastructure strategy aligned with a blueprint-driven hardware-to-software transformation is vital to service provider long-term competitiveness in the global digital ecosystem.*

There is a clear market trend and industry consensus that Hardware-to-Software (HW2SW) migration will play an increasingly essential role in the transformation of Communications Service Provider (CoSP) networks. The proliferation of network and telecommunications infrastructure is playing a major role in driving migration toward software-centric networks, augmenting the service provider intelligent edge, NFV/SDN, and hybrid cloud adoption strategies.

As such, service provider decision makers that adapt best to emerging intelligent edge demands are succeeding in their business objectives, especially in the area of workload optimization within data center environments. Those that lack these insights are risking serious competitive shortcomings into the foreseeable future. As a result, an agile workload-optimized data center infrastructure strategy aligned with a blueprint-driven hardware-to-software transformation is vital to service provider long-term competitiveness in the global digital ecosystem.

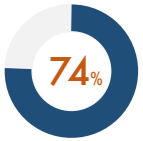
In this paper, Futurum Research set out to better understand the changing landscape that is taking place as CoSPs are transforming their current infrastructure to support the rapid proliferation of communications driven by technology trends such as 5G, Edge, IoT, and AI while concurrently meeting the most demanding consumer experience trends that include the highest standards in reliability, with the most ubiquitous and immersive data-driven experiences.

The industry verticals targeted by the survey included AR/VR, Autonomous Driving, Banking/Finance, Energy/Utilities, Gaming, Healthcare, Industrial IoT, Public Safety, Retail, Smart Cities, and Transportation.

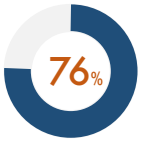
After completing our research study and analyzing the data, it is clear that Communications Service Providers seeking to build an infrastructure that can handle the automation and real-time nature of updates, upgrades, and reliability must develop a strategy, paired with solid implementation and operational plans, that includes the deployment of powerful NFV and SDN tools. Our data clearly shows this as a current and rapidly-growing trend being carried out by Communications service providers around the globe.

## SETTING THE BASELINE CoSP PERSPECTIVES

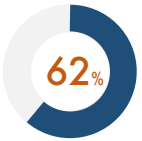
Understanding why an organization may choose a particular path can be clarified if we understand the larger picture that frames an organizaitons perspective. With this in mind, we asked our panel of CoSP executives and technology leaders to share their thoughts on a select group of topics related to technology selection, deployment and strategies. They agree:



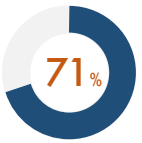

74% agree **having data closer to computing resources** is important as apps increasingly consume larger amounts of data faster.



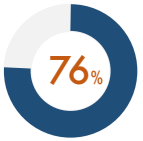

76% agree **centralized NFV topologies** provide the shared pool of servers needed to provide maximum statistical multiplexing of compute loads for multi-tenated customers.



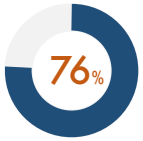

**62%** agree **computing devices can't access enough data fast enough** to keep pace with needs and data center performance.



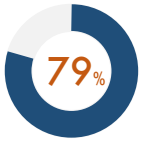

71% agree **emerging applications are going to stress** their data centers and edge networks.



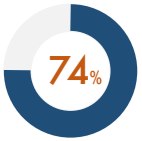

76% agree their business increasingly relies on **migrating to software-based architectures to drive cost savings** and boost network efficiency.



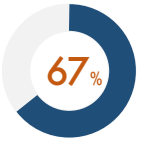

76% agree **virtualization resources and hosting of VNFs need to be pushed to the service edge** in order to reduce deployment costs.




79% agree **technology is converging at three different levels**, hardware, applications, and data, combining to drive the need for migration




74% agree they're more interested in, or see greater value in, **HCI (hyper-converged infrastructure) than physical convergence** at this time.




67% agree their **computing systems were not designed to handle the level of analytics and data science** that has become central to performance monitoring, analytics and insights, and operational decisions.

We see each of the above perspectives helping to drive, or providing context to understand, HW2SW migration.

On the strategic level we're very interested in the technology convergence cited above, specifically the three-way convergence of hardware, applications, and data, something we consider a top driver of HW2SW migration. Our panel's perspective appears to validate the premise that service providers are prioritizing software migration in order to implement their technology convergence priorities in digital operations environments. It also reinforces our observation that service providers are embracing tighter integration of hardware and software systems. The acceleration in three-way convergence is blurring the traditional lines of operations and business processes, resulting in the increasing mutual interdependency of capabilities, including among standalone technology drivers, such as analytics integration, virtualization, and software migration.

It is important to note that the three-way convergence trend overlaps but is distinct from the HCI trend consisting primarily of the "three S" technologies - storage, servers (computing) and switches (networking) – predominant in data center environments. For network architects, it's crticial to stay on top of the three-way convergence trend and to ensure network design and resurces align with the accelerating demands of convergence.

- FUTURUM PERSPECTIVE We're starting to see a mirrored dependency growing where hardware and software systems are working more closely together than ever, blurring the line between them so that the capabilities of one are linked to the capabilities the other. For developers and technology providers, it's important to stay ahead of these trends to ensure both products and skills are up-to-date with emerging technologies and customer requirements.

