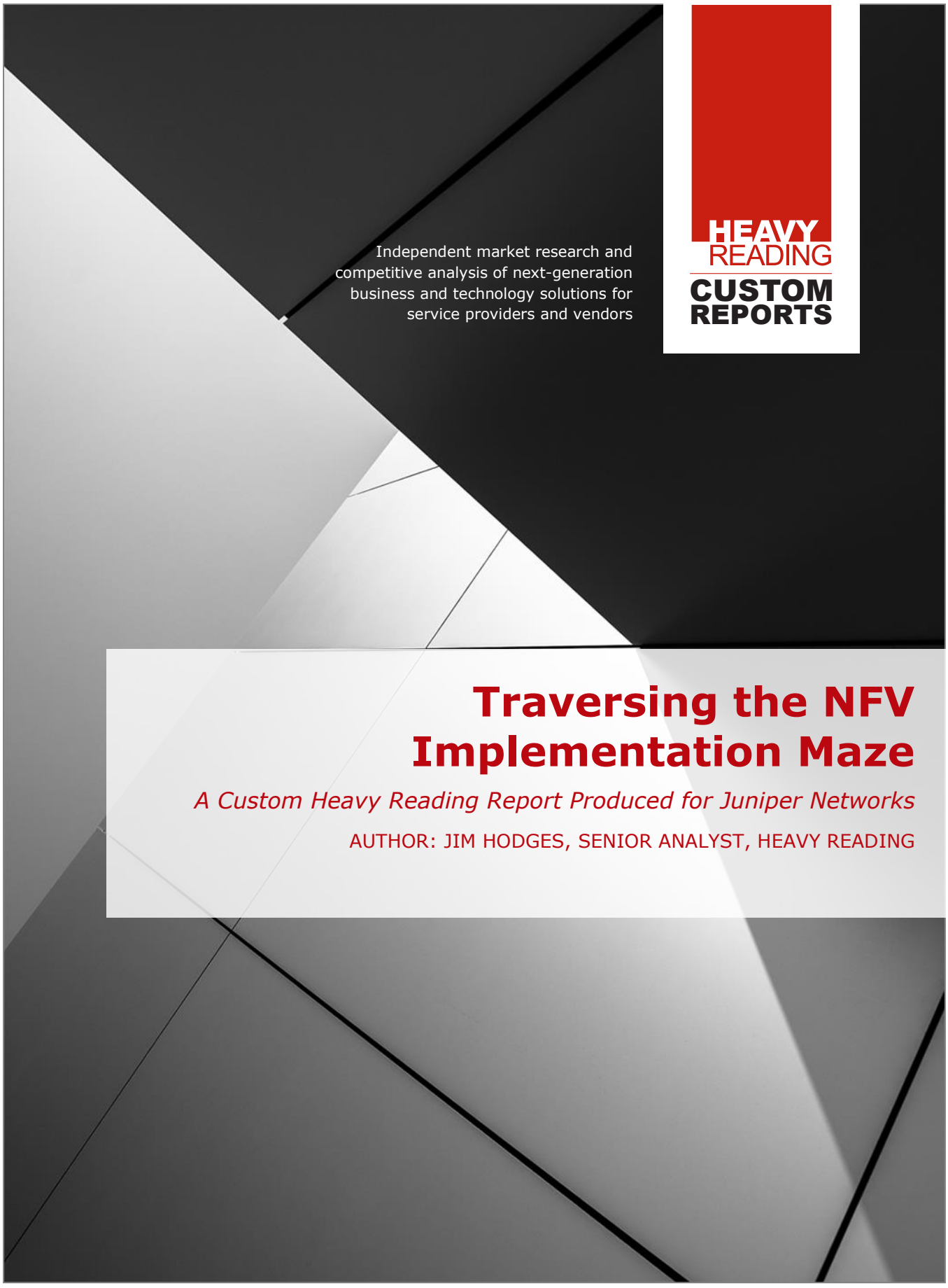

Independent market research and competitive analysis of next-generation business and technology solutions for service providers and vendors

HEAVY READING
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Traversing the NFV Implementation Maze

A Custom Heavy Reading Report Produced for Juniper Networks

AUTHOR: JIM HODGES, SENIOR ANALYST, HEAVY READING

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1. EXECUTIVE SUMMARY

When network functions virtualization (NFV) conceptually arrived on the telecom landscape some four years ago via the first seminal ETSI white paper, it promised to usher in a new era in the design, scale and service delivery models of telecom networks. Predictably, since then, NFV – the disruptively elegant approach for migrating telecom networks to the cloud – has driven a major cycle of change for both network operators and their vendors.

While the promise of NFV has still not been commercially realized on a massive scale, there is little doubt (except among a few outlier iconoclasts) that NFV will be commercialized and will become the architecture template for the next few decades. In fact, 2016 has already quietly witnessed a small number of limited commercial deployments. However, as with any generational technology shifts of this magnitude, there are both business and technology roadblocks to be addressed.

In this case, the degree of change and compressed timeframes lead us to believe that the implementation process for network operators is much less a linear A-to-B journey than it is an exercise in traversing a technology maze in which several key decisions must be correctly made in parallel to avoid a wrong-turn scenario. Accordingly, taking stock and assessing where networks operators are in the maze is a vital exercise to help the industry in general identify logical next steps and formulate corrective action strategies.

Therefore, in conjunction with Juniper Networks, Heavy Reading created a comprehensive survey designed to holistically capture the state of NFV implementation and commercial readiness The survey was distributed by email to Light Reading's global list of communications service provider registrants who were invited to take the survey on the understanding of anonymity (i.e., that the respondents' names, job titles and companies will not be made available to the study's sponsor or eventual readers) and that the results will only be presented in aggregate form. Respondents were not told which supplier sponsored the study.

Key Findings

The key findings of this custom research study are as follows:

On paper, service agility remains the lead driver for NFV, but network operators realize that successful NFV implementations will be achieved only if they can leverage several interrelated capabilities. Network operators view service agility as one link in a chain to help them reduce capex and opex, as well as drive revenue generation. As a proof point, when asked to rank a series of business attributes driving NFV commercial deployment, service respondents scored service agility highest (569 points), followed by reduced opex (523), reduced capex (518), revenue generation (517) and then service automation (463).

What is now emerging is a holistic NFV implementation model that relies heavily on automation, application acceleration policy, third-party software integration, managed services and security capabilities. For example, when asked to pick the top three capex reduction attributes, the top scoring attributes were application development acceleration (90), scalability (81) and open framework/third-party integration (77). Another way to look at this input is that service agility will be tangibly realized by spending less money to support applications, and accelerating service delivery timelines via third-party software integration.

Network operators believe they can leverage NFV to achieve a significant reduction in opex. To achieve this, they are focusing on some of the same attributes, such as application development acceleration and automation/policy control, as well as utilizing centralized service creation and centralized business policy enforcement.

The other advantage operators see in application acceleration is that it will drive new revenue streams. Accordingly, operators of all sizes are focusing on expanding managed service offerings to help push the needle.

Given its disruptive roots, network operators view NFV as having a major impact on both business and operational processes. The process that was top of mind was network resource and infrastructure planning process (59%), followed closely by several other major processes, including deployment of managed services and centralized policy and control (both 52%), network budgeting and investment (51%) and then security (50%).

The impact of security is well documented throughout the survey results. For example, when asked to rank the importance of specific use cases, the leading virtualized network function (VNF) use case was creation of security services (466), followed closed by managed communications services (466), which potentially could include security services (e.g., SECaaS). The next four use cases were software-defined wide area network (SD-WAN) (415), customized managed services (393), virtual customer premises equipment (vCPE) (381) and virtual private network (VPN) services for remote offices (379), which share synergies with vCPE. We view this input as reaffirming the value of managed services, as well as capturing strong levels of interest in deploying SD-WAN and vCPE.

Network operators have already implemented a few select NFV use cases. These tend to be accomplished by Tier 1 operators and in the early going have focused on two use cases: PE router (vPE) and CDN networks (vCDN).

However, looking forward 18-24 months, many more use cases will be deployed by network operators of all sizes. Looking to 2017, the top four production use cases are business virtual CPE (vE-CPE) (29%), consumer vCPE (27%), VNF forwarding graphs (25%) and virtual network platform as a service (vNPaaS) (24%). By 2018, an even greater range of use cases are supported.

Network operators have firm opinions on which capabilities are vital to a successful management and orchestration (MANO) implementation. The top critical attribute by a considerable mark is scalability (64%), followed by automation (53%), agile open network design (51%) and resiliency (49%). Unfortunately, ongoing discussions with network operators identify that many production MANO solutions coming to market are less scalable, less automated and tend to utilize a closed vs. open design. Given this lack of alignment between vital attributes and commercial solution capabilities, it is not difficult to see why MANO has been singled out as an implementation barrier.

vCPE is a highly-ranked implementation use case since it can generate additional revenues and also represents a much lower opex and capex model. From a capex perspective, several attributes previously identified in the generalized capex question, such as automation, accelerated application development and open framework, scored in the top four. However, the clear winner is the ability to leverage a flexible deployment model to reduce capex. Based on scoring utilizing a "pick three" model, this attribute garnered a score of 113, while the next three all fell in the 57-64 range.

On the opex side, vCPE network operators view the ability to leverage automation and policy as the strongest attribute to realize significant opex reduction. The next three were centralized business update and policies enforcement (65), then flexible deployment model (60) and secured service connectivity and application assurance (57). In addition to reaffirming the value of automation in a vCPE context, it is worth noting that automation and policy was also the hands down winner in the general opex reduction question.

vCPE revenue generation attributes are similar to NFV attributes in terms of a lead driver. For example, the ability to accelerate application is the key driver in both. However, reflecting that vCPE has unique requirements the next three are flexible deployment models (66), centralized service creation (66) and support of SD-WAN capabilities (49).

Network operators are still in the process of deciding if there is an optimal vCPE deployment architecture. Based on a small sample of commercial deployments, 14% have chosen the on-premises model, 9% the centralized cloud model and 5% the hybrid model. Looking ahead to 2017, the centralized cloud model scored the highest (26%), followed closely by both on-premises and hybrid both scoring 23%. By 2018, the hybrid model achieved the highest score (33%).

vCPE is also attractive, since it enables the delivery of additional vCPE-based managed security services. Based on commercial deployments, the most popular managed service by a considerable margin is firewall (25%) and then intrusion detection (14%). However, looking ahead only a few months into 2017, the options equalize, as interest and intent to deploy other capabilities, such as content filtering and application security and detection, rapidly gain in popularity.

Despite the technical and business advantages that vCPE delivers, several key implementation barriers remain. The top barrier identified was operations/business support system (OSS/BSS) integration (41%), followed by lack of end-to-end solutions (37%), lack of sufficiently mature solutions (36%) and lack of education and skill sets (32%). With the exception of skill sets, the top three are very much vendor-focused, indicating that network operators expect more from their vCPE vendors. Specifically, they are looking for more mature complete solutions that can be seamlessly integrated into existing OSS/BSS systems.

The three clear drivers for SD-WAN deployment are opex reduction (672), capex reduction (607) and consistent and reliable performance (581).

Network operators are applying a common set of criteria in the vendor selection process. This was validated by asking the survey respondents to apply a common list of criteria to the purchase of vCPE, SD-WAN and security VNFs.

Unfortunately, a previously defined obstacle – the ability to support OSS/BSS integration – is a top three consideration in all cases. The other criteria that scored highly are virtualization product roadmap, commitment to open source for vCPE (42%), proof-of-concept (PoC) trial performance for both security and NFV solutions (46% + 44%) and price for SD-WAN (46%). The takeaways of this input are quite clear. OSS integration and product roadmaps are critical factors across the board. In addition, price and PoC performance remain important decision points as is commitment to open source.

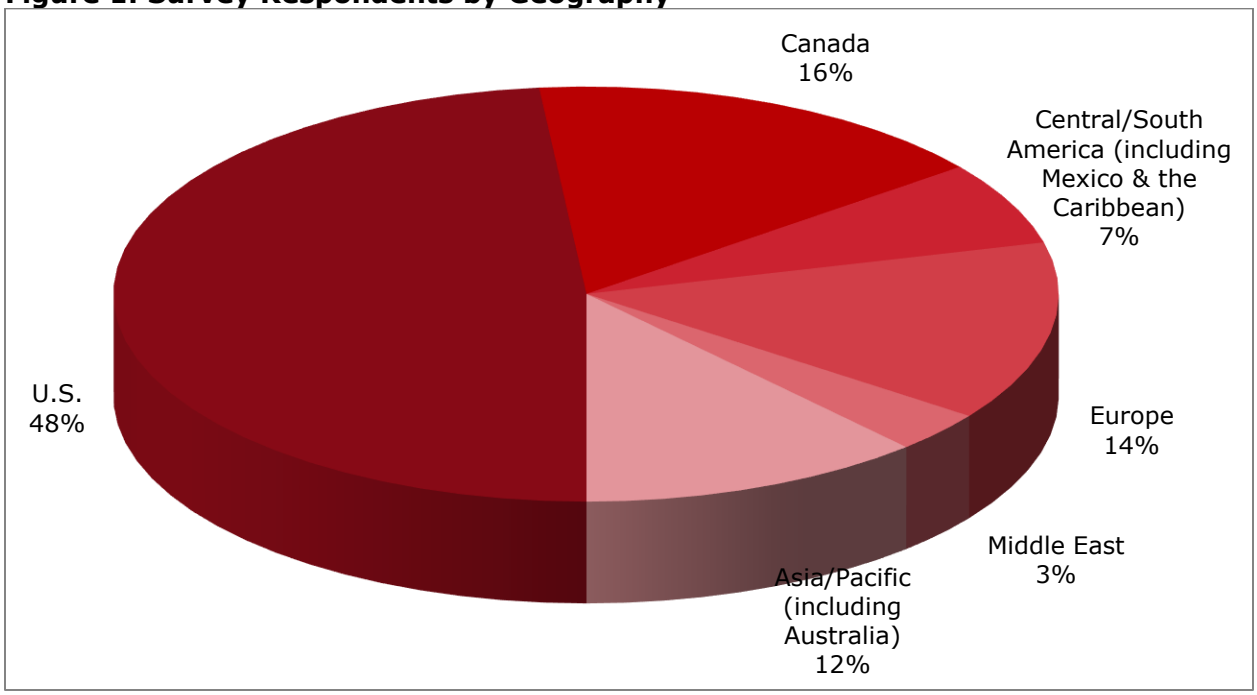
We consider the inclusion of open source support as a criteria for vCPE vendor selection as significant. We view it as reinforcing our view that open source is continuing to gain momentum. It's not yet a ubiquitous criteria attribute, but is starting to crack the top three lead by Tier 1 operators who are driving the first implementation wave.

2. SURVEY DEMOGRAPHICS SUMMARY

This report is based on a major online survey launched in the second quarter of 2016 to assess the drivers, challenges and impacts of NFV commercialization.

The survey contained a total of 30 questions and was promoted to attract a large base of qualified and high-value communications service provider respondents. As shown in **Figure 1**, the survey attracted a global mix of 93 qualified respondents. The largest sample was from the U.S., followed by Canada, Europe, Asia/Pacific, Central/South America and the Middle East.

Figure 1: Survey Respondents by Geography



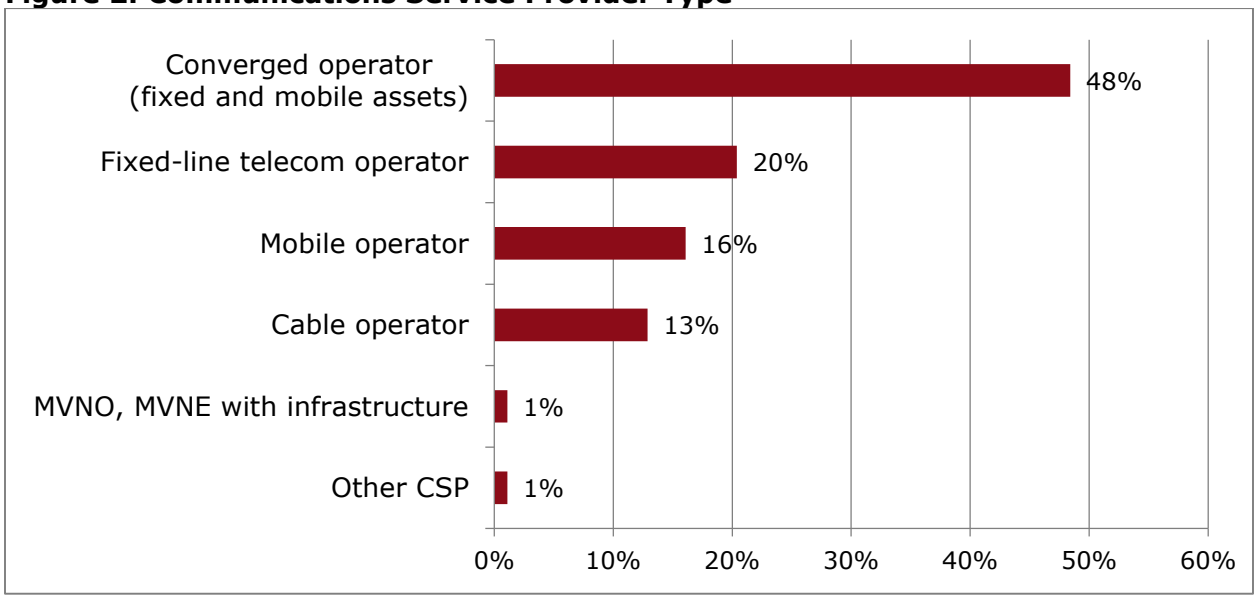
Question: Where is your company located? (N=93)

The survey utilized several demographic questions, including the type of service providers the respondents worked for. As shown in **Figure 2**, 48% of respondents were employees of converged operators, 20% were from fixed line operators, 16% from pure-play mobile operators and 13% from cable operators. We view this an optimal mix since NFV cuts across all network types, but also presents several unique implementation challenges depending on underlying access technology.

