Re-envisioning the CSP network

How adaptable, thinking networks pave the way for 5G

IBM Institute for Business Value

In this report

Designing and building virtualized telecom network clouds

Automating network and service operations with artificial intelligence

Using DevOps for onboarding, testing and operationalizing network services

IBM communications industry solutions

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Is your network future-ready?

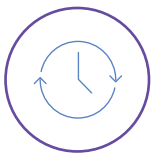
Communications service providers (CSPs) are facing highly disruptive challenges. Expanding volumes of data and video, mobile workload volatility, a greater number of connections and demand for lower latency are driving CSPs to develop transformative strategies. To enable the 5G future, they are reinventing networks with cloud-based virtualized networking. Virtualization and cloudification allow for an unprecedented level of cognitive automation, enabling networks to conduct intelligent, agile, responsive network and service operations. Adopting a development and operations (DevOps) methodology facilitates an automated factory approach that extends across the entire lifecycle – far beyond deployment of services. This gives CSPs more bandwidth to rethink their businesses and to discover untapped potential and new directions for exploration.

A call to action

Consumers today have an unstoppable hunger for digital services. Specifically, their use of mobile video is skyrocketing and creating network traffic jams. Mobile video traffic is forecast to grow by around 50 percent annually through 2023, accounting for 75 percent of all mobile data traffic.[1] The increase is largely due to the popularity of streaming video and will further accelerate with new technologies, such as virtual and augmented reality applications.

But it is not only consumers who are eating up large amounts of bandwidth. As enterprises continue to digitize operations, their demand for bandwidth substantially increases as well. This growth is due to innovations in areas like cloud computing and Internet of Things (IoT), as well as video-centric applications, such as those for training and video surveillance. Mobile business internet traffic is projected to increase at a compound annual growth rate of 41 percent through 2021.[2]

Expanding bandwidth in the traditional way – by adding new hardware appliances – is simply unrealistic. It requires significant funding and cannot keep pace with exponentially growing demands. Combined with the need for more connections and lower latency for real-time communication, this bandwidth challenge has spurred the introduction of 5G. With 5G, network virtualization and cloudification are fundamental to realizing network services delivery aligned with customer and service provider expectations.



82%

of CSP Innovators surveyed identified faster time-to-market as the key driver for network virtualization

80%

of CSP Innovators surveyed are using – or plan to use – AI to perform predictive network maintenance

65%

of CSP Innovators surveyed see better customizability as the key benefit of open source

The imperative for action has never been stronger. As a key enabler of the coming 5G infrastructure, network function virtualization (NFV) is the next logical step in the network evolution. NFV replaces single physical network appliances with virtualized network functions (VNFs) linked together across virtual machines. VNFs enable better use of network resources, allowing those resources to run more software on a given amount of physical infrastructure. A VNF is more flexible and scalable when enabled with a software-defined network (SDN) layer that allows it to be connected and reconnected in ways a hardware design can't.

NFV combines rapid adaptation to network changes with transport capabilities. In particular, NFV will enable 5G networks in which various virtual networks run on top of a single, physical infrastructure using technology that allows the network to be shared shared dynamically, or "sliced."[3] Virtual networks then can be rapidly customized to meet the needs of operators, consumers, and enterprise applications and services, such as those for remote healthcare and connected cars.

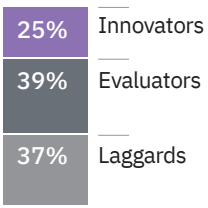
Virtualization at scale requires a network cloud infrastructure that allows optimization through rapid scaling and descaling, resource sharing, agility and availability through lifecycle management of network services and applications. While it's possible to deploy VNFs in solution silos today, fuller optimization requires removal of these silos so VNFs can run across a multi-function, multi-location, multi-service environment. Deploying VNFs in a network cloud environment like this provides scalability, business agility, fast-service innovation and delivery. It also enables economies of scale alongside IT applications, which can help CSPs realize significant cost savings.