# 1 KEY DRIVERS OF HW2SW MIGRATION AND TRANSFORMATION INVESTMENTS

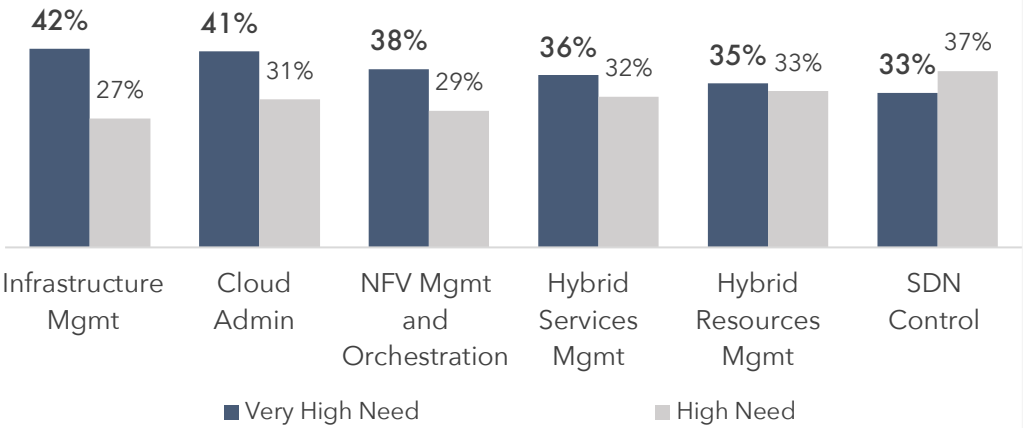
*There are many factors driving organizations to embrace HW2SW migration, from the technical to the financial, and from the internal need to customer requirements..*

**What are the top drivers for digital operations enablement driving investments in hardware to software migration today?**

With HW2SW migration continuing apace, it is important to understand the top ***digital operations needs driving HW2SW investment today***. When we asked our panel to evaluate each potential need/driver individually, Infrastructure Manageement is (slightly) the highest rated "very high" need. Cloud Administration is cited as the second-rated driver, which makes sense since service providers are committed to using multi-cloud platforms to accelerate their OSS/BSS transformation and adoption of cloud-native applications.

## TECHNOLOGY INVESTMENT DRIVERS FOR HW2SW MIGRATION

Q: Where do you see the biggest needs for digital operations enablement that drives investment in hardware to software migration today?




Please select your TOP THREE drivers

**61%**
NFV Management and Orchestration

**60%**
Infrastructure Management

**45%**
Hybrid Services Management

But that position changes when we asked respondents to select their Top Three choices. Cloud Administration, one of the top needs cited in the first chart, is only cited by 24 percent of our panel as a top three driver. While it may be important, it isn't necessarily the critical priority. Both Infrastructure Management and Hybrid Service Management carried over and again resonated with survey respondents as a top three factor in driving overall HW2SW and digital operations investment priorities.

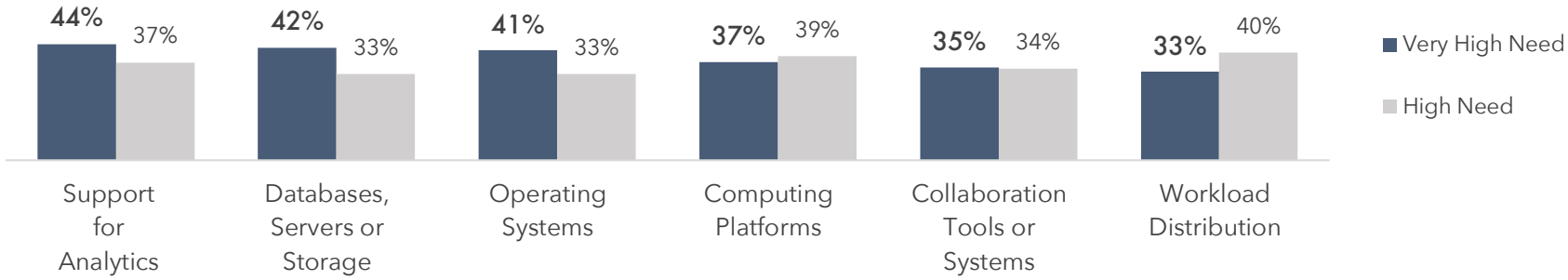
*Who deviates from the norm? CoSPs in EMEA and Greater China prioritize Infrastructure Management as the Top Three driver. EMEA prioritizes the Top Three as: Infrastructure Management, Hybrid Services Management, and SDN Control, respectively.*

## Where is the need for NFV/SDN or accelerated software architectures?

In driving overall HW2SW investment decision-making ***over the coming 18 to 24 months***, our research showed that NFV Management and Orchestration tops Infrastructure Management due to its pivotal role in spurring digital operations enablement and delivering virtual network functions (VNF) management and VNF license management capabilities.

### THE COMING NEED FOR NFV/SDN

Q: Where do you anticipate seeing the need for NFV/SDN or accelerated software architecture adoption within 18 - 24 months?




*Who deviates from the norm? CoSPs in North America rate Databases, Servers or Storage and Operating Systems slightly above Support for Analytics as a Very High Need (43 percent, 43 percent and 39 percent, respectively).*

## What are the key verticals to watch?

Moving beyond the technology and architectural drivers, it's important to understand which vertical segements (or use cases) are ***currently*** considered the key beneficiaries of (the most need for) NFV/SDN or accelerated software adoption.

Over a year ago, industrial IoT aimed at enterprises was perceived to be the dominant 5G use case. Today, however, AR/VR strengthens the 5G consumer use case—as well as the enterprise use case—diversifying vertical opportunities for service providers in both the enterprise and consumer market segments.

Equally important, the CoSP panelists view industrial IoT as the most frequent use case they anticipate requiring NFV/SDN and software architecture assimilation, although not necessarily the most intense. As a results, CoSPs need to pay continued close attention to the AR/VR and banking/finance segments to improve the balance of their investments and resource allocation.

In the future, the data hints that needs, or priorities, may decrease on a relative level in the 18 to 24 month range, but we believe this number is misleading as the demand will not actually decrease, but rather the expectation by providers is that the NFV and SDN investments will be in place leaving a smaller number of transitions.

When we ask for respondents to name the top three use cases/vertical segments they anticipate requiring NFV/SDN or accelerated software architecture over the coming 18 – 24 months, again, IoT is the top choice (a measure of focus on the biggest need).