In addition, these respondents performed diverse roles in their organizations. As shown in **Figure 3**, these include R&D, IT data center and cloud, sales and marketing. However, the largest group (44%) worked in network planning and engineering teams, while the next largest group (22%) worked in R&D and technical strategy teams.

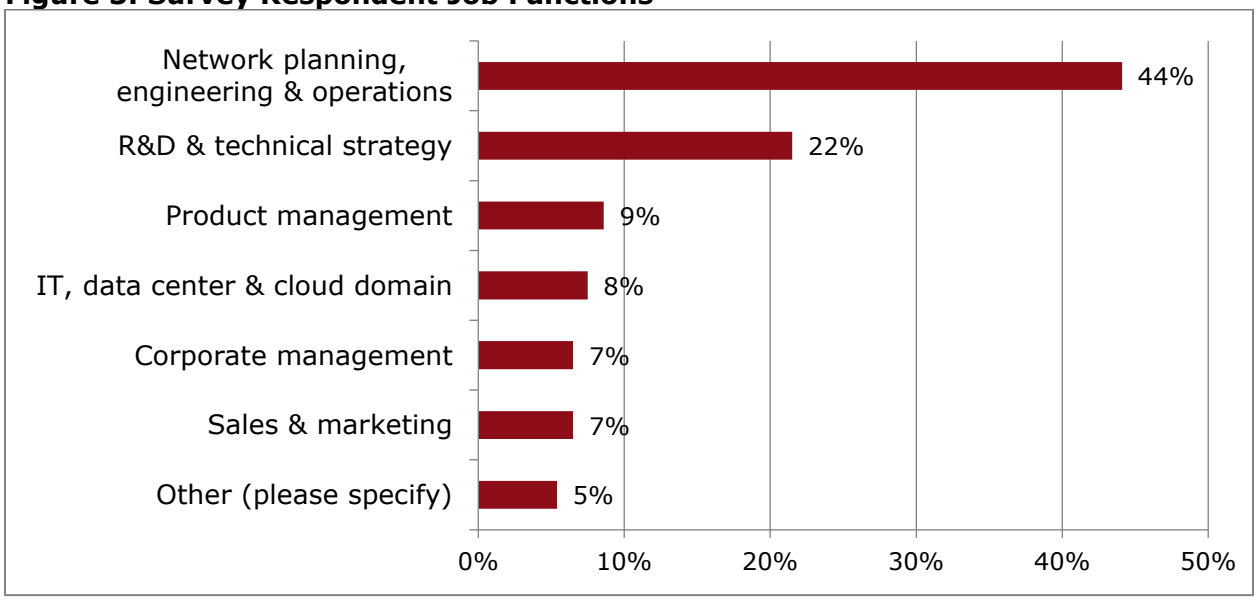
We feel this heavier weighting of technical resources is ideal for this survey, since this research project was heavier on the technology side given it addressed in detail technical issues, use cases and decisions that have to be made to take NFV implementations from PoC to production environment.

Figure 2: Communications Service Provider Type



Question: What type of network service provider do you work for? (N=93)

Figure 3: Survey Respondent Job Functions



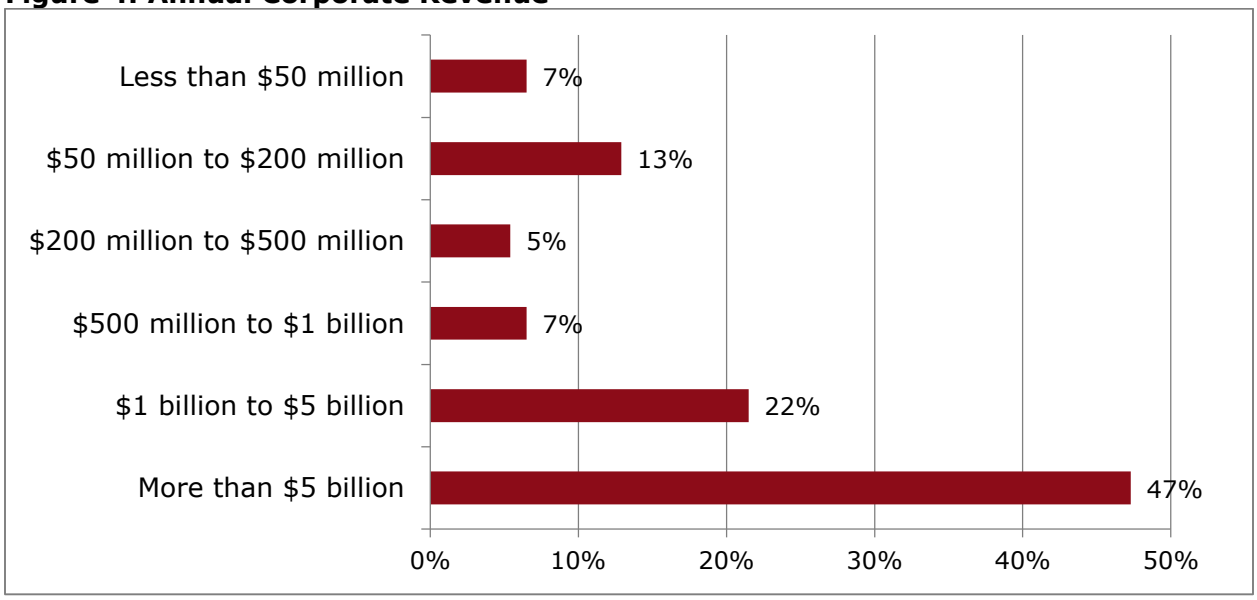
Question: What is your primary job function? (N=93)

The final demographic question addressed the size of network service provider the respondents worked for. As shown in **Figure 4**, based on revenues, almost half (47%) worked for Tier 1 operators, while the other 53% were spread among fairly uniformly among Tier 2 and Tier 3 operators. Essentially, we consider 29% to fall into the Tier 2 category (22% + 7%) and 25% to fall into the Tier 3 market (5% + 13% + 7%).

In order to assess response sensitivity based on network operator size, we filtered survey input using two similar sized groups of respondents. These are the Tier 1 (more than $5 billion) (47%) and Tier 2/3 (all other revenue categories) (53%) filter groups. Although we

provide a high-level assessment of differences and similarities in the responses of these two groups in the main body of this report, detailed comparative tables for all questions are provided in **Section 4**.

Figure 4: Annual Corporate Revenue



Question: Annual revenues of your company? (N=93)

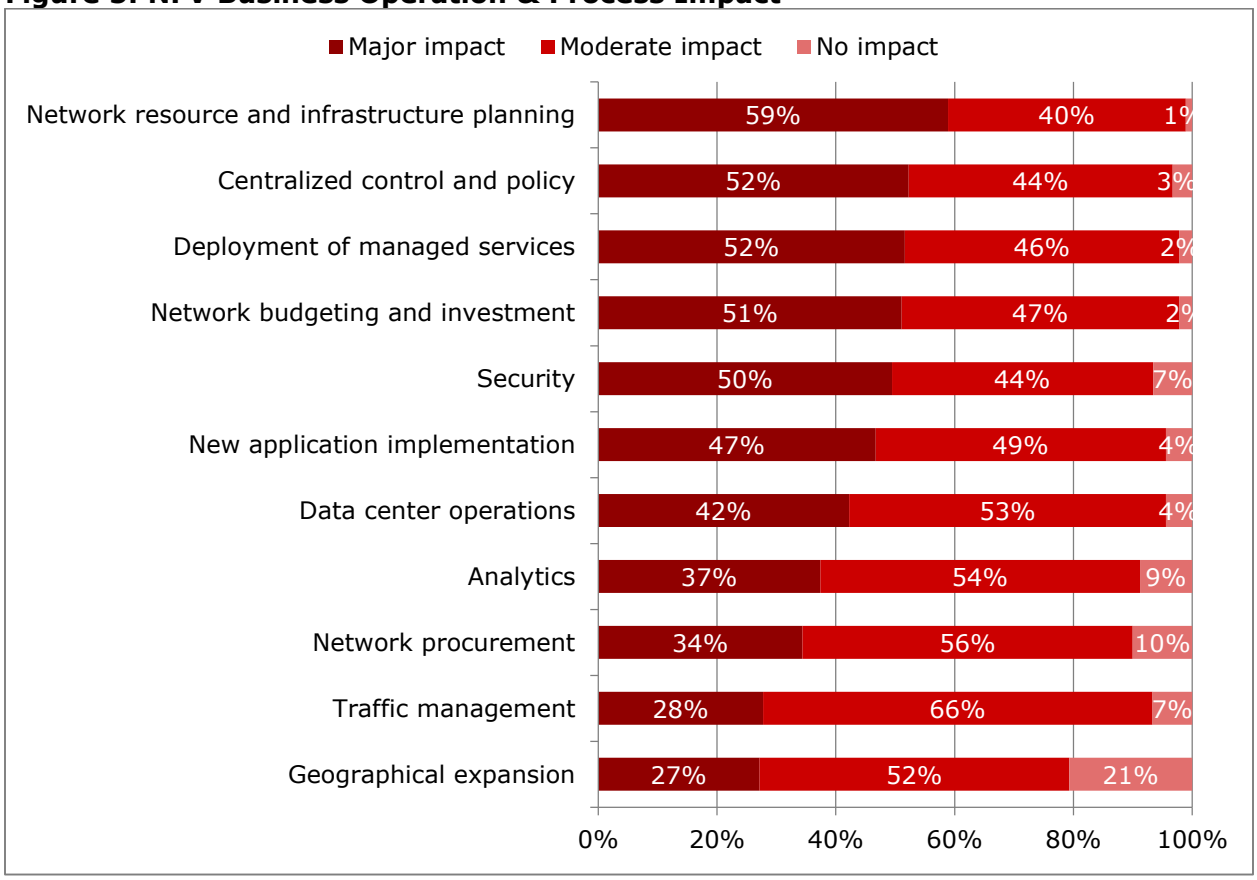
3. IMPLEMENTING NFV: THE FIVE Ps

As noted in the introduction, implementing NFV is a complex undertaking since it fundamentally alters network operator models at essentially all levels. As a result, in order to capture the "big picture," the survey addressed what we view as the 5 "Ps" that any implementation plan must consider. These are:

- **Process:** The impact of NFV on business and technical processes
- **Profit:** How to exploit the cloud to drive new revenue streams while reducing opex and capex
- **Priorities:** Developing a list of virtualization use case priorities
- **Production:** Creating a carrier specific live production implementation schedule that aligns with the defined process and priorities
- **Proposal:** Defining the key metrics that will be utilized to ultimately select a vendor to fulfill a request for proposal (RFP)

Starting first on a process level, as shown in **Figure 5**, it is readily apparent that NFV commercialization impacts business processes on many levels.

Figure 5: NFV Business Operation & Process Impact



Question: How much impact will NFV have on the following business operations and processes at your company? (N=90-92)

Focusing on major impact levels, the highest scoring input logically was the network resource and infrastructure planning process itself (59%), followed closely by several other major processes, including deployment of managed services and centralized policy and control (both 52%), network budgeting and investment (51%) and then security (50%).

As noted previously, the survey attracted a large technical base of respondents, which we believe is one reason why technical-driven processes (including security) scored highly. But these respondents also recognized that, in addition to operational processes, business processes were significantly altered. In our view, this point is reinforced by the ranking of the managed services model, since it is clear that many network operators view the multi-tenant nature of the cloud as an important attribute for driving new revenue streams via managed services (e.g. vIMS, UCaaS).

Moreover, we are encouraged with the operational process impact of centralized control and policy since it aligns with our view that the exploiting the cloud will mandate the introduction of a more powerful policy control model both for customer experience and network control to enforce end-to-end security policies.

Using our two filter groups based on major impact input, the top three inputs for Tier 1s were deployment of managed services (61%), centralized policy and control (61%) and network resource and infrastructure planning (61%).

Tier 2/3 operators saw things a little differently; they ranked deployment of managed services lower (38%). However, these operators also viewed network resource and infrastructure planning (57%) and centralized control and planning (44%) as top three worthy. It's also worth noting that security scored relatively highly in both demographic groups (57% and 43% respectively).

The other key component of measuring business process impact is documenting the impact of NFV-related business drivers.

Seemingly since Day 1, the key business driver for NFV has been the ability to streamline business processes to shorten introduction of new services and even shorten procurement cycles. The outcome of tying together these attributes to drive new revenue streams, including the managed services model, which scored highly in the previous section, became generally known as service agility.

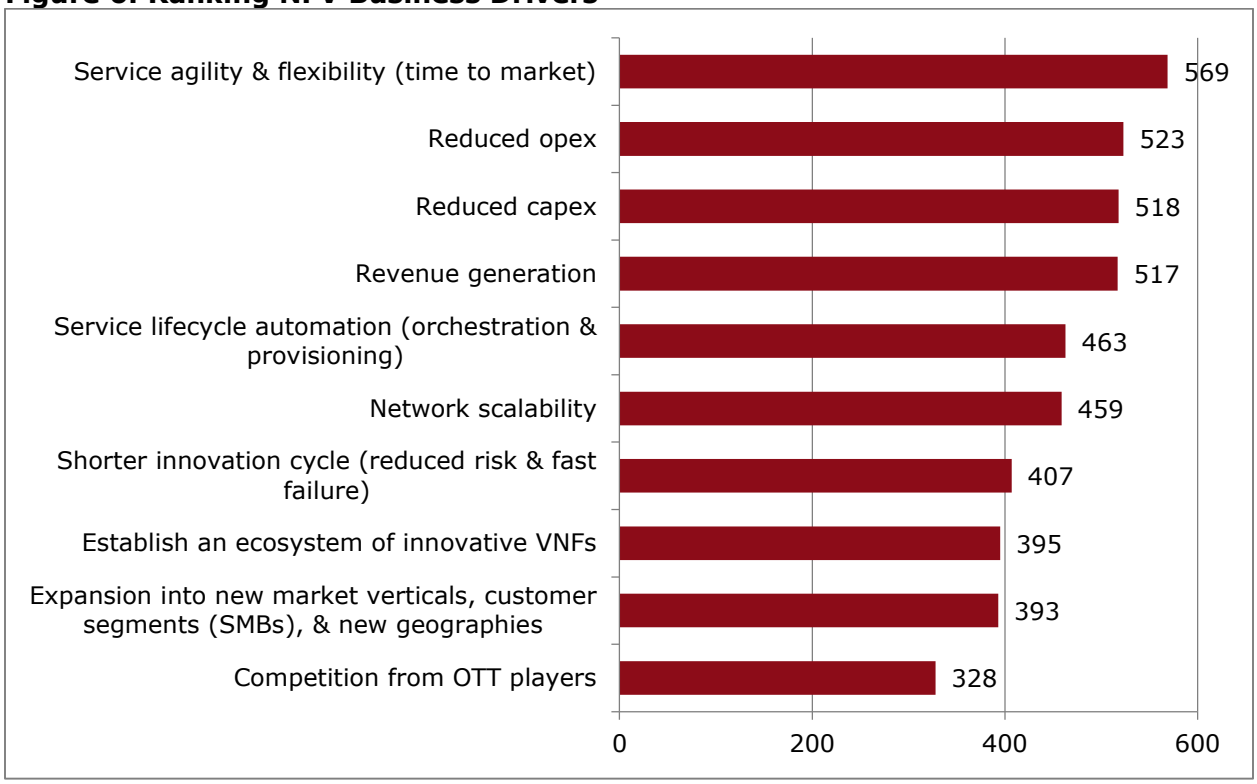
Even after a whirlwind four years of trials, ecosystem expansion and sprouting of new technical alliances, the promise of agility still remains the key business driver, as shown in **Figure 6**.