It also makes automation of operations essential. Network virtualization and cloudification go hand-in-hand with predictive, automatic and artificial intelligence (AI)-enabled operations. Together, these create a "living" network that senses what is currently happening, anticipates changes, learns and determines how to best make those changes. It allows for a new level of automation, based on AI or machine-created or enabled automation, resulting in a network that takes action based on a given situation.

Virtualization and cloudification not only bring automation and programmability to telecom networks, they also enable rapid innovation. In fact, they facilitate network enablement through agile network DevOps for continuously building, onboarding, testing and operationalizing new services, and implementing ongoing updates of existing services.

Worldwide, CSPs are moving toward network virtualization at their own pace. As of February 2018, AT&T had virtualized 55 percent of its network.[4] Verizon has committed to fund dividends by saving USD 10 billion through virtualization by 2021.[5] In Europe, Telefonica's Unica initiative focuses on building more automated, software-based global networks.[6] And in Southeast Asia, Japan leads in network virtualization, closely followed by South Korea and China.[7]

Cluster analysis of survey data revealed three archetypes with distinct characteristics reflecting their network virtualization approach.



The distinguishing variables used to drive the analysis are:

- Adoption level of NFV/SDN
- Extent automation is included in the network transformation roadmap
- Degree of integration of AI and automation
- Level of automation in network supply chain
- Extent of using DevOps in network operations
- Extent of turning to external suppliers

CSP executives' view on network cloudification

In an effort to understand the industry's progress in network virtualization, identify leaders, comprehend their vision and derive learnings to share with their peers, we conducted extensive research, including interviews with 200 CSP executives across the globe (see sidebar on page 17, "Methodology").

Our research revealed that network virtualization is already helping a number of CSP companies drive efficiency and agility in their networks to create new value. We applied cluster analysis to identify segments among the interviewees based on their approach to network virtualization and how they execute on that vision. Three archetypes emerged, which we have named CSP Innovators, Evaluators and Laggards (see sidebar).

Most CSP Innovators are already implementing NFV/SDN technology to support current and/or new services. They understand that the technology is essential for their Digital Reinvention™ within their networks. Innovators are redefining the way they bring services and applications to the users. They realize the necessity of including automation in their organizations' network transformation roadmaps and say AI is a key underlying technology for effectively automating network operations.

For many of the Innovators, the network supply chain may have been automated to some degree for today's network, but needs to be digitized to further accelerate the agility required for NFV. They are already applying DevOps in the network environment. And nearly half of them are working with suppliers or systems integrators to jointly develop and realize network virtualization and automation.

Evaluators are either conducting operational trials or testing the technology in a lab environment. Automation is a focus area in their network transformation plans, but to date they have only modestly automated the supply chain of the network – let alone begun the digitization needed for NFV. They intend to integrate AI into their automation plans and to use DevOps when starting their network virtualization journey. The majority are turning to external suppliers for network virtualization and automation support, but only for defined areas.

Laggards are falling behind the Innovators and Evaluators. They are still in the consideration/evaluation phase, and automation and DevOps for network operations are not yet on their radar. The majority plan to turn to suppliers and integrators in two-to-three years.

Innovators (25 percent of the group we interviewed) are the standouts. They report they have outperformed their peers in both revenue growth and profitability in the past three years and also lead in innovation. Most Innovator organizations have a workforce of over 10,000 employees and annual revenue of over USD 10 billion. Evaluators (39 percent of interviewees) and Laggards (37 percent) are typically smaller in both workforce and annual revenue.

Through their intentions and actions, the practices of Innovators offer insights to the others – the Evaluators and Laggards – into how to develop new capabilities and structure their organizations' networking virtualization initiatives to be successful.