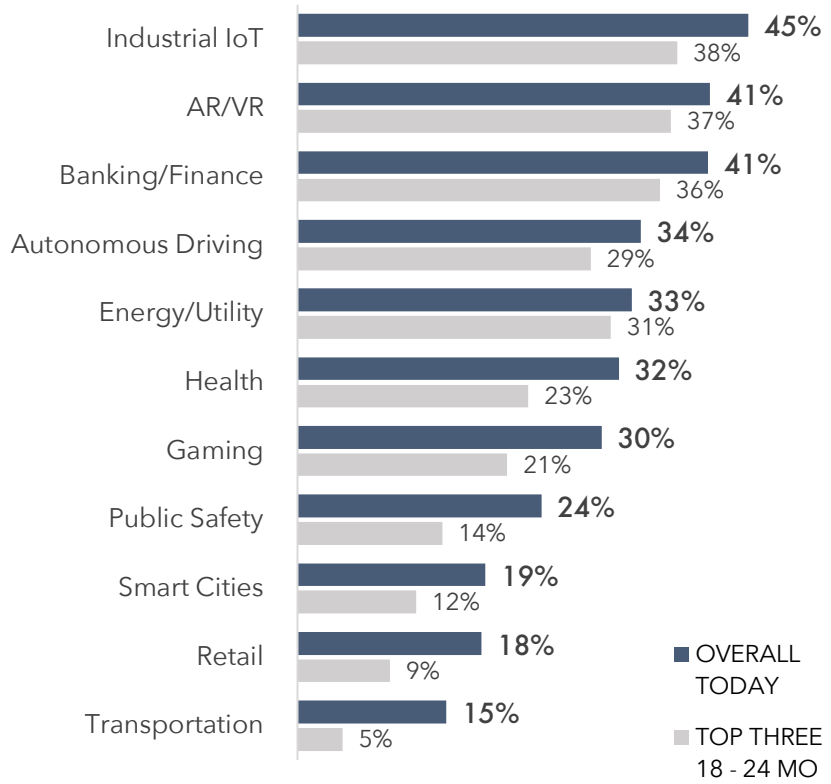
But the difference between the top five is relatively low. In parallel with the top cases of today, other use cases such as AR/VR, Banking/Fnance, Energy/Utility, and Autonomous Driving should also be considered equally high priority – especially considering other verticals are significantly below the top tier.

*Top Use Cases (today) by Region:*

- AsiaPAC — AR/VR (52%)
- EMEA — Banking/Finance (47%)
- Greater China — Health (51%)
- Latin America — AR/VR (60%)
- North America — Industrial IoT (57%)

## WHAT ARE THE HOT USE CASES (VERTICAL SEGMENTS) FOR NFV/SDN TODAY? AND IN 18 - 24 MONTHS?

Q: What are the use cases (vertical segments) you anticipate requiring NFV/SDN or accelerated software architecture adoption today (and in 18 - 24 months)?




► FUTURUM PERSPECTIVE In our opinion, the data reflects a clear indication that now is the crucial time for investments in NFV and SDN as early implementations will be optimized for more rapid network transformation enabling the early adopters a greater opportunity to update and innovate more quickly than organizations still in the process of migrating to more agile network architectures.

# 2 ADOPTION BARRIERS AND CHALLENGES

*While there are strong drivers for HW2SW migration, there are numerous challenges and barriers that must be overcome by those planning, implementing, and managing the transformation process.*

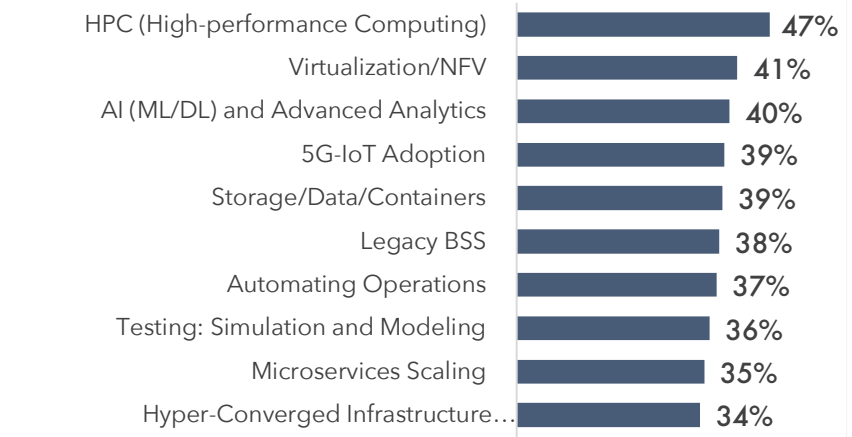
In trying understand the challenges CoSPs and their customers face, we asked a very broad question on overall barriers. Our CoSP respondents shared they expect ongoing struggles with HPC implementations within their own network, as well as for their users, as the most significant adoption challenge in HW2SW environments.

CoSPs are not alone in meeting the challenges of reliably and systematically keeping pace with the computation, storage, and networking demands of HPC applications. As a result, data center workload optimization is essential in addressing the scaling and data management demands of HPC.

The advent and quickening adoption of 5G-IoT is obliging service providers to meet new HPC demands related to the storage and processing of massive amounts of data in a short amount of time. The Asia-Pacific region, in particular and where 5G deployments are the furthest along, CoSPs are encountering HPC-based challenges due to factors such as expansion of interworking with enterprise HPC platforms and exploring how they can optimize their own HPC investments and builds.

## OVERCOMING THE ADOPTION BARRIERS

Q: Which applications are creating the most significant adoption challenges for your network or your users today?




► FUTURUM PERSPECTIVE It's important to also take note of the distribution of respondents across the ten applications that we queried our panel on. While HPC, Virtualization/NFV, and AI & Advanced Analytics at the top of the list, areas like 5G-IoT adoption drew very close to the top three, Storage/Data/Containers, Legacy BSS, and Automating Operations. This indicates that there are a wide number of forces driving adoption of NFV/SDN and that likely it is a convergence of more than five or six of these applications pushing forward investment rather than any one or two. This is especially true given the interdependence of these technologies in emerging networks such as containers and microservices or 5G and AI.