For example, when asked to rank a series of business attributes, using a ranking score methodology (10 points for a first-place ranking 1 point for a tenth-place ranking) service agility scored the highest (569 points), followed by reduced opex (523), reduced capex (518), revenue generation (517) and service automation (463).

Utilizing our two filter groups, Tier 1 and Tier 2/3 priorities are fairly similar. Both groups see service agility as the lead driver and place opex and capex reduction in the top four. However, Tier 1s consider lifecycle automation a top three consideration while the Tier 2/3 rank it in sixth place. Both believe (rightly or wrongly) that competition from over-the-top (OTT) players is their lowest concern.

Generally, we the view the close scoring of these top five as reinforcing that, while agility is still the most powerful business driver, to thrive in a live production model will require less spending and more revenue generation.

Figure 6: Ranking NFV Business Drivers



Question: Please rank the following NFV business drivers based on the level of impact they are likely to have at your company (N=91-92)

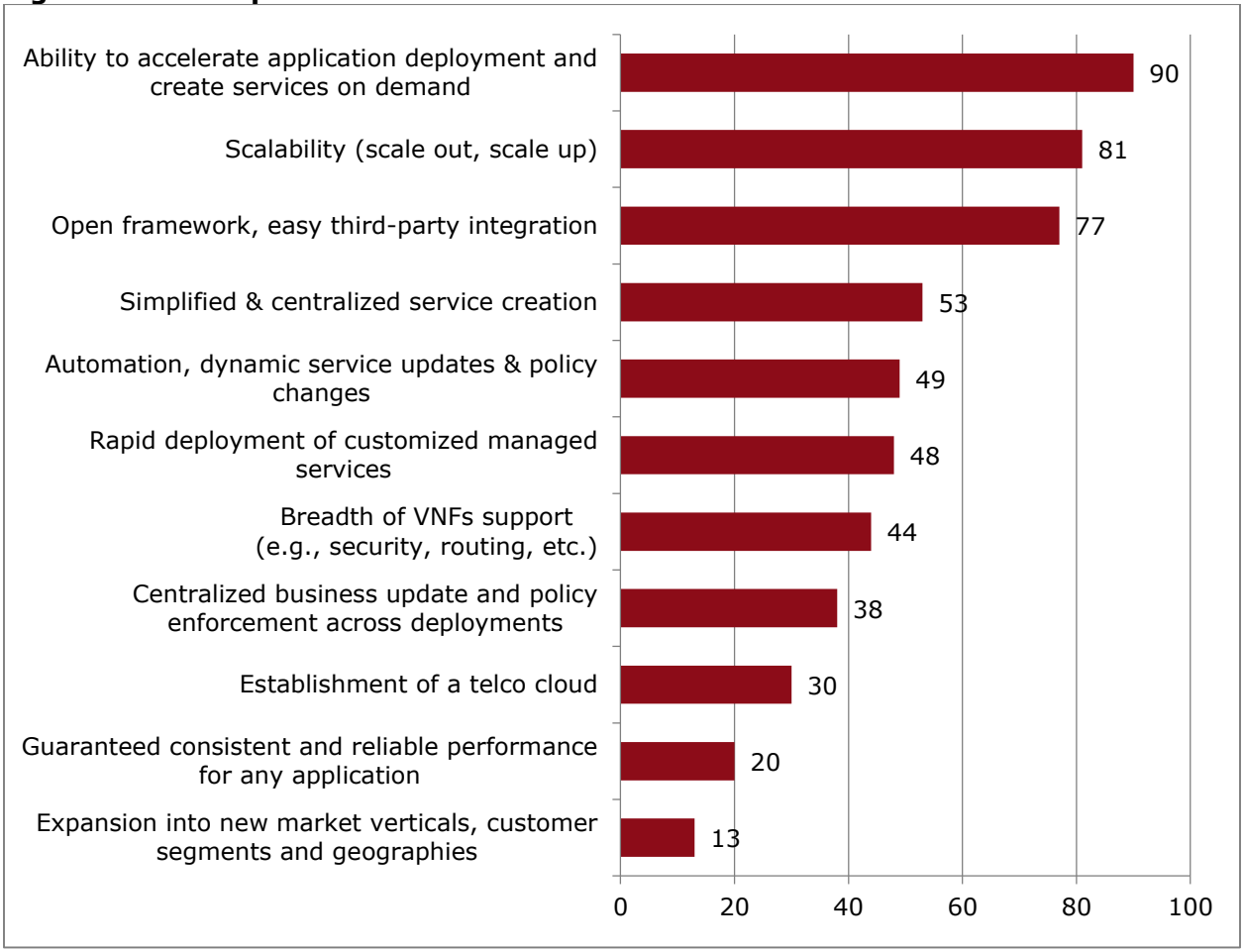
The high ranking of capex and opex reduction is also consistent with previous research, so a key part of the process focus of the survey was to understand in more detail the relative importance of a broad range of attributes and their ability to meaningfully reduce capex.

As shown in **Figure 7**, when asked to pick the top three capex reduction attributes, the top three scoring attributes were application development acceleration (90), scalability (81) and open framework/third party integration (77), followed by centralized service creation (53) and automation/service updates and policy changes (49).

We also noted a considerable amount of similarity in the rankings between the two filter groups. In both groups, scalability and application acceleration ranked as top three considerations. For Tier 2/3 respondents, open framework was the top consideration vs. a fourth-place ranking for Tier 1s. These same Tier 1s in turn ranked centralized service creation as a third-place consideration vs. a seventh-place ranking by Tier 2/3 operators.

We believe this data point reinforces the view that there is a direct link between service agility and reduced capex. However, in our view it also indicates that further meaningful capex reduction can be achieved by adopting more aggressive third-party software integration models, supported by automated centralized service creation processes.

Figure 7: NFV Capex Reduction Attributes



Question: Which three NFV attributes are the most important for capex reduction? (N=92)

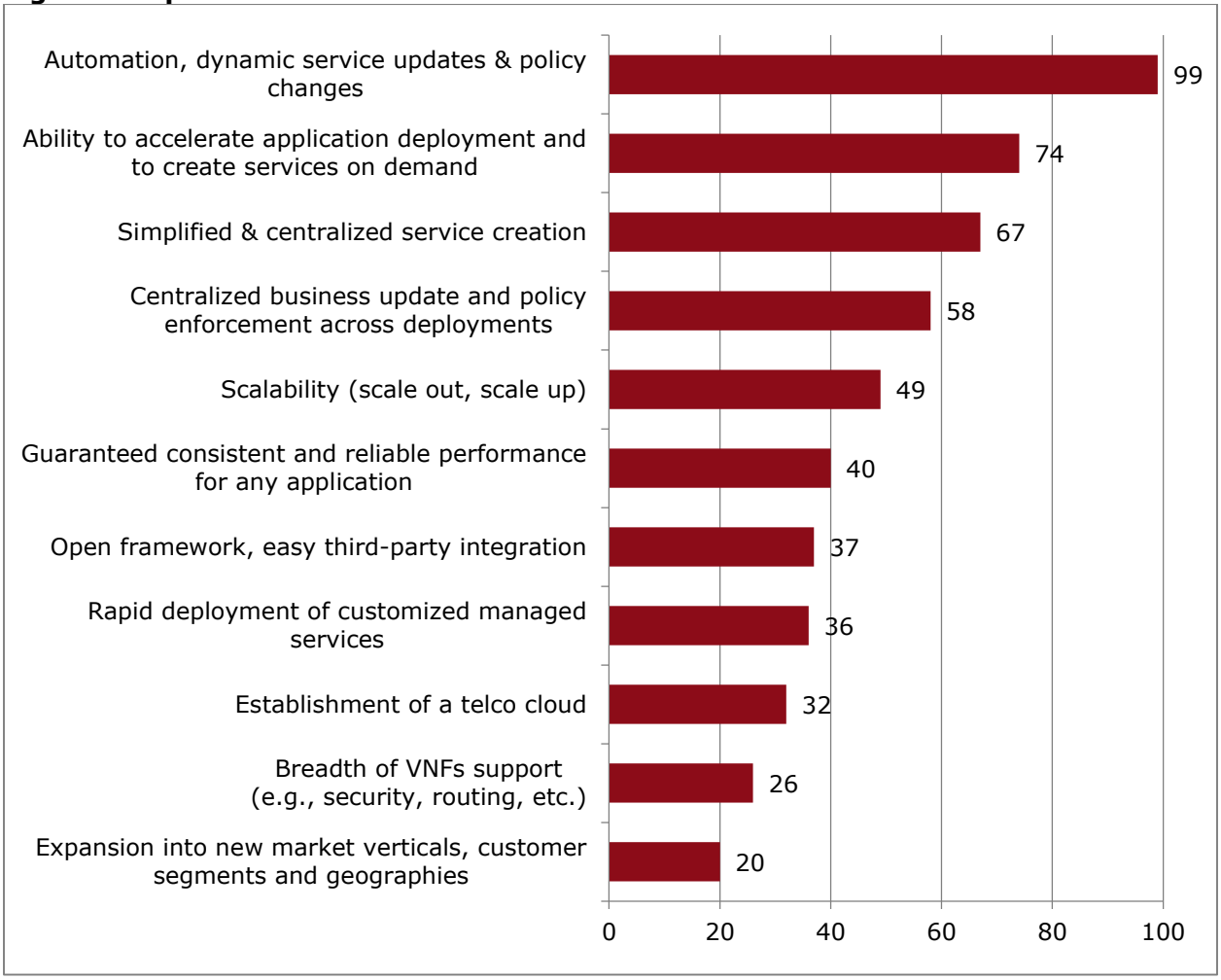
We also wanted to explore the opex implications of NFV process improvement. In order to provide a template for comparing the inputs we leveraged the same group of attributes from the previous section. Not surprisingly, given the differences between capex and opex, the inputs were different.

Still, in terms of criteria, as shown in **Figure 8**, the inputs are not radically different in that four of the previous top five attributes are still relevant. Instead, the top five inputs in an opex context are automation/service updates and policy control (99), application development acceleration (74), centralized service creation (67), centralized business policy enforcement (58) and scalability (49). Only open framework/third-party integration fell out of the top five (from second to seventh).

There was also a considerable degree of similarity in these results in the two filter groups. For both groups, while the ordering was somewhat different, application acceleration, automation and simplified and centralized service creation were top three considerations,

Again we are encouraged that the survey respondents have a clear sense of the opex implications of NFV, including grasping the positive impact that end-to-end policy and automation can exert.

Figure 8: Opex Attributes



Question: Which three NFV attributes are the most important for opex improvement? (N=92)

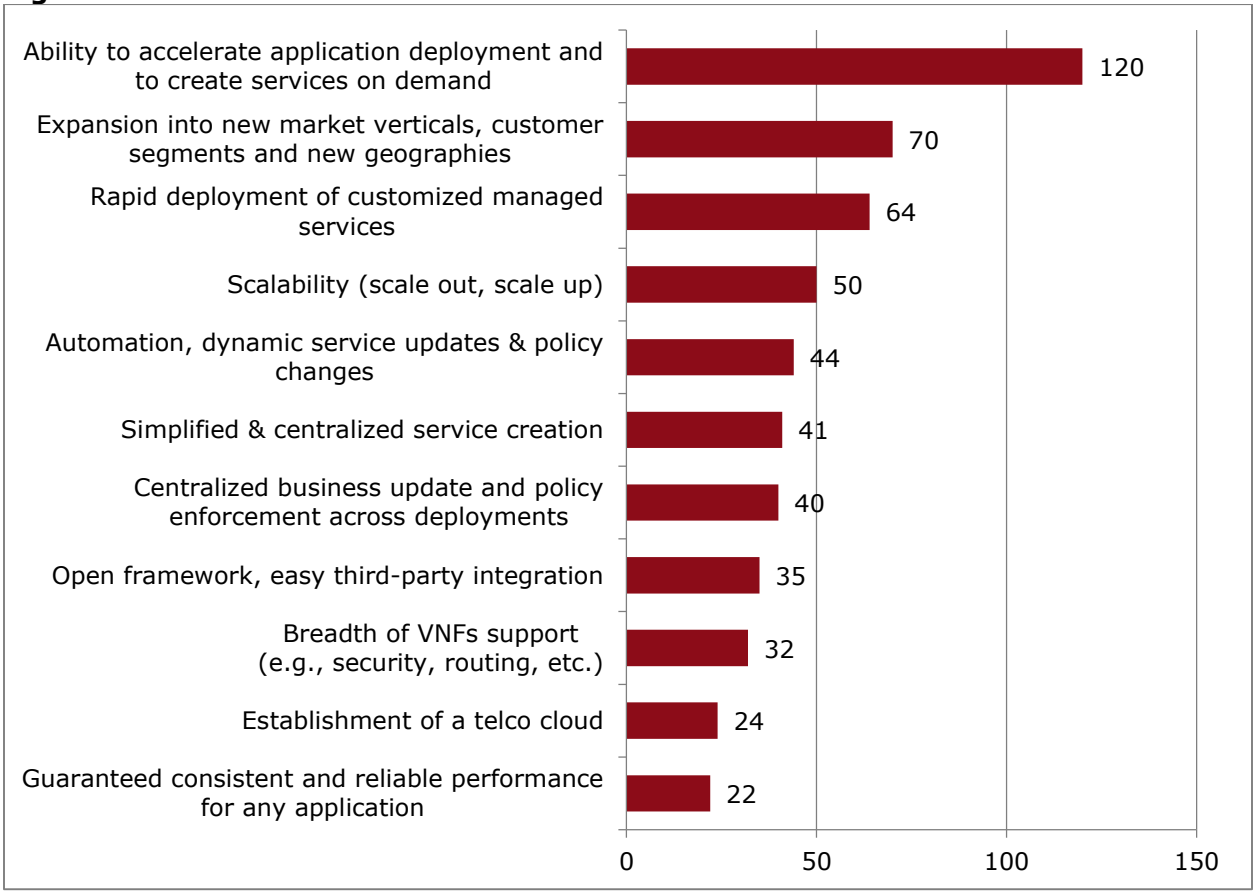
In order to facilitate a seamless shift from *process* to *profit*, we asked the respondents to rank these same attributes in a revenue generation context.

As shown in **Figure 9**, the top runner remained application acceleration (120), scoring well ahead of several new factors, including market expansion (70), customized managed services (leveraging the multi-tenant XaaS cloud) (64), and two familiar key support capabilities – scalability (50) and dynamic policy (44).

The rankings between the two filter groups was also very similar. Both groups ranked application acceleration and market expansion as first and second priorities. Both also ranked scalability as a fourth-place priority. While Tier 2/3s ranked automation and policy as third-place consideration, it was an eighth-place consideration for Tier 1s.

Based on these inputs we conclude that network operators are strongly focused on accelerating a cloud driven service on-demand model both in existing markets, but also extending the model into new market verticals to achieve even loftier revenue generation targets.

Figure 9: Revenue Generation Attributes



Question: Which three NFV attributes are the most important for revenue generation? (N=92)

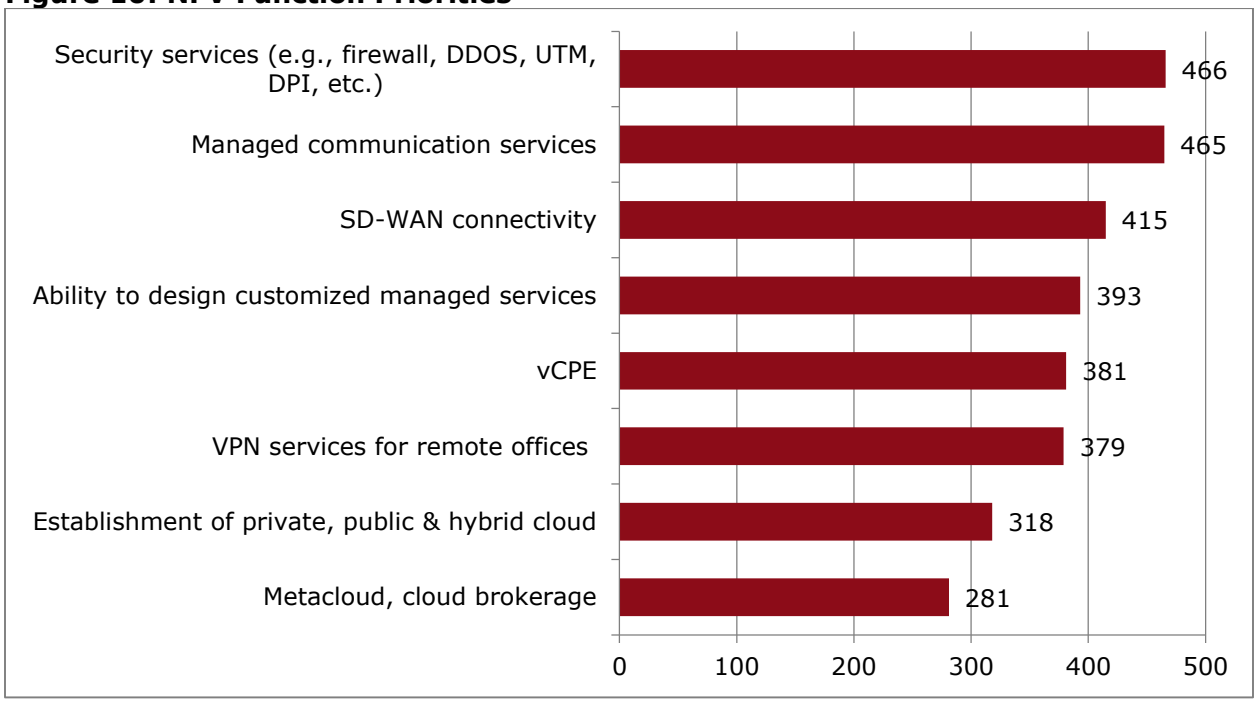
In the next section of the survey we shifted focus to NFV *production* and *priorities*. Starting first with priorities, the goal was to develop a more granular view of which VNF-based use cases they believed could best help them meet their *process* and *profit* goals.