# 3 WHO IS LEADING HW2SW INVESTMENT DECISIONS?

*Having a plan is great, but having the right corporate and executive support and funding is essential.*

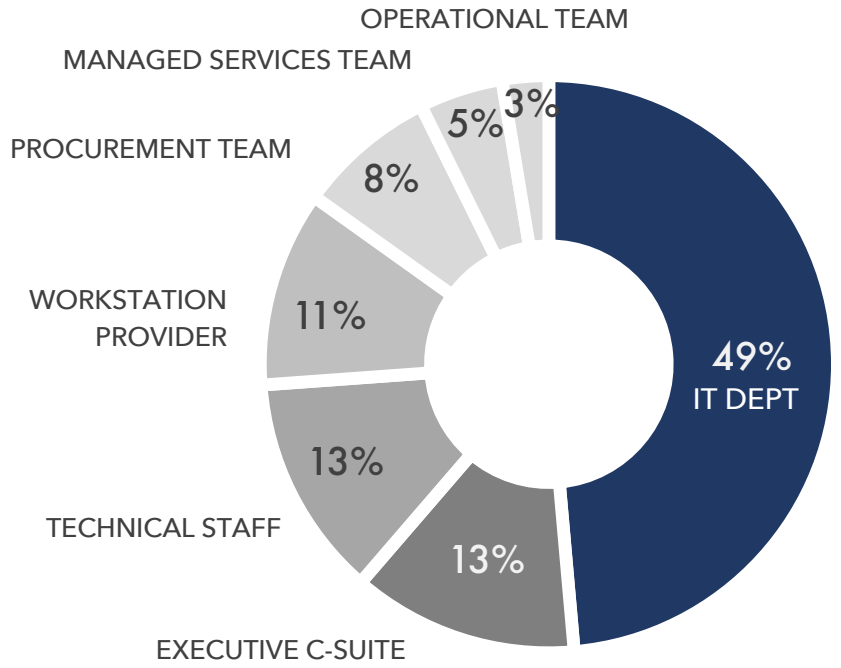
With HW2SW transformation playing an increasingly strategic role in CoSP agility strategies, it becomes important to better understand what part of the respondents' organizations are driving the company's investment decisions. Respondents showed the following sources of funding:

Clearly, the IT part of the CoSP organization is the top stakeholder for enabling HW2SW investments. There is also the potential for their role to expand, as some procurement teams can prove hard-pressed to lead investment decisions for increasingly complex virtual, pay-per-use (PPU), and multi-cloud licensing schemes.

CoSPs are identifying their IT units as the leading bloc for ongoing HW2SW procurement investments, indicating the IT side of the house is driving organization-wide HW2SW migration and digital transformation. With CoSPs accelerating their NFV/SDN and hybrid service/resource management investments, the IT side is taking on increased decision-making responsibilities across the organization.

## MAKING THE INVESTMENT DECISION

Q: Who is primarily responsible for making the investment decisions in your, or your user's, NFV and telco software systems?




► FUTURUM PERSPECTIVE It's important to recognize that there are two layers of decision makers that are critical to enabling and supporting these investments. While the IT department clearly is the primary purchaser, the CXO, operations, and the business units themselves will be indirectly responsible for driving forward these investments. Customer needs and expectations are driving the need for a more robust and adaptable network infrastructure, but ultimately IT will be the most likely to sign off on the specific tools and software adopted.

# 4 NFV/SOFTWARE SELECTION CRITIA

*As the data shows, there is a fine line between differing priorities when it comes to section criteria.*

Since NFV and migration to software-centric network architectures are central to the digital transformation objectives of CoSP, it becomes crucial to understand the selection criteria service providers are utilizing.

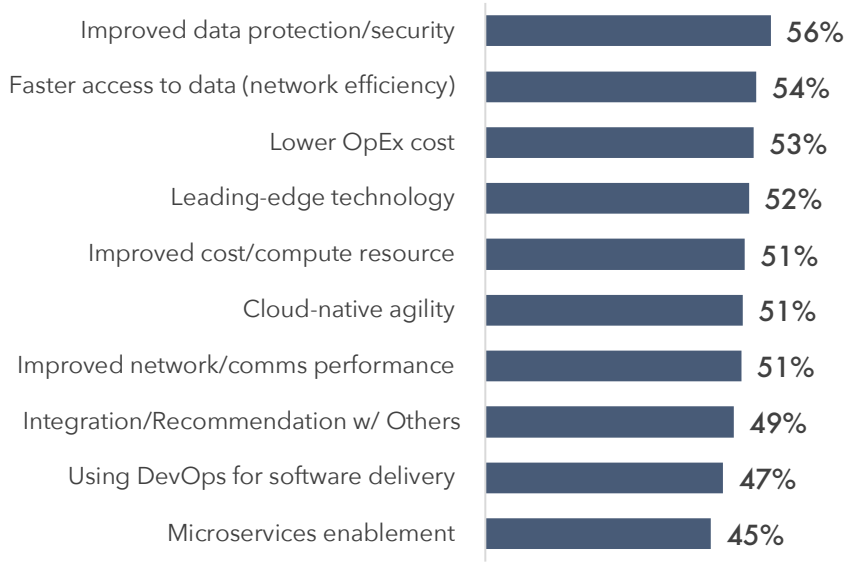
Not surprisingly and in line with what we see in other research, CoSPs pinpoint Security and Improved Data Protection as the top selection criteria for NFV/telco software solutions.

The "security is paramount" principle is no exception when it comes to NFV and software migration implementations, aligning with customer demands for security-first services. Service providers can ill-afford a security breach that diminishes their brand name and reputation. While security is normally a table stakes requirements, many CoSPs are progressing from their early NFV/SDN deployments to regualarized virtual and hypbird operatons across their organization, elevating security into the selection criteria with the top importance.

Of note, CoSPs are steadfast in emphasizing network efficiency (faster access to data) and lower OpEx costs as their second and third most important selection criterion. The continued importance of network efficiency links to growing CoSP demand to scale and manage the massive volumes of data that 5G-IoT and digital transformation brings to their networks. The top emphasis on lower OpEx costs correlates to boosting their competitiveness against other digital operators

## SELECTION DRIVERS IN NFV AND TELCO SOFTWARE SOLUTIONS

Q: Please rate the following in terms of significance in the selection of NFV and telco software solutions (Significant Drivers Only):



and cloud providers from the anticipated operational and business process efficiencies gained through virtualization and orchestration.

While CoSPs identify Integration Compatibility in the bottom half of the list, the overall (significant plus moderate driver) rating is 90 percent, confirming their need for continuity and backward compatibility (e.g., 4G/5G, hybrid cloud) to accomplish their digital transformation goals.

- FUTURUM PERSPECTIVE We believe that the high respective numbers of CoSPs being driven by faster access to data (54 percent) and the desire to Lower Op Ex at 53% are well represented and well justified. As 5G proliferates, we see a strong drive within service providers to innovate in order to monetize the opportunity. Those that aren't innovating quickly will look to technology enablers to reduce costs. Additionally, the ranking of Cloud-Native Agility, which came in just below the top five, is worth noting. Hybrid environments have led to a surge of interest for building cloud native applications. We believe this will also pull up the numbers (improve the value as a selection driver) for Microservices over the coming years.

# 5 NFV-ENABLED WORKLOAD OPTIMIZATION

*AI, Machine Learning and Analytics drive the building blocks and middle layer, but end-to-end it's the cloud.*

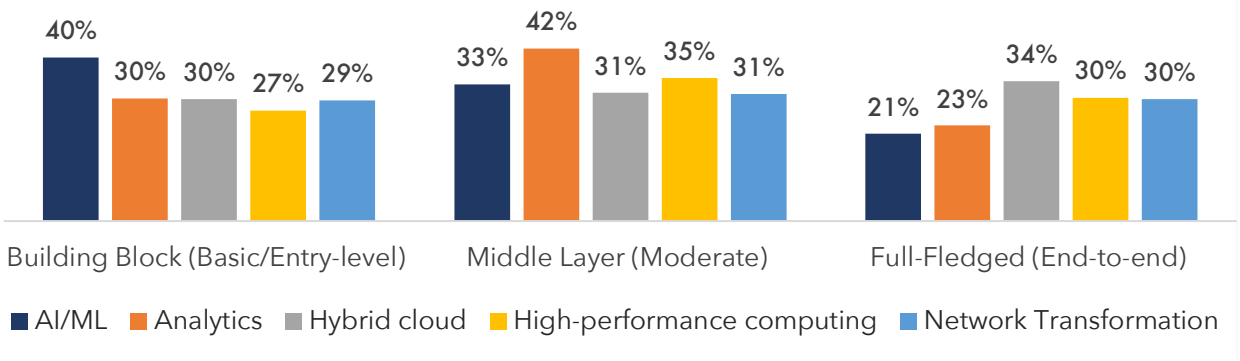
We asked our panel to identify the highest-priority applications driving NFV-enabled workload optimization, framing applications within three different categories: building block, middle layer, and full-fledged E2E (end-to-end).

With a clear lead, CoSPs regard AI/ML as the highest priority application for implementing the building block component of their NFV-enabled workload optimization designs, but it is close. This verifies the hypothesis that service providers increasingly view AI/ML as fundamental in executing the automation and scalability of their workload optimization configurations.

For middle layer capabilities, service providers deem Advanced Analytics as the key application, and for fulfilling their E2E requirements, Hybrid Cloud becomes the highest priority application. This aligns with the overall trend of service providers and enterprises using more cloud computing resources to meet the scaling and agility requirements of digital transformation and 5G-IoT buildouts. For full-fledged workload configurations, hybrid cloud capabilities take the lead. CoSPs continue to deal with the complexities of both hybrid cloud (private/public) and embedding hybrid capabilities across multi-cloud (e.g., SaaS, IaaS, PaaS) implementations, elevating Hybrid Cloud as the top application requirement within end-to-end environments.

## PRIORITIZING WORKLOAD OPTIMIZATION BY LAYER

Q: Please rank the following in terms of highest priority applications for NFV-enabled workload optimizaiton configurations:




► FUTURUM PERSPECTIVE While we expect Hybrid Cloud implementations to continue to be a prioritized item for CoSPs and their customers, we also expect a tighter alignment between AL/ML and Analytics, as the two effectively form the basis of intelligent network operations moving forward.

# 6 NFV/SDN PURCHASING TRENDS

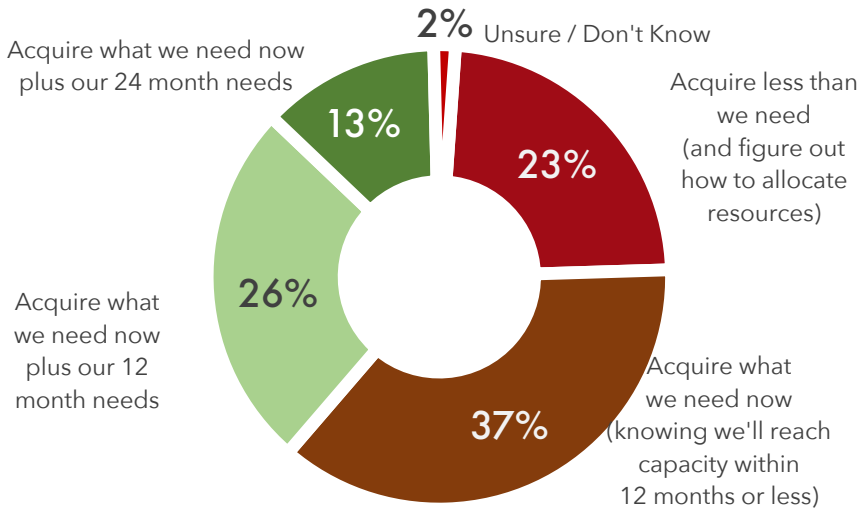
*While most organizations like to take a long-view on planning and purchasing, the here-and-now principle flourishes when it comes to acquisition behavior.*

When purchasing software-based computing and NFV/SDN solutions, the "here and now principle" reigns supreme, with some 37 percent of CoSPs reporting relying on a strategy of acquiring only what they need to fulfill their immediate demands. Another 26 percent report they are doing some advance planning, fulfilling their immediate needs, as well as factoring in their projected needs for 12 months. Of concern is that almost a quarter of all CoSP organizations (23 percent) indicate they acquire ***less than their immediate needs*** and roll the dice by relying on resource allocation at a later time to avoid shortfalls that might impact service delivery.