Utilizing the same ranking system approach (in this case a first-place vote = 8 points and an eighth-place vote = 1 point) as shown **Figure 10**, the top VNF use case was creation of security services (466), followed closed by managed communications services (466), which include a range of services (e.g., vIMS, UCaaS, hosted voice, SECaaS).

The next four use cases were substantially behind, but closely grouped. These were SD-WAN (415), customized managed services (393), vCPE (381) and VPN services for remote offices (379), which share synergies with vCPE. We view this input as closing the loop on several levels. First, it reinforces the security process ranking (see **Figure 5**) and confirms the value of managed services, as well as the perceived generalized strong levels of market interest in deploying SD-WAN and vCPE.

Looking at the in the input using our two filter groups there was also a considerable degree of similarity. In both groups, managed communication services and security services were top three considerations. SD-WAN achieved a second place ranking with Tier 1s, while Tier 2/3s viewed it as a fifth-place consideration.

Figure 10: NFV Function Priorities



Question: VNFs are specific network functions that run on one or more virtual machines (VMs), on bare metal servers or on physical networking infrastructure. Please rank the following VNFs in order of importance to your company (N=90)

As noted, network operators have well-defined implementation priorities on how to leverage VNFs in the cloud. The next logical question is how well established are their strategies with respect to granular *production* commercial grade use cases.

Accordingly, assessing readiness is the focus of the next section of the survey. To achieve this, we asked respondents to provide insight into which use cases had been deployed or would soon be deployed. To facilitate the process, we provided respondents with a detailed list of specific use cases. While some were unique to specific operator types (e.g., mobile vs. cable), the majority were germane to all network operators.

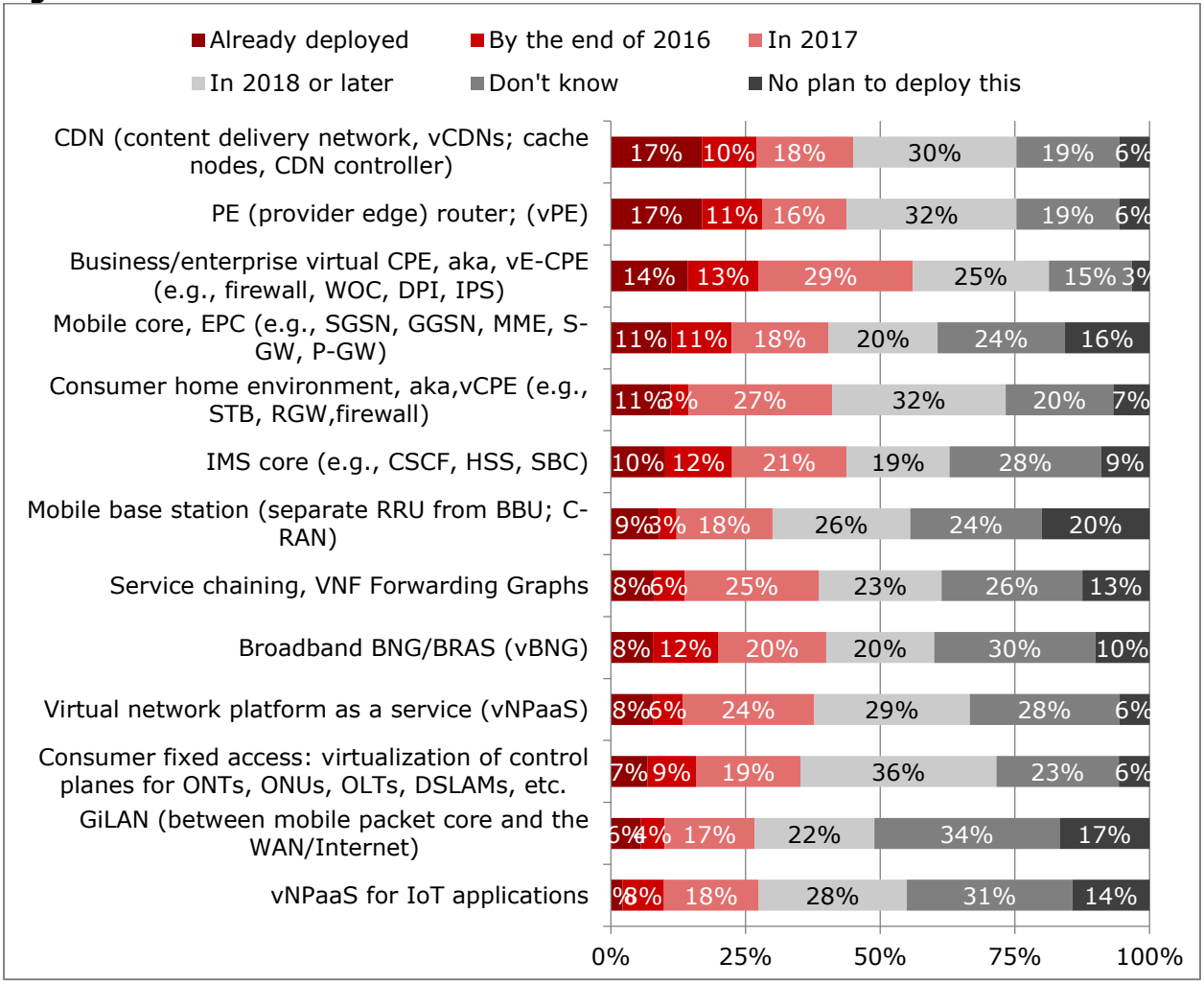
As we had anticipated, a small number of use cases have been deployed in a live commercial production environment (see **Figure 11**). Reflecting the fact that these are very early, first-wave deployments, they tend to fall into the 2% to 10% range, with a few reaching up to 17%. Two use cases hit this mark: **PE router (vPE)** and **CDN networks (vCDN)**. While the ranking of vCDN was somewhat surprising, we believe it can be attributed to several factors, including the exponential scale requirements of video caching, as well as the requirement to interconnect with OTT operators, such as Google and YouTube, which already utilize a cloud-based CDN approach.

However, **Figure 11** also shows that network operators, based on 2016 production commitments, see a number of additional opportunities. These include business vCPE (13%), vBNG (12%) IP Multimedia Subsystem (IMS) core (12%) and mobile core (11%). Yet, to be clear, the spreads are not that impactful, since several other use cases, some carrier-specific (e.g., OLTs and DSLAMs for fixed operators) or vNPaaS, achieved scores of 9% and 8% respectively.

Among our two filter groups Tier 1s have already deployed use cases in greater numbers. This trend continues in 2016 and 2017 as well. However, priority wise, both groups tend to rank vPE, CDN and vE-CPE highly.

Looking to 2017, the top four production use cases are business virtual CPE (vE-CPE) (29%), Consumer vCPE (27%), VNF forwarding graphs (25%) and vNPaaS (24%), which is consistent with the strong interest shown in managed services and vCPE. But overall, given the spreads are limited and become ever more closely aligned in 2018, we view this input as reinforcing that NFV migration remains a carrier specific journey with its own set of decision points and paths to successfully traverse the NFV implementation maze.

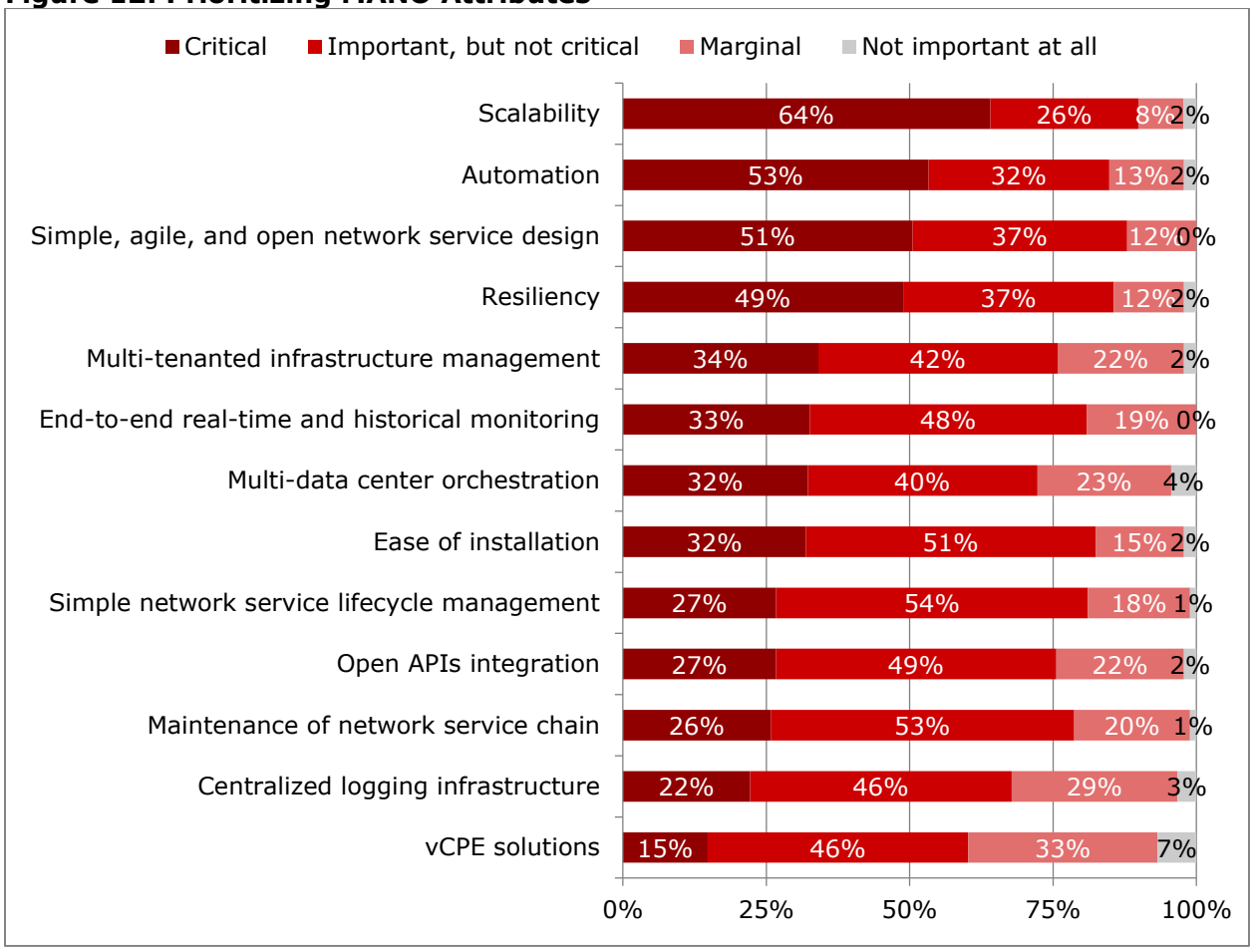
Figure 11: NFV Production Use Cases



Question: When does your company expect to deploy NFV commercially for the following use cases in a production environment? (N=88-91)

One topic that has been swirling around the past 12-18 months as a potential production showstopper is the NFV MANO layer. Given the implications, the survey included a question designed to investigate which MANO features were critical to ensure production viability. As shown in **Figure 12**, the top critical attribute by a considerable margin is scalability (64%), followed by automation (53%), agile open network design (51%) and resiliency (49%).

Figure 12: Prioritizing MANO Attributes



Question: The NFV MANO layer, as defined by the ETSI, provides an architectural framework for management and orchestration of all resources in the cloud data center (compute, network, storage), distributed virtualized infrastructures, NFVI, VNFs and network services. Please rate the importance of the following attributes to NFV MANO. (N=89-92)

Looking at the input using our two filter groups, we observed a strong degree of similarity. For example, Tier 1s ranked scalability, open network design and automation as the top three considerations, while the Tier 2/3s ranked scalability, resiliency and automation in the top three.

We find these rankings quite insightful, since the traditional roadblocks we hear from network operators trying to launch a production MANO is inability to scale, difficulty integrating open source technology and lack of automation. Given this lack of alignment between desired attributes and commercial solution capabilities, it is not difficult to see why MANO has been singled out as the lead implementation problem child.

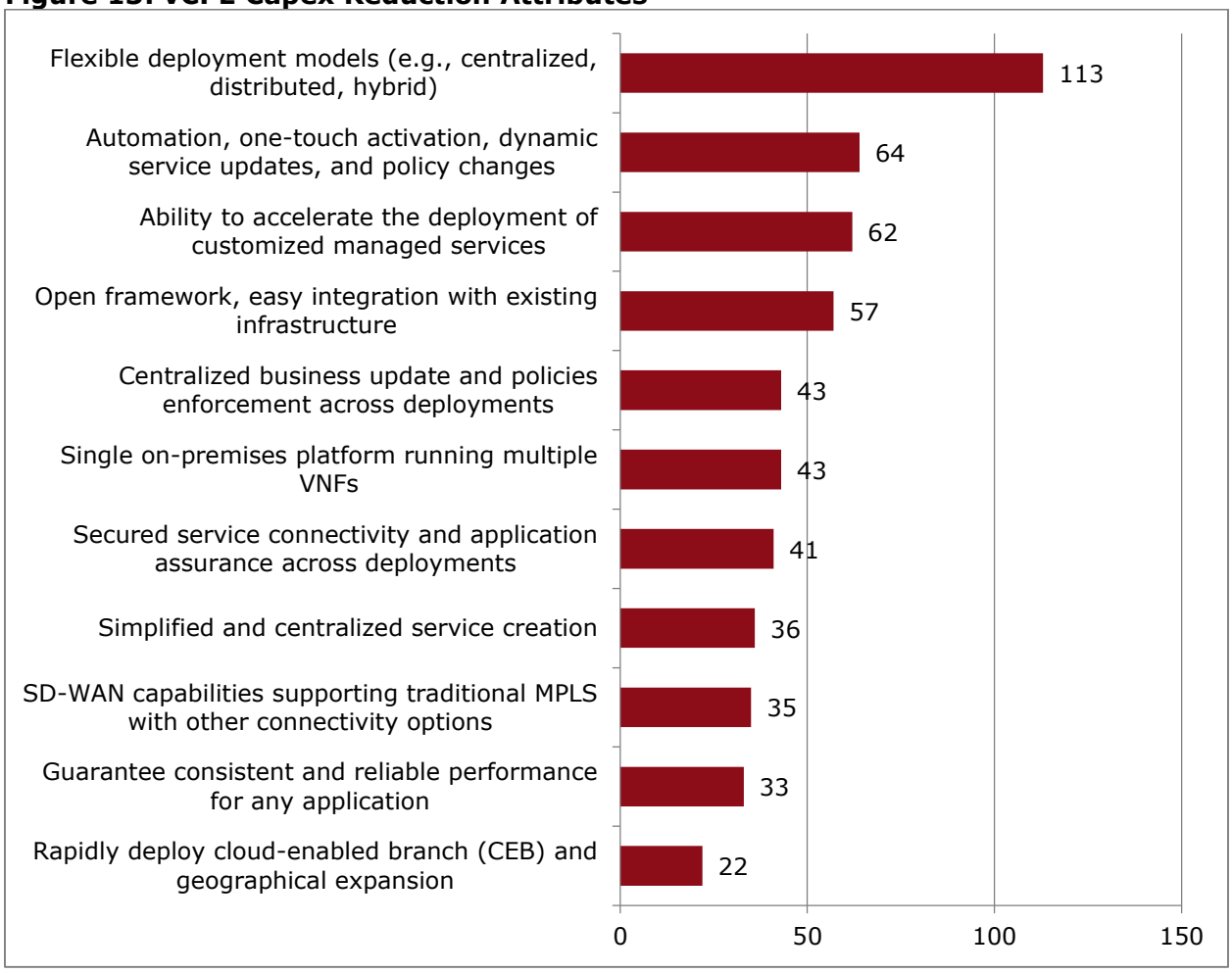
In the next section of the survey, we investigated three specific use cases in more detail to tie together some of the research threads. Of course we did not know when we created the survey that the SD-WAN, vCPE and security related use cases would score well, but given Juniper's market focus there was considerable interest in understanding specific drivers and production deployment timeframes.