Our research shows that, for the most part, CoSPs are basing their NFV/SDN and software-based computing purchasing decision on "here and now" principles. Due to the dynamic nature of digital transformation, this current approach to buying is unsurprising, particularly as CoSPs (as well as their enterprise customers) are expanding their use of consumption-based, as-a-service (e.g., SaaS) models.

## MAKING THE PURCHASE DECISION - HOW MUCH IS ENOUGH?

Q: When purchasing software-based computing or SDN/NFV solutions, do you or your users:




However, almost two-thirds of CoSPs will run out of resources within 12 months, relying on deft resource allocation to avoid potential service disruption and outages and putting a premium on maximizing their data center workload optimization solutions.

- FUTURUM PERSPECTIVE We understand the availability of on-demand computing resources today, and that many companies are looking to right size spending. But there is great risk with any approach that doesn't incorporate some level of preparation for meeting volatility in demand. Elasticity of network and resources is key, but even the 26 percent that are purchasing with only a 12-month runway appear to be balancing spend management against the risks of being underprepared for growth.

# 7 GROWTH PROJECTIONS AND BUDGET TRENDS

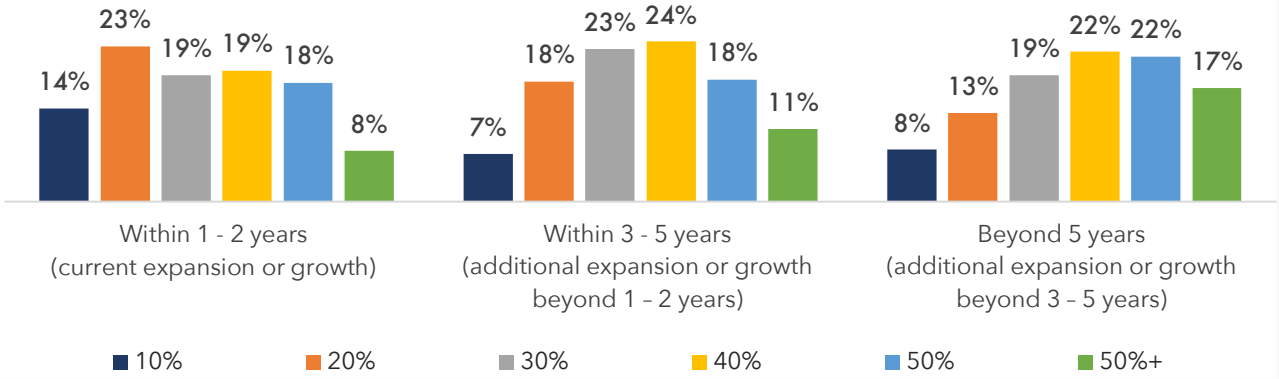
*From the migration of assets to the network edge to TCO/TTM benefits to spend expectations, the key word is growth and high expectations.*

*How fast will CoSPs migrate assets to the network edge?*

When asked about network edge migration projections and the placement of resources to move, store, and process data closer to its source to the point of delivery, it was clear that networking edge needs were poised to peak more in the five-year plus time frame. That said, near-term one to two-year demands were expected to generate robust double-digit growth, with a steady demand uptick also anticipated in the three to five-year interval. Here is what our research showed:

## GROWTH AT THE NETWORK EDGE

Q: With the network edge defined as the placement of resources to move, store and process data closer to its sources or the point of service delivery, how much more edge migration to you anticipate needing for your enterprise or your users over the coming years? In other words, our networking edge needs will expand by...




## OBSERVATIONS

- 63% expect a shift to the edge of 30% or more withn the coming 24 months
- 53% expect an additional shift to the edge of 40% or within the 3 – 5 year planning horizon
- 38% expect an additional shift to the edge of 50% or more 5 years or more into the future

- FUTURUM PERSPECTIVE It is clear that CoSPs view their networking edge needs as peaking in the beyond 5-year time frame after a steady demand uptick in the 3-5 years interval. This indicates their intelligent edge strategies require attention to long-term growth expectations, especially in relation to the placement of resources needed to move, store, and process data closer to its sources or the point of service delivery.

*What are TCO/TTM Expectations ?*

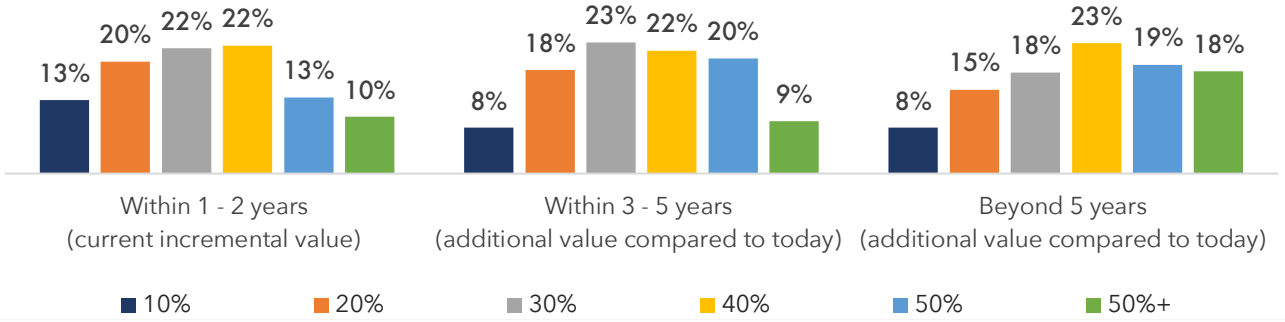
Similar to edge migration, we asked survey respondents to consider their ***projected TCO/TTM expectations*** from ready-to-deploy solutions purchased from hardware and software vendors. In this instance, they were likewise choosing across a spectrum of increments and time-spans, (i.e., 0-9%, 10-19%, 20-29%, 30-30%, 40-49%, 50%+) in relation to near-term (1-2 years), mid-term (3-5 years), and long-term (5 years+) time spans. It was clear and not at all surprising that CoSPs anticipate and expect their total cost of ownership (TCO) and time-to-market (TTM) benefits to gain value over time. The results are as follows:

CoSPs anticipate their current TCO/TTM benefits to progressively add value over the mid-and long-terms, ***provided their hardware/software vendors offer ready-to-deploy solutions today***. This indicates that CoSPs have clear expectations that suppliers build in long-term TCO/TTM benefits into their solutions today and in the future.

Short term, we anticipate TCO will shift from much higher numbers associated with hardware (today) to more operationally friendly and software-centric licensing and subscription fees (over the coming 2-5 years).

## CHANGING TCO/TTM EXPECTATIONS

Q: How much additional value compared to today do you anticipate (or require) in terms of Total Cost of Ownership (TCO) and Time To Market (TTM) if hardware + software vendors provide ready-to-deply solutions?




This shift in demand should provide service providers the capability to decrease capital expenditures (CAPEX) allocated to infrastructure spend and quickly transition toward rapidly identifying opportunities and deploying services and applications using software defined and virtualized capabilities (i.e., new and enhanced revenue streams).

- FUTURUM PERSPECTIVE We believe CAPEX is a key metric that service providers will be paying closest attention to. Given the strong understanding of need around the migration from hardware to software, providers are going to want to quickly know how to speed up time to market to drive new revenues as technology and consumer trends enable them.

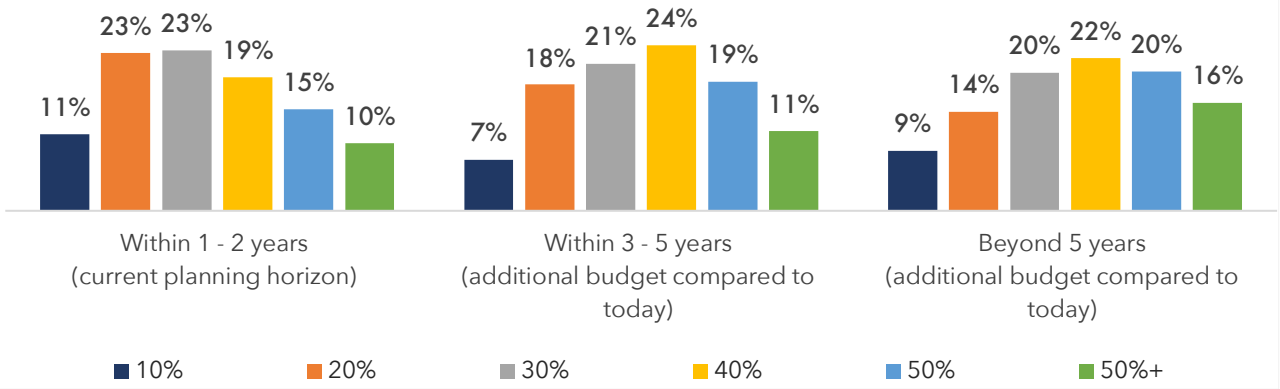
*What are Budget & Spend Expectations?*

Lastly, we asked survey respondents to choose across a spectrum of ***projected budget increases*** in 10 percent increments in relation to near-term (1-2 years), mid-term (3-5 years), and long-term (5 years+) time spans. Plans are great, but budgets are how things actually transition from plans to operational value. It's clear that a majority of CoSPs expect their NFV/SDN budgets (and hopefully their customer's budgets) to increase in the over 40% range in both the mid-term and long-term. Why the significant increases? For many CoSPs the coming decade will be one of transition, from older to newer archtectures and legacy to emerging revenue models.

With CoSPs expecting to open up their wallets at robust spend rates (40%+ increases) for NFV/SDN adoption into the foreseeable future, ***hardware/software suppliers must prioritize capturing this spending surge***. With the largest spending boosts expected in the beyond five years range, CoSPs are clearly earmarking NFV/SDN investment as a long-term strategic priority (not to mention their user base).

BUDGET AND SPEND EXPECTATIONS

Q: How much more do you expect you or your users wil budget/spend for NFV/SDN adoption over the coming years? In other words, our NFV/SDN spend will expand by...




Moreover, NFV/SDN suppliers do not need to wait around as near-term spending is projected to predominantly expand in the 20%-30% range with intermediate 3-5 year increases in the 40% range anticipating increasing budget prioritization.

► FUTURUM PERSPECTIVE Over the longer period of time polled, we strongly believe spending will transition from hardware to software to a more agile continuous improvement of software and application transformation that enables service providers to respond more quickly to ever changing market demands.

# CONCLUSIONS

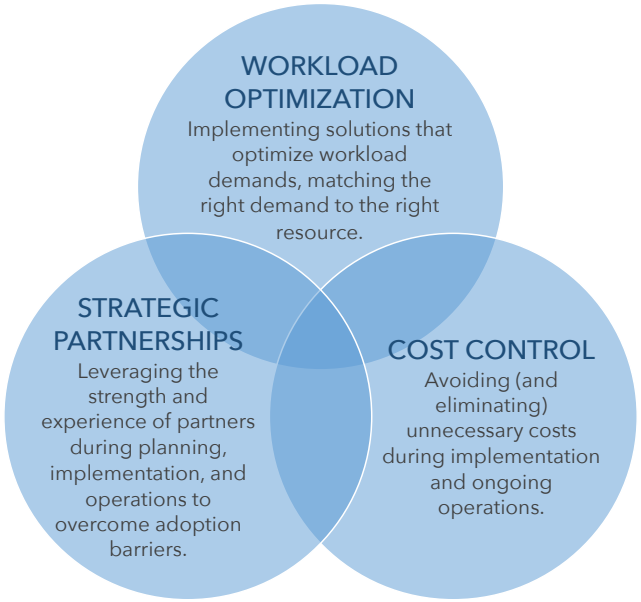
*What does the future of successful NW2SW migration look like? Workload Optimization, Cost Control, Strategic Partnerships.*

Data center workload optimization is essential to fulfilling CoSP HW2SW transformation demands. This requires suppliers to understand the top drivers of HW2SW transformation and to engage with customers and prospects in a manner that both takes those drivers into consideration and also helps customers incorporate these drivers into their strategic conversations.