The high scoring of these use cases served to make the research even more relevant and compelling. The starting point was vCPE and specifically the attributes that are critical to achieving capex reduction.

Interestingly, as shown in **Figure 13**, several attributes previously identified in the generalized capex question (see **Figure 7**), such as automation, accelerated application development and open framework still scored in the top four.

However, the clear winner is the ability to leverage a flexible deployment model to reduce capex. Based on scoring utilizing a "pick three" model, this attribute garnered a score of 113, while the next three all fell in the 57-64 range. In terms of filter group input, Tier 1s and Tier 2/3s both considered flexible deployment models as the clear top attribute.

Figure 13: vCPE Capex Reduction Attributes



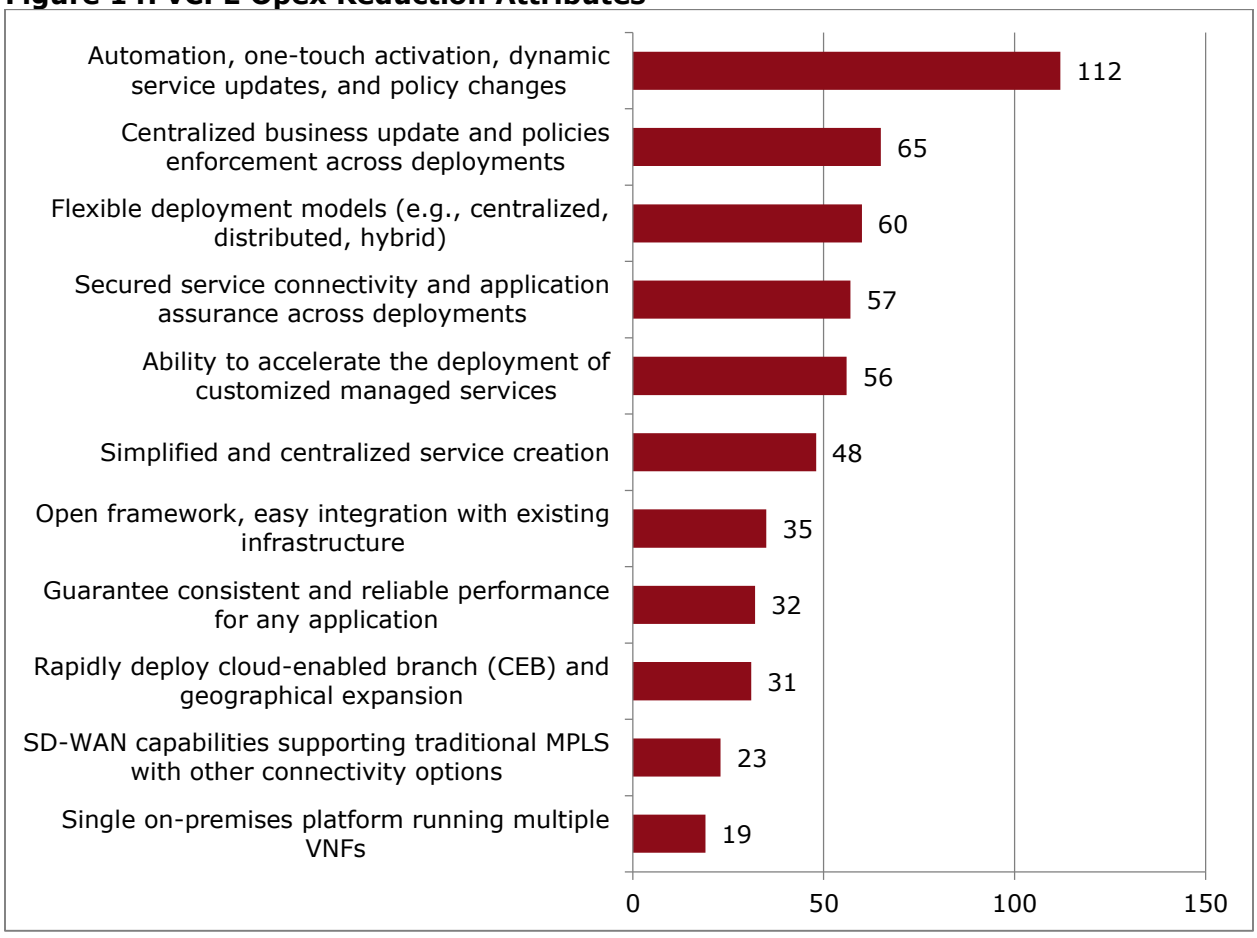
Question: vCPE moves functions usually embedded in network appliances at a customer's site into VNF software that can run on commercial-off-the-shelf (COTS) server hardware, including routers, WAN optimization controllers, firewalls, IDS/IPS and VPNs. vCPE offers the ability to deploy VNFs in several locations, including on-premises at customer or branch locations, centralized at carrier data centers or in the cloud and a hybrid model consisting both on-premises and centralized. Which three vCPE attributes are most important for capex reduction? (N=93)

The next question followed the same approach, but asked survey respondents to provide input of key *opex* reduction attributes. As shown in **Figure 14**, utilizing this same pick three approach, automation and policy was the clear winner with 112 points.

The next three were centralized business update and policies enforcement (65), then flexible deployment model (60) and secured service connectivity and application assurance (57). In addition to reaffirming the value of automation in a vCPE context, it is worth reinforcing that automation and policy was also the hands down winner in the general opex reduction question (see **Figure 8**).

In terms of filter group input, automation and policy was the top attribute for both. Centralized business update and policy enforcement was either a top two or top three consideration for them as well. SD-WAN was the lowest ranking attribute for Tier 2/3s, but achieved a fifth-place ranking by Tier 1s.

Figure 14: vCPE Opex Reduction Attributes



Question: Which three vCPE attributes are most important for opex reduction? (N=91)

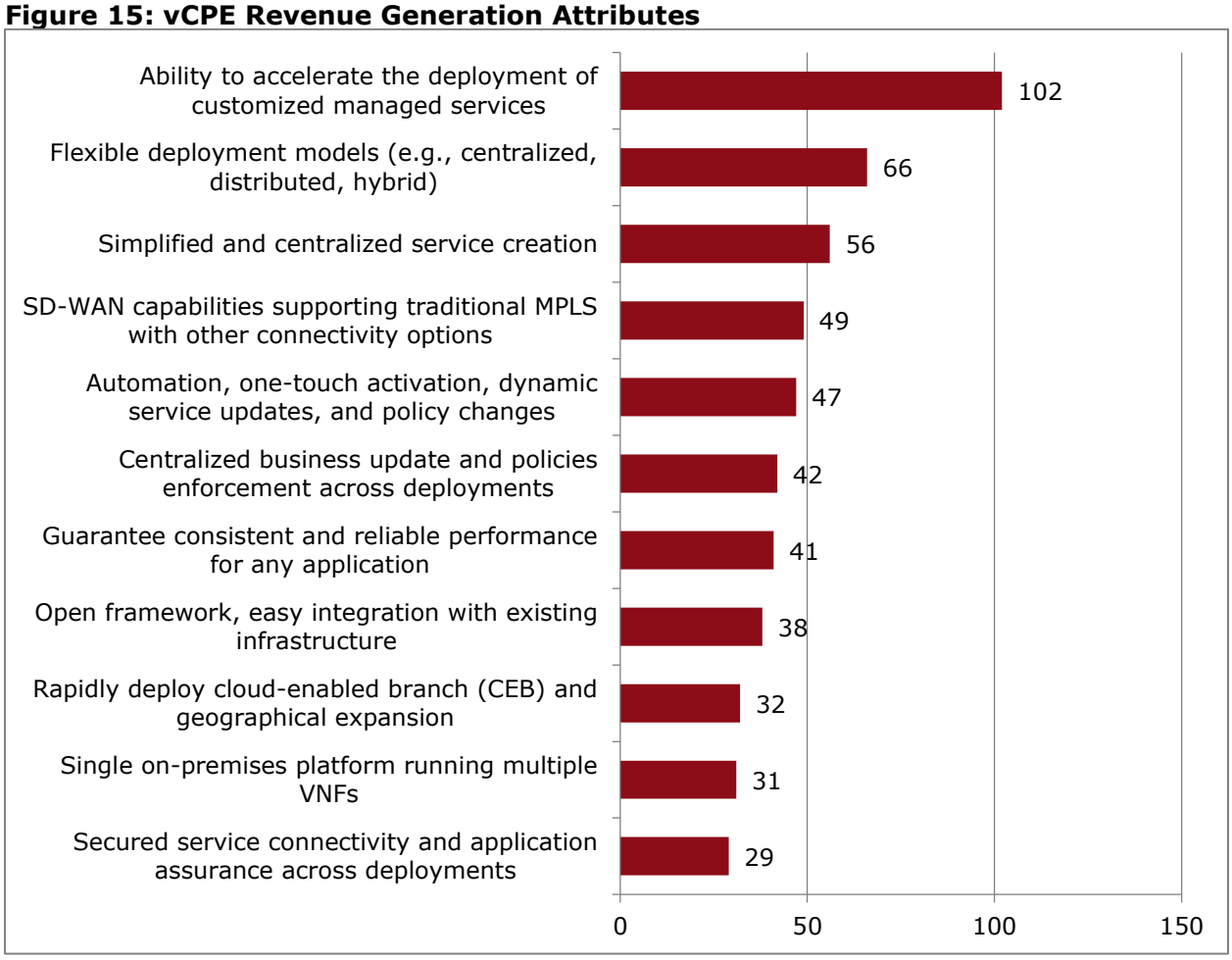
The next vCPE question addressed specific revenue-generation attributes. The intent of this question was to map vCPE attributes to the more general NFV revenue generation attributes (see **Figure 9**). As shown in **Figure 15**, the vCPE revenue generation attributes are similar to NFV attributes in terms of a lead driver. For example, the ability to accelerate application is the key driver for both (120 vs. 102).

However, reflecting that vCPE has unique requirements the next three are flexible deployment models (66), centralized service creation (66) and support of SD-WAN capabilities (49). This is not too surprising given we have observed flexible deployment and centralized service creation score highly in other questions as well.

Both filter groups saw the ability to accelerate deployment of managed services as the top priority. SD-WAN and automation rounded out the top three responses for Tier 1s, while Tier 2/3s chose flexible deployment models and centralized service creation.

This input in our view crystalizes that network operators continue to view application acceleration as a critical component in their service delivery strategies and also are committed to putting in place a flexible, simplified and centralized service creation model to ensure application acceleration can be achieved.

Figure 15: vCPE Revenue Generation Attributes



Question: Which three vCPE attributes are most important for revenue generation? (N=90)

Based on the input of **Figure 13**, it's clear that vCPE is such an appealing production use case because it is not encumbered by a rigid architecture framework. Instead, vCPE can be deployed using three approaches: hosting software intelligence in the cloud itself, running the software VNF on premises, or utilizing a combination of both. And clearly, based on the input of **Figure 14**, this level of flexibility is highly regarded. The question then becomes is

which of these three approaches that is emerging as the dominant production model. As shown in **Figure 16**, no one single model seems to have yet established itself.

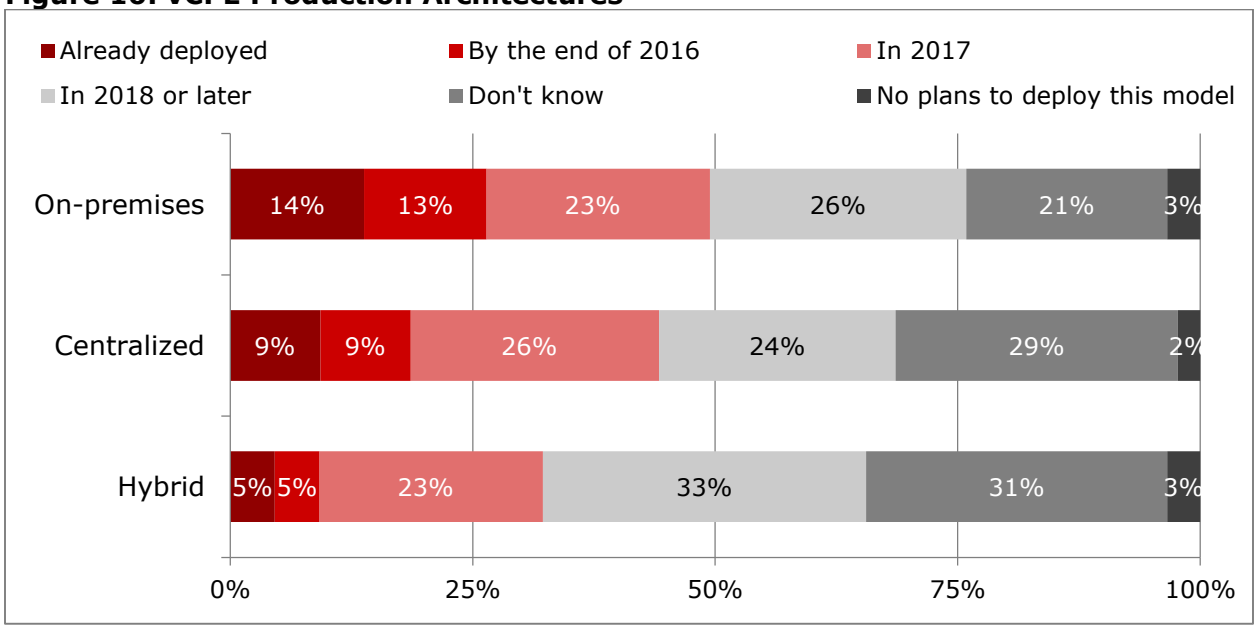
Although based on a small sample of commercial deployments, 14% have chosen the on-premises model, 9% the centralized cloud model and 5% the hybrid model. The same trend extends for current year deployments, with 13% on premises, 9% centralized and 5% hybrid. However, looking ahead only a few months in 2017, the centralized cloud model scored the highest (26%), followed closely by both on-premises and hybrid, both scoring 23%. By 2018, the hybrid model achieved the highest score (33%).

We believe these results indicate that network operators are open to all three approaches. While they are looking to simplify initial deployments via on-premises deployments that likely have more simplified MANO requirements, it's also readily apparent they don't want to be painted into a corner by losing the ability to leverage the cloud to scale as appropriate.

Our view of this input is that network operators have largely gotten it right in that they have a clear view of the vCPE revenue potential and understand that flexibility will be key to realizing their goals.

Based on filter group input, Tier 1s are well ahead on the deployment front, but both groups prefer the on-premises model for these first wave deployments. Looking ahead, this deployment trend will continue until 2018 when the bulk of deployments for Tier 2/3 will commence. It's also worth noting that the Tier 2/3s had much higher level of "don't know" responses vs. Tier 1s.

Figure 16: vCPE Production Architectures



Question: When does your company expect to implement the following vCPE deployment models? (N=86-87)

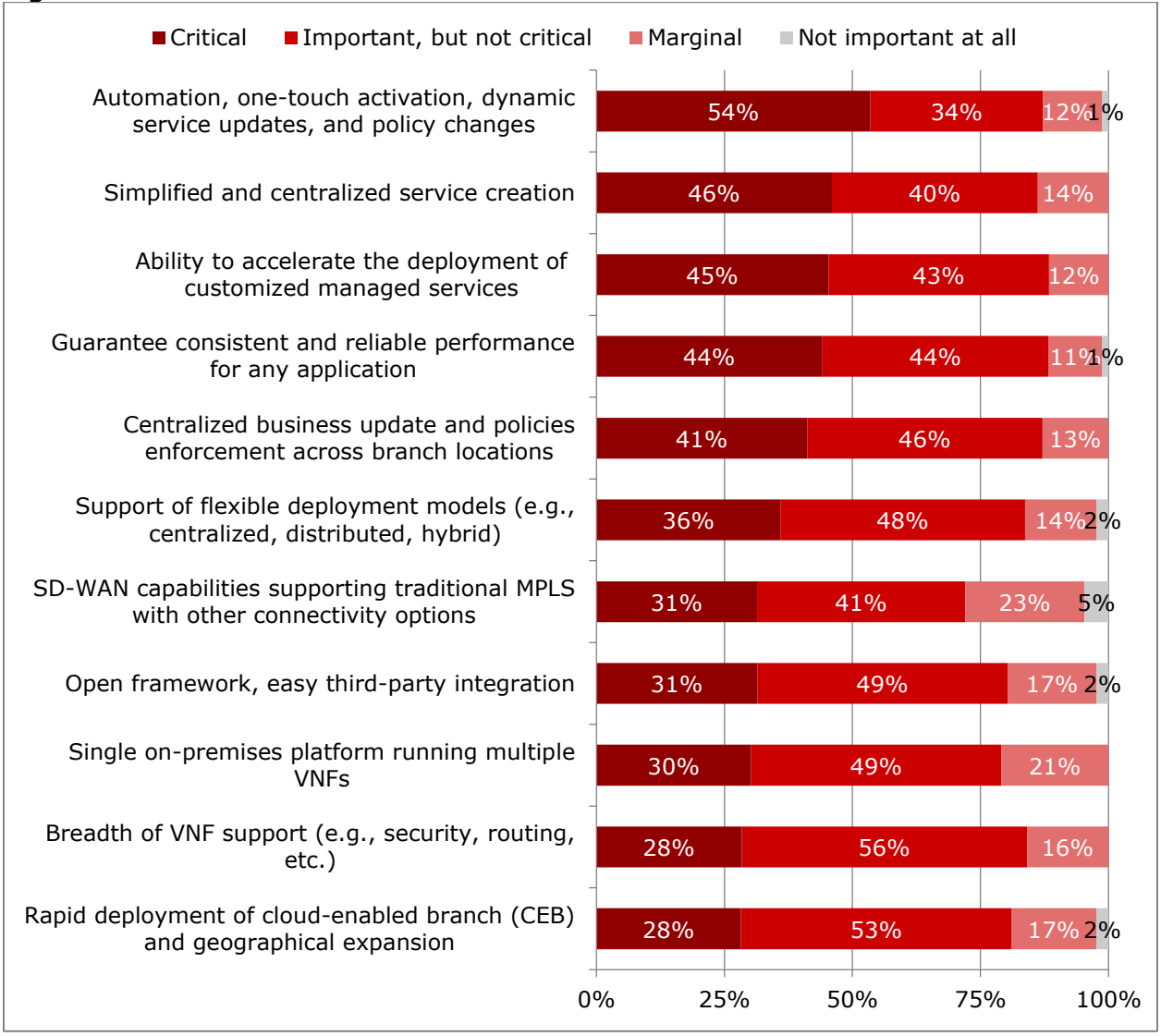
The next question in the survey also addressed vCPE. Specifically, this question was designed to bring together business and technical drivers and attributes in order to achieve a harmonized ranking of the factors.

As shown in **Figure 17**, the top four are familiar responses. Of these, the leading response based on critical attribute responses is automation (54%), simplified centralized service creation (46%), application acceleration (45%) and guarantee consistent reliable performance of any application (44%).

Looking at the Tier 1 and Tier 2/3 filter groups, there is a strong level of consensus. For Tier 1s, the top three critical attributes are automation, consistent application performance and then centralized service creation and customized managed service (tied for third). For Tier 2/3s automation is also the leading attribute, followed by customized managed services and centralized service creation (tied for second) and then consistent application performance.

In our view, this reinforces the strong value proposition that all network operators place on implementing a framework that affords the greatest level of implementation flexibility and application performance, which ultimately translates into greater revenue and profit.

Figure 17: vCPE Attributes



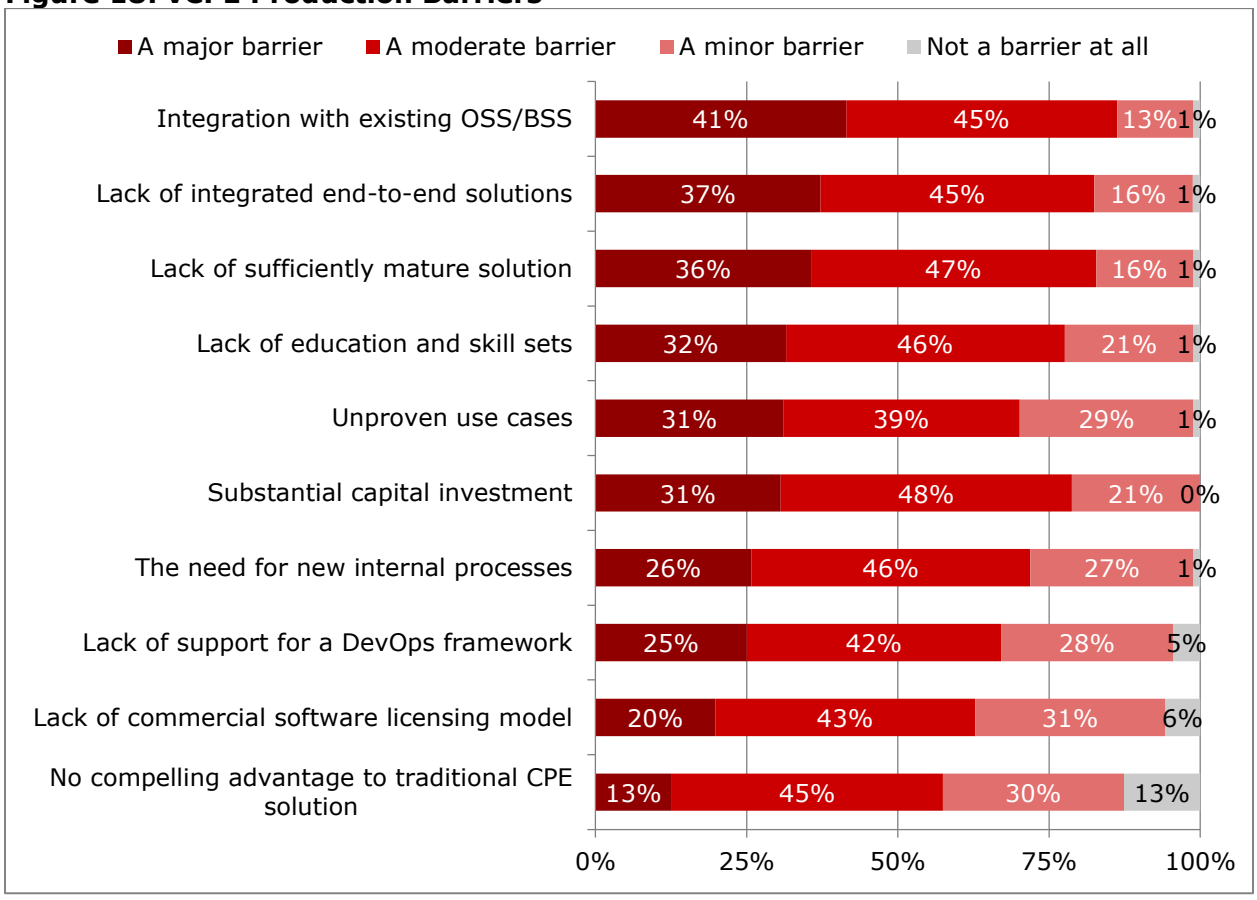
Question: Please rate the importance of the following vCPE attributes. (N=85-87)

In addition to understanding the key tenets of a successful vCPE, we also wanted to understand the barriers to live production deployments. As shown in **Figure 18**, based on levels of *major barrier* response levels, there remains a significant number of implementation barriers. The top response identified was OSS/BSS integration (41%), followed by lack of end-to-end solutions (37%), lack of sufficiently mature solutions (36%) and lack of education and skill sets (32%).

From a filter group perspective, the top three major barriers for Tier 1s are OSS/BSS integration, lack of mature solutions and unproven use cases. For the Tier 2/3s the top concerns are capital investment and lack of mature solutions (tied for first), then lack of education and skill sets, followed by OSS/BSS integration.

With the exception of skill set input (which is predominately a Tier 2/3 consideration), the top three are very much vendor focused and in our view highlight that network operators expect more from their vCPE vendors. Specifically, they are looking for more mature complete solutions that can be seamlessly integrated into existing OSS/BSS systems.

Figure 18: vCPE Production Barriers



Question: Please rate the following potential barriers to vCPE deployment. (N=85-89)

As we have documented, there is considerable interest in leveraging the cloud scale and automation to enable managed services. Since we have also noted that security is a key focus area of managed services, we addressed the relationship between vCPE and managed security services in the final vCPE-related question.

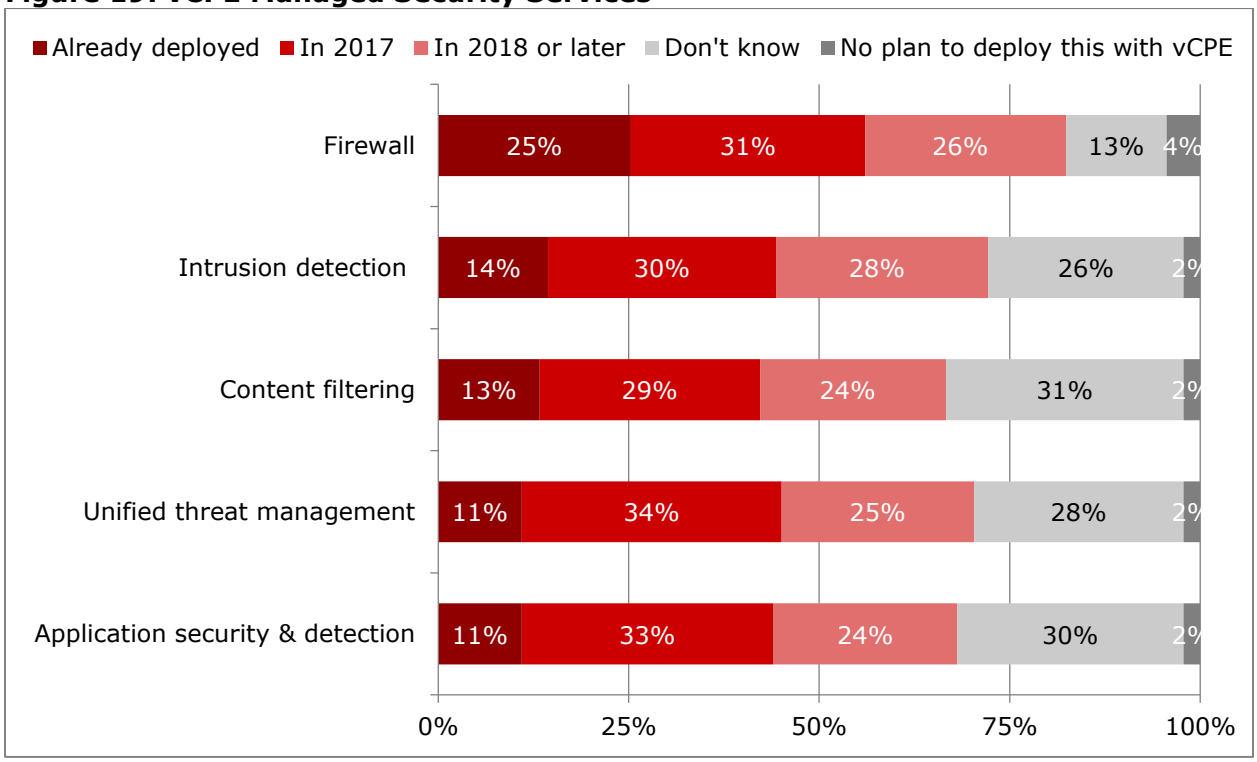
Specifically, we wanted to understand when a network operator would deploy a vCPE solution enhanced with managed security services for enterprise customers. In addition, we wanted to understand which managed security services capabilities were the highest priority.

As shown in **Figure 19**, the process has already commenced. The most popular managed service already deployed by a considerable margin is firewall (25%) and then intrusion detection (14%).

However, looking ahead only a few months into 2017, the options equalize, which we view as logical since a full suite of security services will drive greater managed services revenue. In addition, we view this as consistent with the traditional managed services model of starting with basic features and expanding scope to include other capabilities as customers become more comfortable with adopting additional features.

In terms of filter group input, the top priority of already deployed for both groups is firewall. It's also important to note the general pace of deployment of all functions for Tier 1s in 2017 will be roughly twice that of Tier 2/3. For Tier 1s the top anticipated service for 2017 will be application security and detection.

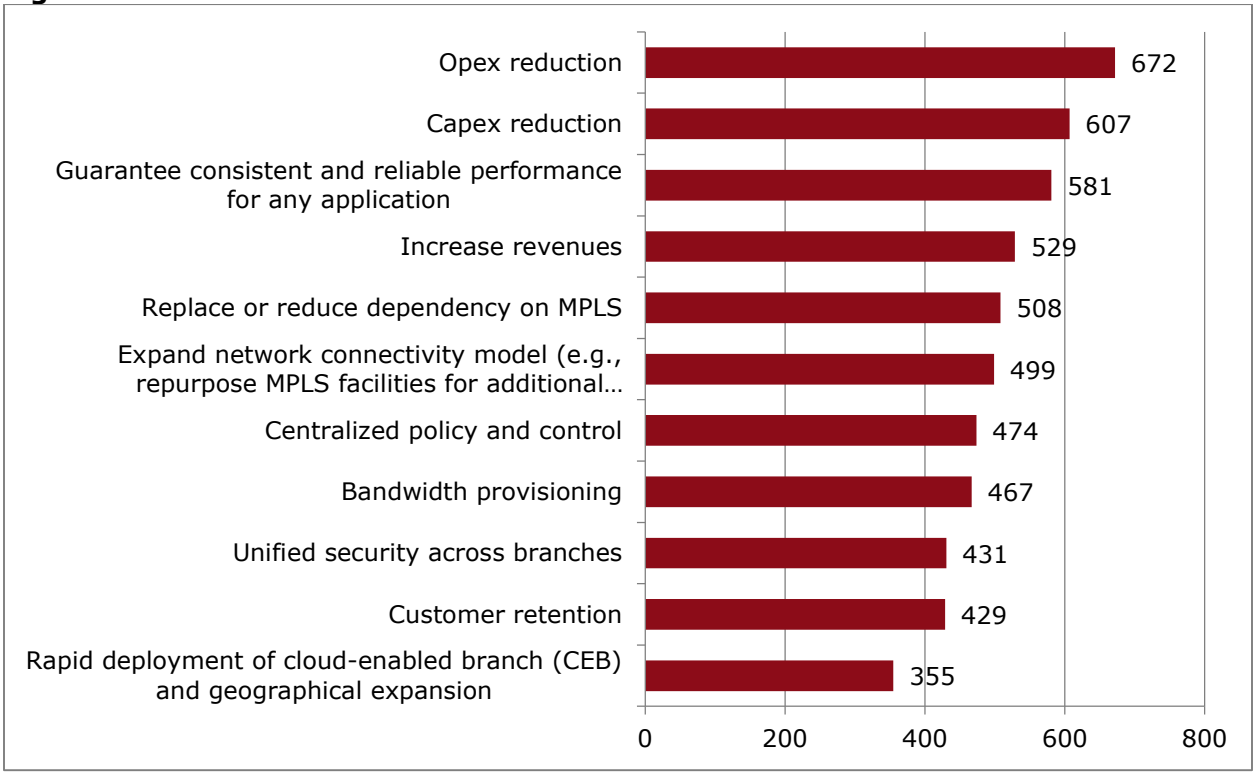
Figure 19: vCPE Managed Security Services



Question: When does your company expect to deploy the following virtualized managed security services for vCPE? (N=90-91)

The survey also sought clarification on SD-WAN production drivers. As shown in **Figure 20**, the clear drivers are opex reduction (672), capex reduction (607) and consistent and reliable performance (581). An extremely strong level of consensus was also noted among the Tier 1 and Tier 2/3 respondents. The top three drivers and ordering selected by both groups were identical: opex reduction, capex reduction and consistent and reliable performance.

Figure 20: SD-WAN Production Drivers



Question: The SD-WAN is a specific application of software-defined network (SDN) technology applied to WAN connections, which are used to connect enterprise networks – including branch offices and data centers – over large geographic distances. Please rank the following SD-WAN deployment drivers in order of importance (1 = most important, 11 = least important). (N=92)

In the next section of the survey, we addressed *proposal* requirements, requesting the survey respondents to provide insight into the factors they most heavily weighted in making vendor selections as part of an RFP exercise. In this case, we focused on four selection scenarios that align with our focus on the high-value use cases previously discussed. These include:

- NFV solution level vendor selection
- vCPE vendor selection
- SD-WAN vendor selection
- Security vendor selection

To simplify data collection, we asked the respondents the same question in succession, requesting them to weight the same broad range of factors in all cases to ensure a common data framework for comparison purposes. As shown in **Figure 21**, there is a high level of commonality, but not unexpectedly, some specific differences as well.