For example, the complexities of HW2SW migration, including three-way integration of hardware, software, and data center infrastructure, requires agile workload-optimization solutions, especially in data center environments. Understanding the high priority infrastructure management plays in digital operations investment and NFV management and orchestration in overall HW2SW investment are key differentiators.

Likewise, suppliers can further distinguish their solutions by emphasizing how they resolve HPC adoption challenges and improve the targeting of industrial IoT business case opportunities. As always, emphasizing how the solution meets the security and data protection demands of customers is a must, and a sales and marketing differentiator against solutions that address security in a secondary way. Service providers that are obliged to purchase NFV/SDN capabilities which do not meet their immediate needs are prime candidates for workload optimization solutions that come to the rescue.

With a sizable portion of all CoSPs ramping up their TCO/TTM and NFV/SDN spending expectations to match in the 30% to 40% range over the next three to five years (and beyond), the stakes are becoming increasingly high. As a result, CoSPs must implement solutions that meet their workload demands across the entire range of hybrid cloud, storage, analytics, and networking applications. Avoiding unnecessary costs and overcoming adoption barriers means choosing a strategic partner that fulfills the full spectrum of emerging HW2SW transformation requirements.



## THREE KEY RECOMMENDATIONS

*Three recommendations on the future of NFV/SDN & HW2SW Migration.*

- Service providers must demand that their workload optimization solutions account not only for HCI demands in data center settings, but also are meeting the radidly growing demands for three-way hardware, applications, and data convergence in their hybrid network/virtual environments.

- CoSPs need to stress that cost control is integral to any vendor's NFV/SDN and HW2SW portfolio development strategy and vision. Without a clear-cut TCO blueprint, service providers risk undercutting their long-term competitiveness by repeating the hardware-centirc investment patterns that resulted in over reliance on closed, proprietary sustems and captivity to supplier cost agendas.

- CoSPs need to expand their strategic partnerships with public cloud providers in order to streamline costs, leverage cloud provider software expertise and multi-regional footrpints, and augment workload transitions and collaboration.

## THREE KEY PREDICTIONS

*Three predictions on the future of NFV/SDN & HW2SW Migration.*

- Software-centric Architectures Triumph: CoSPs are clearly betting their HW2SW investments will produce the overall TCO benefits essential to powering their long-term competitiveness and meeting the fast evolving 5G-IoT and digital transformation demands of their customers. CoSPs do not need to buy additional real estate to meet their strategic HW2SW objectives. By using capabilities like NFV/SDN, smart analytics/automation, and hybrid multi-cloud platforms, the existing data center and central office assets of CoSPs are ready to drive their software-centric architecture builds. Moreveor, CoSPs will increasingly partner with major public cloud providers to avance their HW2SW business objectives.

- Industrial IoT Flourishes: Service providers relish low-hanging use cases that will justify their massive 5G investments. The broad, multi-discipline aspect of industrial IoT applications, while also allowing for specialization where needed, enables them to capitalize on meeting the ecosystem demands of their customers, especially in 5G and digital environments. CoSPs are strengthening their ecosystem credentials by fulfilling the distinct indoor and campus service requirements of industrial IoT applications through the delivery of 5G and private LTE capabilities. This also enables CoSPs to limit the need to bet on more narrow verticals where investments toward developing resoruces and expertise could diminish if economic prospects recede or the pace of adoption slows within a vertical industry.

- Blossoming of As-a-Service: The acceleration of CoSP HW2SW plans will accelearate their NFV/SDN and software-based computing purchasing decision on "as-a-service" principles. Due to the dynamic nature of digital transformation and the scaling demands of 5G-IoT, CoSPs are expanding their use of consumption-based, as-a-service (e.g., SaaS, PaaS) models. CoSP TCO strategies will shift from much higher numbers associated with hardware to more operationally friendly and software-centric licensing and subscription fees (over the coming 2-5 years). This shift in demand enables service providers to decrease the capital expenditures (CapEx) allocated to infrastructure spend and quickly transition toward rapidly identifying opportunities and deploying services and applications using software defined and virtualized capabilities (i.e., new and enhanced revenue streams).

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*A brief word about the authors and sponsors of this research paper and the supporting study.*

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# APPENDIX DEMOGRAPHICS

*This paper is based on the cumulative experience of the Futurum Research team and a primary market study defined by the following demographics.*

To better understand industry-wide Hardware-to-Software trends and their key touchpoints, we surveyed 465 business executives and technology professionals, with broad geographic distribution primarily across North America, Europe Middle East Africa (EMEA), and Asia-Pacific (APAC) within the Communications Service Provider (CoSP) community, including both employees and individuals (such as contractors and advisors) directly supporting CoSP organizations.

Key demographic data points include:

- All respondents fully qualified as either very familiar (73 percent) or familiar (27 percent) with NFV/virtualization applications like vCPE, vIMS, vEPC, vSBC, and vPCRF, ensuring data quality and integrity.
- 71 percent of our panel are in the IT organization (including the CIO and technical team), 16 percent are in the Product organization (including the Chief Product Officer, Chief Technologogy Officer, or development team), and 13 percent are qualified C-Suite Executives within supporting organizations.
- Size of organizations encompassed: 50,000+ (20 percent), 5,000-49,999 (32 percent), 1,000-4,999 (48 percent).
- Annual revenues are as follows (in USD): $10 billion or more (19 percent), $5 – 9.9 billion (33 percent), $1 – 4.9 billion (34 percent), $500 – 999 million (13 percent).
- 70 percent of our panel are employees within a Communications Service Provider, consisting of Mobile Services Providers (27 percent), Fixed/Fixed Mobile Providers (19 percent) and Data Services Providers (24 percent).
- 30 percent of are panel are in the professional services field directly supporting CoSPs with expertise in telecommunications, NFV, SDN, or Edge Computing.
- Geographic distribution consisted of: EMEA (34 percent), North America (28 percent), APAC (23 percent), Greater China (12 percent), LATAM (3 percent).