The first observation is that a previously-defined obstacle – the ability to support OSS/BSS integration – is a top three consideration in all cases. The same is true for virtualization product roadmap. The other attributes that attained top three status in one or more vendor selection process are commitment to open source for vCPE (42%), PoC trial performance for both security and NFV solutions (46% + 44%) and price for SD-WAN (46%).

The takeaways of this input are quite clear. OSS integration and product roadmaps are critical factors across the board. In addition, price and PoC performance remain important decision points, as is commitment to open source. We see this later point reinforcing our view that open source is continuing to gain momentum as network operators formulate vendor selection strategies. It's not yet a ubiquitous attribute, but is starting to crack the top three lead by Tier 1 operators who are driving the first implementation wave. See **Section 4** for more details on filter group specific input.

Figure 21: Vendor Selection Attributes – NFV / vCPE / SD-WAN / Security

	NFV		vCPE		SD-WAN		Security	
	Critical	Important	Critical	Important	Critical	Important	Critical	Important
Existing account presence	17%	54%	16%	56%	16%	64%	21%	55%
Vendor with both IT and network domain skill sets	36%	47%	28%	51%	37%	42%	42%	42%
Virtualization product roadmap	**48%**	40%	**44%**	43%	**44%**	42%	**47%**	41%
Ability to support OSS/BSS integration	**55%**	35%	**46%**	38%	**46%**	36%	**44%**	37%
Price	44%	47%	39%	49%	**46%**	41%	**46%**	44%
Commitment to open source	37%	48%	**42%**	33%	36%	41%	35%	42%
Ecosystem partnership program	25%	44%	31%	46%	20%	54%	23%	52%
Breadth of professional services	27%	45%	26%	53%	22%	50%	24%	57%
Perceived industry innovator	26%	45%	24%	51%	22%	48%	27%	53%
Advisory on new services and business models	16%	53%	19%	50%	21%	41%	20%	52%
PoC trial performance	**46%**	31%	39%	36%	41%	36%	**44%**	37%

Question: Please rate the importance of the following factors in selecting an NFV vendor (N=87-89); …a vCPE vendor (N=88-90); …an SD-WAN vendor (N=86-90); …a security vendor (N=87-89)

4. FULL SURVEY RESULTS

In this section we provide a detailed breakdown of the survey input for each question, utilizing two demographic filter groups. These groups are referred to as Tier 1 and Tier 2/3. Tier 1 operators generate more than $5 billion in revenue over a fiscal year, while Tier 2/3s include all those network operators that generate less than $5 billion in revenue annually (see **Figure 4**). The general split between these two groups is 47% Tier 1 and 53% Tier 2/3. The purpose of utilizing these two distinct groups is to identify differences in response input between the largest and smallest network operators.

Question: How much impact will NFV have on the following business operations and processes at your company?

Tier 1 *(N=43-44)*

	Major impact	Moderate impact	No impact
Deployment of managed services	67%	30%	2%
Network resource and infrastructure planning	61%	36%	2%
Network budgeting and investment	46%	55%	0%
New application implementation	56%	37%	7%
Security	57%	41%	2%
Centralized control and policy	61%	36%	2%
Data center operations	46%	55%	0%
Network procurement	30%	64%	7%
Geographical expansion	36%	52%	11%
Traffic management	39%	57%	5%
Analytics	43%	55%	2%

Tier 2/3 *(N=46-48)*

	Major impact	Moderate impact	No impact
Deployment of managed services	38%	60%	2%
Network resource and infrastructure planning	57%	44%	0%
Network budgeting and investment	56%	40%	4%
New application implementation	38%	60%	2%
Security	43%	47%	11%
Centralized control and policy	44%	52%	4%
Data center operations	39%	52%	9%
Network procurement	39%	48%	13%
Geographical expansion	19%	52%	29%
Traffic management	17%	74%	9%
Analytics	32%	53%	15%

Observation: Based on major impact responses, the top three inputs for Tier 1s were deployment of managed services (61%), then centralized policy and control (61%) and network resource and infrastructure planning (61%).

Tier 2/3 operators saw things a little differently, ranking deployment of managed services lower (38%). However, these operators also viewed network resource and infrastructure planning (57%) and centralized control and planning (44%) as top three worthy. It's also worth noting that security scored highly in both demographic groups (57% and 43% respectively).

Question: Please rank the following NFV business drivers based on the level of impact they are likely to have at your company (1 = greatest impact, 10 = least impact).

Tier 1 *(N=44)*

	Score
Service agility and flexibility (time to market)	269
Reduced capex	261
Service lifecycle automation (orchestration and provisioning)	238
Reduced opex	237
Revenue generation	220
Network scalability	212
Shorter innovation cycle (reduced risk and fast failure)	205
Expansion into new market verticals, new customer segments (SMBs) and new geographies	203
Establish an ecosystem of innovative VNFs	182
Competition from OTT players	143

Tier 2/3 *(N=48)*

	Score
Service agility & flexibility (time to market)	300
Revenue generation	297
Reduced opex	286
Reduced capex	257
Network scalability	247
Service lifecycle automation (orchestration and provisioning)	225
Establish an ecosystem of innovative VNFs	213
Shorter innovation cycle (reduced risk and fast failure)	202
Expansion into new market verticals, new customer segments (SMBs) and new geographies	190
Competition from OTT players	185

Observation: Tier 1 and Tier 2/3 priorities as fairly similar. Both groups see service agility as the lead driver and place opex and capex reduction in the top four. However, Tier 1s consider lifecycle automation a top three consideration, while the Tier 2/3 rank it in sixth place. Both believe (rightly or wrongly) that competition from OTT players is their lowest concern.

Question: Which three NFV attributes are the most important for capex reduction?

Tier 1 *(N=44)*

	Score
Ability to accelerate application deployment and to create services on demand	50
Scalability (scale out, scale up)	34
Simplified and centralized service creation	31
Open framework, easy third-party integration	29
Rapid deployment of customized managed services	25
Automation, dynamic service updates and policy changes	21
Breadth of VNFs support (e.g., security, routing, etc.)	20
Centralized business update and policy enforcement across deployments	17
Establishment of a telco cloud	16
Guaranteed consistent and reliable performance for any application	9
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	6

Tier 2/3 *(N=48)*

	Score
Open framework, easy third-party integration	48
Scalability (scale out, scale up)	47
Ability to accelerate application deployment and to create services on demand	40
Automation, dynamic service updates and policy changes	28
Breadth of VNFs support (e.g., security, routing, etc.)	24
Rapid deployment of customized managed services	23
Simplified and centralized service creation	22
Centralized business update and policy enforcement across deployments	21
Establishment of a telco cloud	14
Guaranteed consistent and reliable performance for any application	11
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	7

Observation: There is a considerable amount of similarity in the rankings. For both groups, scalability and application acceleration are ranked as top three considerations. For

Tier 2/3 respondents, open framework was the top consideration vs. a fourth-place ranking for Tier 1. The Tier 1s, in turn, ranked centralized service creation as a third-place consideration vs. a seventh-place ranking by Tier 2/3 operators.

Question: Which three NFV attributes are the most important for opex improvement?

Tier 1 *(N=43)*

	Score
Ability to accelerate application deployment and to create services on demand	39
Automation, dynamic service updates and policy changes	36
Simplified and centralized service creation	32
Centralized business update and policy enforcement across deployments	28
Guaranteed consistent and reliable performance for any application	23
Establishment of a telco cloud	19
Scalability (scale out, scale up)	17
Rapid deployment of customized managed services	17
Open framework, easy third-party integration	17
Breadth of VNFs support (e.g., security, routing, etc.)	14
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	9

Tier 2/3 *(N=48)*

	Score
Automation, dynamic service updates and policy changes	63
Ability to accelerate application deployment and to create services on demand	35
Simplified and centralized service creation	35
Scalability (scale out, scale up)	32
Centralized business update and policy enforcement across deployments	30
Open framework, easy third-party integration	20
Rapid deployment of customized managed services	19
Guaranteed consistent and reliable performance for any application	17
Establishment of a telco cloud	13
Breadth of VNFs support (e.g., security, routing, etc.)	12
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	11

Observation: There was also a considerable degree of similarity in these results in the two filter groups. For both groups, while the ordering was somewhat different, application acceleration, automation and simplified and centralized service creation were top three considerations.

Question: Which three NFV attributes are the most important for revenue generation?

Tier 1 *(N=44)*

	Score
Ability to accelerate application deployment and to create services on demand	58
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	38
Breadth of VNFs support (e.g., security, routing, etc.)	28
Scalability (scale out, scale up)	24
Rapid deployment of customized managed services	21
Simplified and centralized service creation	18
Open framework, easy third-party integration	15
Automation, dynamic service updates and policy changes	15
Centralized business update and policy enforcement across deployments	15
Guaranteed consistent and reliable performance for any application	13
Establishment of a telco cloud	12

Tier 2/3 *(N=48)*

	Score
Ability to accelerate application deployment and to create services on demand	62
Rapid deployment of customized managed services	43
Expansion into new market verticals, new customer segments (e.g., SMB) and new geographies	32
Automation, dynamic service updates and policy changes	29
Scalability (scale out, scale up)	26
Centralized business update and policy enforcement across deployments	25
Simplified and centralized service creation	23
Open framework, easy third-party integration	20
Establishment of a telco cloud	12
Guaranteed consistent and reliable performance for any application	9
Breadth of VNFs support (e.g., security, routing, etc.)	4

Observation: Both groups ranked application acceleration and market expansion as first and second priorities. Both also ranked scalability as a fourth-place priority. While Tier 2/3s ranked automation and policy as third-place consideration, it was an eighth-place considera-tion for Tier 1s.

Question: Please rank the following VNFs in order of importance to your company (1 = most important, 8 = least important).

Tier 1 *(N=44)*

	Score
Security services (e.g., firewall, DDOS, UTM, DPI, etc.)	239
SD-WAN connectivity	230
Managed communication services	226
Ability to design customized managed services	211
vCPE	194
VPN services for remote offices	159
Establishment of private, public and hybrid cloud	140
Metacloud, cloud brokerage	129

Tier 2/3 *(N=46)*

	Score
Managed communication services	239
Security services (e.g., firewall, DDOS, UTM, DPI, etc.)	227
VPN services for remote offices	220
vCPE	187
SD-WAN connectivity	185
Ability to design customized managed services	182
Establishment of private, public and hybrid cloud	178
Metacloud, cloud brokerage	152

Observation: There was a strong degree of alignment between the two filter groups. In both groups, managed communication services and security services were top three considerations. SD-WAN achieved a second place ranking with Tier 1s, while Tier 2/3s viewed it as a fifth-place consideration.

Question: When does your company expect to deploy NFV commercially for the following use cases in a production environment?

Tier 1 *(N=42-44)*

	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plan to deploy this
Broadband BNG/BRAS (vBNG)	12%	14%	21%	14%	33%	7%
Business/enterprise virtual CPE, a.k.a. vE-CPE (e.g., firewall, WOC, DPI, IPS)	18%	18%	43%	14%	7%	0%
Consumer fixed access: virtualization of control planes for ONTs, ONUs, OLTs, DSLAMs, etc.	7%	12%	26%	31%	21%	2%

	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plan to deploy this
Consumer home environment, a.k.a. vCPE (e.g., STB, RGW, firewall)	12%	7%	35%	23%	16%	7%
Mobile core, EPC (e.g., SGSN, GGSN, MME, S-GW, P-GW)	14%	19%	16%	21%	21%	9%
IMS core (e.g., CSCF, HSS, SBC)	16%	14%	26%	19%	21%	5%
CDN (content delivery network, vCDNs; cache nodes, CDN controller)	19%	12%	26%	26%	12%	5%
PE (provider edge) router; (vPE)	21%	16%	23%	30%	7%	2%
Virtual network platform as a service (vNPaaS)	9%	7%	35%	28%	21%	0%
Mobile base station (separate RRU from BBU; C-RAN)	9%	7%	26%	19%	28%	12%
Service chaining, VNF forwarding graphs	7%	12%	33%	26%	17%	5%
GiLAN (between mobile packet core and the WAN/Internet)	5%	5%	19%	21%	42%	9%
vNPaaS for IoT applications	2%	11%	30%	21%	27%	9%

Tier 2/3 *(N=46-47)*

	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plan to deploy this
Broadband BNG/BRAS (vBNG)	4%	11%	19%	26%	28%	13%
Business/enterprise virtual CPE, a.k.a. vE-CPE (e.g., firewall, WOC, DPI, IPS)	11%	9%	15%	36%	23%	6%
Consumer fixed access: virtualization of control planes for ONTs, ONUs, OLTs, DSLAMs, etc.	7%	7%	13%	41%	24%	9%
Consumer home environment, a.k.a. vCPE (e.g., STB, RGW, firewall)	11%	0%	19%	40%	23%	6%
Mobile core, EPC (e.g., SGSN, GGSN, MME, S-GW, P-GW)	9%	4%	20%	20%	26%	22%
IMS core (e.g., CSCF, HSS, SBC)	4%	11%	17%	20%	35%	13%
CDN (content delivery network, vCDNs; cache nodes, CDN controller)	15%	9%	11%	34%	26%	6%
PE (provider edge) router; (vPE)	13%	7%	9%	33%	30%	9%
Virtual network platform as a service (vNPaaS)	6%	4%	15%	30%	34%	11%
Mobile base station (separate RRU from BBU; C-RAN)	9%	0%	11%	32%	21%	28%

	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plan to deploy this
Service chaining, VNF forwarding graphs	9%	0%	17%	20%	35%	20%
GiLAN (between mobile packet core and the WAN/Internet)	6%	4%	15%	23%	28%	23%
vNPaaS for IoT applications	2%	4%	6%	34%	34%	19%

Observation: Tier 1s have already deployed use cases in greater numbers. This trend continues in 2016 and 2017 as well. However, priority wise, both groups tend to rank vPE, CDN and vE-CPE highly. IMS core is a much higher priority for Tier 1s than Tier 2/3s (16% vs. 4%).

Question: Please rate the importance of the following attributes to NFV MANO.

Tier 1 *(N=42-44)*

	Critical	Important, but not critical	Marginal	Not important at all
Ease of installation	34%	46%	18%	2%
Automation	64%	23%	14%	0%
Simple, agile and open network service design	59%	32%	9%	0%
Multi-tenanted infrastructure management	41%	41%	18%	0%
Multi-data center orchestration	32%	39%	27%	2%
Simple network service lifecycle management	23%	57%	21%	0%
Maintenance of network service chain	28%	54%	16%	2%
vCPE solutions	14%	48%	33%	5%
End-to-end real-time and historical monitoring	30%	49%	21%	0%
Centralized logging infrastructure	21%	44%	33%	2%
Open APIs integration	28%	49%	21%	2%
Resiliency	51%	42%	7%	0%
Scalability	70%	28%	2%	0%

Tier 2/3 *(N=46-48)*

	Critical	Important, but not critical	Marginal	Not important at all
Ease of installation	30%	55%	13%	2%
Automation	44%	40%	13%	4%
Simple, agile and open network service design	43%	43%	15%	0%
Multi-tenanted infrastructure management	28%	43%	26%	4%

	Critical	Important, but not critical	Marginal	Not important at all
Multi-data center orchestration	33%	41%	20%	7%
Simple network service lifecycle management	30%	52%	15%	2%
Maintenance of network service chain	24%	52%	24%	0%
vCPE solutions	15%	44%	33%	9%
End-to-end real-time and historical monitoring	35%	48%	17%	0%
Centralized logging infrastructure	23%	47%	26%	4%
Open APIs integration	26%	49%	23%	2%
Resiliency	47%	32%	17%	4%
Scalability	59%	24%	13%	4%

Observation: A strong degree of similarity. Tier 1s ranked scalability, open network design and automation as the top three considerations, while the Tier 2/3s ranked scalability, resiliency and automation in the top three.

Question: Which three vCPE attributes are most important for capex reduction?

Tier 1 *(N=44)*

	Score
Flexible deployment models (e.g., centralized, distributed, hybrid)	58
Ability to accelerate the deployment of customized managed services	34
Open framework, easy integration with existing infrastructure	31
Automation, one-touch activation, dynamic service updates and policy changes	25
Simplified and centralized service creation	23
Single on-premises platform running multiple VNFs	22
Centralized business update and policies enforcement across deployments	19
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	16
Guarantee consistent and reliable performance for any application	13
Secured service connectivity and application assurance across deployments	10
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	8

Tier 2/3 *(N=48)*

Attributes	Score
Flexible deployment models (e.g., centralized, distributed, hybrid)	55
Automation, one-touch activation, dynamic service updates and policy changes	39

Attributes	Score
Secured service connectivity and application assurance across deployments	31
Ability to accelerate the deployment of customized managed services	28
Open framework, easy integration with existing infrastructure	26
Centralized business update and policies enforcement across deployments	24
Single on-premises platform running multiple VNFs	21
Guarantee consistent and reliable performance for any application	20
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	19
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	14
Simplified and centralized service creation	13

Observation: Tier 1s and Tier 2/3s both consider flexible deployment models as the clear leading attribute.

Question: Which three vCPE attributes are most important for opex reduction?

Tier 1 *(N=43)*

Attributes	Score
Automation, one-touch activation, dynamic service updates and policy changes	63
Secured service connectivity and application assurance across deployments	32
Centralized business update and policies enforcement across deployments	26
Flexible deployment models (e.g., centralized, distributed, hybrid)	24
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	21
Ability to accelerate the deployment of customized managed services	18
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	17
Guarantee consistent and reliable performance for any application	16
Simplified and centralized service creation	15
Open framework, easy integration with existing infrastructure	13
Single on-premises platform running multiple VNFs	6

Tier 2/3 *(N=48)*

Attributes	Score
Automation, one-touch activation, dynamic service updates and policy changes	49
Centralized business update and policies enforcement across deployments	39
Ability to accelerate the deployment of customized managed services	38

Attributes	Score
Flexible deployment models (e.g., centralized, distributed, hybrid)	36
Simplified and centralized service creation	33
Secured service connectivity and application assurance across deployments	25
Open framework, easy integration with existing infrastructure	22
Guarantee consistent and reliable performance for any application	16
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	14
Single on-premises platform running multiple VNFs	13
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	2

Observation: Automation was the leading attribute for both filter groups. Centralized business update and policy enforcement was either a top two or top three consideration for them as well. SD-WAN was the lowest ranking attribute for Tier 2/3s, while it was top five for Tier 1s.

Question: Which three vCPE attributes are most important for revenue generation?

Tier 1 *(N=43)*

Attributes	Score
Ability to accelerate the deployment of customized managed services	46
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	32
Automation, one-touch activation, dynamic service updates and policy changes	24
Guarantee consistent and reliable performance for any application	23
Simplified and centralized service creation	23
Flexible deployment models (e.g., centralized, distributed, hybrid)	22
Open framework, easy integration with existing infrastructure	21
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	20
Single on-premises platform running multiple VNFs	16
Secured service connectivity and application assurance across deployments	14
Centralized business update and policies enforcement across deployments	12

Tier 2/3 *(N=47)*

Attributes	Score
Ability to accelerate the deployment of customized managed services	56
Flexible deployment models (e.g., centralized, distributed, hybrid)	44
Simplified and centralized service creation	33

Attributes	Score
Centralized business update and policies enforcement across deployments	30
Automation, one-touch activation, dynamic service updates and policy changes	23
Guarantee consistent and reliable performance for any application	18
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	17
Open framework, easy integration with existing infrastructure	17
Secured service connectivity and application assurance across deployments	15
Single on-premises platform running multiple VNFs	15
Rapidly deploy cloud-enabled branch (CEB) and geographical expansion	12

Observation: For both groups, the ability to accelerate deployment of managed services is the top priority. SD-WAN and automation rounded out the top three responses for Tier 1s, while Tier 2/3s chose flexible deployment models and centralized service creation.

Question: When does your company expect to implement the following vCPE deployment models?

Tier 1 *(N=41-42)*

Model	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plans to deploy this model
On-premises	19%	21%	29%	19%	7%	5%
Centralized	15%	15%	24%	29%	12%	5%
Hybrid	7%	7%	29%	39%	15%	2%

Tier 2/3 *(N=45-46)*

Model	Already deployed	By the end of 2016	In 2017	In 2018 or later	Don't know	No plans to deploy this model
On-premises	9%	4%	18%	33%	33%	2%
Centralized	4%	4%	27%	20%	44%	0%
Hybrid	2%	2%	17%	28%	46%	4%

Observation: In terms of deployments, Tier 1s are well ahead on the deployment front, but both groups prefer the on-premises model for these first wave deployments. Looking ahead, this deployment trend will continue until 2018, when the bulk of deployments for Tier 2/3 will commence. It's also worth noting that the Tier 2/3s had much higher levels of "don't know" responses than Tier 1s.

Question: Please rate the importance of the following vCPE attributes.

Tier 1 *(N=40-42)*

Attributes	Critical	Important, but not critical	Marginal	Not important at all
Support of flexible deployment models (e.g., centralized, distributed, hybrid)	42%	46%	10%	2%
Ability to accelerate the deployment of customized managed services	48%	40%	13%	0%
Centralized business update and policies enforcement across branch locations	46%	37%	17%	0%
Automation, one-touch activation, dynamic service updates and policy changes	59%	27%	15%	0%
Breadth of VNF support (e.g., security, routing)	41%	41%	19%	0%
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	34%	44%	20%	2%
Open framework, easy third-party integration	34%	54%	12%	0%
Simplified and centralized service creation	48%	33%	19%	0%
Rapid deployment of cloud-enabled branch (CEB) and geographical expansion	34%	51%	15%	0%
Guarantee consistent and reliable performance for any application	49%	42%	10%	0%
Single on-premises platform running multiple VNFs	29%	51%	20%	0%

Tier 2/3 *(N=44-46)*

Attributes	Critical	Important, but not critical	Marginal	Not important at all
Support of flexible deployment models (e.g., centralized, distributed, hybrid)	31%	49%	18%	2%
Ability to accelerate the deployment of customized managed services	44%	46%	11%	0%
Centralized business update and policies enforcement across branch locations	36%	55%	9%	0%
Automation, one-touch activation, dynamic service updates and policy changes	49%	40%	9%	2%
Breadth of VNF support (e.g., security, routing)	17%	70%	13%	0%
SD-WAN capabilities supporting traditional MPLS with other connectivity options (broadband Internet, 4G, LTE, etc.)	29%	38%	27%	7%
Open framework, easy third-party integration	29%	44%	22%	4%

Attributes	Critical	Important, but not critical	Marginal	Not important at all
Simplified and centralized service creation	44%	47%	9%	0%
Rapid deployment of cloud-enabled branch (CEB) and geographical expansion	23%	55%	18%	5%
Guarantee consistent and reliable performance for any application	40%	47%	11%	2%
Single on-premises platform running multiple VNFs	31%	47%	22%	0%

Observation: There is a strong level of consensus. For Tier 1s, the top three critical attributes are automation, consistent application performance, then centralized service creation and customized managed service (tied for third). For Tier 2/3s, automation is also the leading attribute, followed by customized managed services and centralized service creation (tied for second) and then consistent application performance.

Question: Please rate the following potential barriers to vCPE deployment.

Tier 1 *(N=41-43)*

Barrier	A major barrier	A moderate barrier	A minor barrier	Not a barrier at all
Lack of education and skill sets	23%	51%	23%	2%
The need for new internal processes	28%	51%	19%	2%
Lack of support for a DevOps framework	16%	49%	30%	5%
Unproven use cases	33%	38%	29%	0%
Lack of integrated end-to-end solutions	32%	51%	15%	2%
Lack of sufficiently mature solution	38%	48%	12%	2%
Integration with existing OSS/BSS	48%	41%	12%	0%
No compelling advantage to traditional CPE solution	7%	55%	24%	14%
Substantial capital investment	19%	55%	26%	0%
Lack of commercial software licensing model	12%	43%	38%	7%

Tier 2/3 *(N=43-46)*

Barrier	A major barrier	A moderate barrier	A minor barrier	Not a barrier at all
Lack of education and skill sets	39%	41%	20%	0%
The need for new internal processes	24%	41%	35%	0%

Barrier	A major barrier	A moder-ate barrier	A minor barrier	Not a barrier at all
Lack of support for a DevOps framework	33%	36%	27%	4%
Unproven use cases	29%	40%	29%	2%
Lack of integrated end-to-end solutions	42%	40%	18%	0%
Lack of sufficiently mature solution	33%	47%	20%	0%
Integration with existing OSS/BSS	36%	49%	13%	2%
No compelling advantage to traditional CPE solution	18%	36%	36%	11%
Substantial capital investment	42%	42%	16%	0%
Lack of commercial software licensing model	27%	43%	25%	5%

Observation: The top three major barriers for Tier 1s are OSS/BSS integration, lack of mature solutions and unproven use cases. For the Tier 2/3s the top concerns are capital investment and lack of mature solutions (tied for first), then lack of education and skill sets, followed by OSS/BSS integration.

Question: When does your company expect to deploy the following virtualized managed security services for vCPE?

Tier 1 *(N=44)*

	Already deployed	In 2017	In 2018 or later	Don't know	No plan to deploy this with vCPE
Firewall	32%	41%	18%	5%	5%
Intrusion detection	16%	41%	27%	14%	2%
Unified threat management	14%	48%	23%	14%	2%
Content filtering	14%	34%	30%	21%	2%
Application security and detection	9%	50%	21%	18%	2%

Tier 2/3 *(N=46-47)*

	Already deployed	In 2017	In 2018 or later	Don't know	No plan to deploy this with vCPE
Firewall	19%	21%	34%	21%	4%
Intrusion detection	13%	20%	28%	37%	2%
Unified threat management	9%	21%	28%	40%	2%
Content filtering	13%	24%	20%	41%	2%
Application security and detection	13%	17%	28%	40%	2%

Observation: Of services already deployed, firewall is the top priority for both groups. The pace of deployments for Tier 1s in 2017 will be roughly twice that of Tier 2/3. For Tier 1s, the top anticipated service for 2017 will be application security and detection.

Question: Please rank the following SD-WAN deployment drivers in order of importance (1 = most important, 11 = least important).

Tier 1 *(N=44)*

	Score
Opex reduction	336
Capex reduction	281
Guarantee consistent and reliable performance for any application	280
Replace or reduce dependency on MPLS	264
Increase revenues	261
Expand network connectivity model (e.g., repurpose MPLS facilities for additional applications)	254
Customer retention	206
Rapid deployment of cloud-enabled branch (CEB) and geographical expansion	206
Unified security across branches	206
Centralized policy and control	206
Bandwidth provisioning	200

Tier 2/3 *(N=48)*

	Score
Opex reduction	336
Capex reduction	326
Guarantee consistent and reliable performance for any application	301
Increase revenues	268
Centralized policy and control	268
Bandwidth provisioning	267
Expand network connectivity model (e.g., repurpose MPLS facilities for additional applications)	245
Replace or reduce dependency on MPLS	244
Unified security across branches	225
Customer retention	223
Rapid deployment of cloud-enabled branch (CEB) and geographical expansion	149

Observation: There is an extremely strong level of group consensus. The top three drivers and ordering selected by both groups were identical: opex reduction, capex reduction and consistent and reliable performance.

Question: Please rate the importance of the following factors in selecting an NFV vendor.

Tier 1 *(N=40-43)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	23%	56%	21%	0%
Vendor with both IT and network domain skill sets	47%	47%	7%	0%
Virtualization product roadmap	55%	40%	5%	0%
Ability to support OSS/BSS integration	61%	34%	2%	2%
Price	26%	65%	7%	2%
Commitment to open source	51%	35%	12%	2%
Ecosystem partnership program	31%	50%	17%	2%
Breadth of professional services	31%	43%	24%	2%
Perceived industry innovator	29%	48%	24%	0%
Advisory on new services and business models	14%	57%	26%	2%
PoC trial performance	44%	37%	17%	2%

Tier 2/3 *(N=46-47)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	11%	52%	28%	9%
Vendor with both IT and network domain skill sets	26%	48%	17%	9%
Virtualization product roadmap	43%	40%	15%	2%
Ability to support OSS/BSS integration	49%	36%	13%	2%
Price	61%	30%	7%	2%
Commitment to open source	24%	61%	9%	7%
Ecosystem partnership program	20%	39%	35%	7%
Breadth of professional services	23%	47%	23%	6%
Perceived industry innovator	23%	43%	26%	9%
Advisory on new services and business models	17%	50%	26%	7%
PoC trial performance	47%	26%	19%	9%

Observation: The top three critical attributes for Tier 1s are OSS/BSS integration, product roadmap and commitment to open source. Tier 2/3s are similar in that they rank both OSS/BSS integration and product roadmap in the top three. The exception is price, which is the leading critical attribute for Tier 2/3s, but a lower-priority consideration for Tier 1s. Interestingly, they ranked commitment to open source a lower priority.

Question: Please rate the importance of the following factors in selecting a vCPE vendor.

Tier 1 *(N=42-43)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	17%	62%	21%	0%
Vendor with both IT and network domain skill sets	38%	52%	10%	0%
Virtualization product roadmap	60%	36%	5%	0%
Ability to support OSS/BSS integration	55%	31%	12%	2%
Price	30%	56%	12%	2%
Commitment to open source	54%	30%	12%	5%
Ecosystem partnership program	31%	45%	21%	2%
Breadth of professional services	21%	51%	26%	2%
Perceived industry innovator	26%	54%	21%	0%
Advisory on new services and business models	19%	55%	21%	5%
PoC trial performance	41%	41%	14%	5%

Tier 2/3 *(N=45-47)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	15%	50%	28%	7%
Vendor with both IT and network domain skill sets	20%	50%	20%	11%
Virtualization product roadmap	30%	49%	17%	4%
Ability to support OSS/BSS integration	37%	44%	9%	11%
Price	47%	42%	7%	4%
Commitment to open source	32%	36%	23%	9%
Ecosystem partnership program	30%	46%	13%	11%
Breadth of professional services	30%	54%	11%	4%
Perceived industry innovator	22%	48%	24%	7%
Advisory on new services and business models	20%	46%	28%	7%
PoC trial performance	38%	32%	23%	6%

Observation: Very similar trends to NFV vendor selection. Tier 1s consider product roadmap, OSS/BSS integration and open source commitment as the top three critical attributes, while Tier 2/3s view price, OSS/BSS integration and then PoC trial performance (a new factor) as the top three considerations.

Question: Please rate the importance of the following factors in selecting an SD-WAN vendor.

Tier 1 *(N=41-43)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	19%	71%	10%	0%
Vendor with both IT and network domain skill sets	47%	42%	12%	0%
Virtualization product roadmap	56%	40%	5%	0%
Ability to support OSS/BSS integration	55%	29%	12%	5%
Price	37%	47%	14%	2%
Commitment to open source	45%	45%	7%	2%
Ecosystem partnership program	29%	55%	12%	5%
Breadth of professional services	19%	55%	21%	5%
Perceived industry innovator	27%	49%	22%	2%
Advisory on new services and business models	21%	42%	30%	7%
PoC trial performance	36%	43%	19%	2%

Tier 2/3 *(N=45-47)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	13%	57%	26%	4%
Vendor with both IT and network domain skill sets	28%	43%	21%	9%
Virtualization product roadmap	33%	44%	18%	4%
Ability to support OSS/BSS integration	38%	42%	16%	4%
Price	53%	36%	9%	2%
Commitment to open source	27%	38%	27%	9%
Ecosystem partnership program	11%	53%	27%	9%
Breadth of professional services	24%	46%	20%	11%
Perceived industry innovator	18%	47%	24%	11%
Advisory on new services and business models	20%	40%	36%	4%
PoC trial performance	46%	30%	17%	7%

Observation: For Tier 1s, the top three selection attributes are product roadmap, OSS/BSS integration, IT and network domain skill sets followed by open source commitment in fourth place. For Tier 2/3s, price remains the leading critical attribute, followed by PoC trial performance and OSS/BSS integration.

Question: Please rate the importance of the following factors in selecting a security vendor.

Tier 1 *(N=42-43)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	24%	64%	12%	0%
Vendor with both IT and network domain skill sets	49%	47%	5%	0%
Virtualization product roadmap	57%	41%	2%	0%
Ability to support OSS/BSS integration	57%	31%	10%	2%
Price	37%	49%	12%	2%
Commitment to open source	48%	43%	5%	5%
Ecosystem partnership program	30%	51%	16%	2%
Breadth of professional services	26%	60%	12%	2%
Perceived industry innovator	31%	55%	14%	0%
Advisory on new services and business models	21%	54%	21%	5%
PoC trial performance	41%	43%	14%	2%

Tier 2/3 *(N=45-47)*

	Critical	Important, but not critical	Marginal	Not important at all
Existing account presence	18%	47%	29%	7%
Vendor with both IT and network domain skill sets	36%	38%	22%	4%
Virtualization product roadmap	37%	41%	17%	4%
Ability to support OSS/BSS integration	32%	43%	19%	6%
Price	54%	39%	4%	2%
Commitment to open source	24%	41%	24%	11%
Ecosystem partnership program	15%	52%	17%	15%
Breadth of professional services	22%	54%	15%	9%
Perceived industry innovator	24%	52%	17%	7%
Advisory on new services and business models	20%	50%	24%	7%
PoC trial performance	47%	31%	16%	7%

Observation: The top three critical attributes for Tier 1 operators are product roadmap and OSS/BSS integration (tied for first), followed by IT and network domain skill sets. For Tier 2/3s, price remains the most critical attribute, followed by PoC trial performance and product roadmap.