Designing networks for the cloud

The telecommunications industry is adopting new cloud and virtualization technologies to capitalize on SDN/NFV (see sidebar, "AT&T bets on software-defined networking"). By moving toward cloud-based networking, CSPs can more easily manage and expand their network capabilities and speed up innovation, service fulfillment and operations. Service enhancement, revenue-generating activities and customer programs or improvements – which previously would have caused months of delay due to network rigidity – can be deployed and managed in a matter of days or a few weeks.

NFV is starting to move out of the experimental phase and into commercial deployment on a limited scale. Only 23 percent of our interviewees said they have already started to implement NFV to support current and/or new services. Innovators are clearly leading in this endeavor, with 92 percent having already applied NFV to parts of their network, but there is further work and deployment ahead.

Innovators identified the top three drivers for NFV as: faster time to market (TTM) for new services, better ability to adapt to changing business conditions and reduced creation time for service innovation (see Figure 1). Increased agility facilitates continuous and rapid innovation, faster deployment of new services and better adaptability to new market conditions. These are critical capabilities in a hyper-connected world in which 5G and IoT are essential, and CSPs must compete against digital-native companies that endlessly launch innovative services at unimaginable speeds.

AT&T bets on software-defined networking[8]

In early 2015, AT&T stated its plan to virtualize and software-control 75 percent of its core network functions by 2020. Since then, the company has been aggressively transforming its core network with SDN/NFV. At the end of 2017, the company hit its goal of reaching 55 percent and is positioned to meet its 2018 goal of 65 percent of virtualization.

In 2016, AT&T was the first major global carrier to launch a virtualized mobility packet core. It has further expanded its core network, resulting in the AT&T Flexware platform, which provides VNFs to businesses across the entire spectrum of the market, from Fortune 10 customers to single-site locations, such as retail stores.

If 5G gains mainstream adoption by 2020, as many are expecting, AT&T will have a software-defined network at just the right time to get the most out of 5G, as SDN, 5G and network slicing will be deeply intertwined.

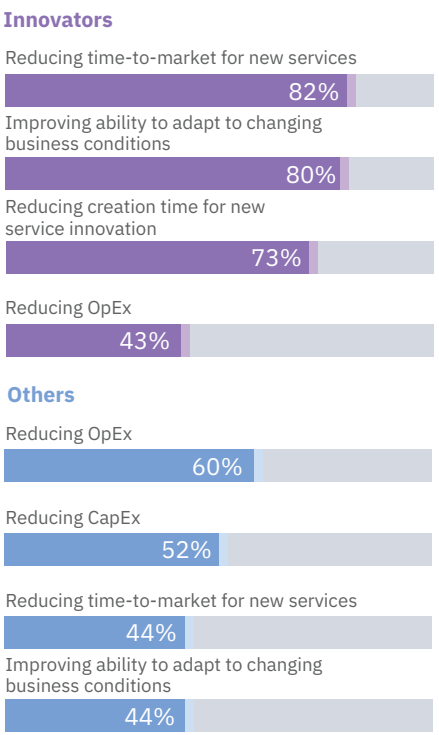
Innovators rank OpEx reduction as the fourth most important value driver, while all other interviewees rank it first. Network virtualization can potentially save on operational costs, as it allows for a new level of automation in the network by using the power of cloud, and accomplishes operational processes with little or no human intervention. CapEx reduction, once seen as the main motivation for network virtualization, is ranked lower by Innovators but is still seen as a key driver by the other interviewees.

VNF implementation is well advanced in security features, such as firewalls and intrusion detection, and in mobile core network elements. Almost all Innovators stated they already have implemented these VNFs. And about two-thirds said they have implemented VNFs for traffic analysis and forensics, as well as application optimization, such as content delivery networks (CDNs) and cache servers.

It is critical to focus on these VNFs, as CSPs can benefit from significant short-term return on investment through reduction of operation costs and hardware. However, silos of solutions for network services, each running their own cloud domains, like cloud appliances, are limiting further CapEx reduction and increasing operational costs. Initial CapEx reduction is occurring, but moving to full cloud enablement can help drive required reductions further.

Innovators are also setting the pace in virtualizing other network functions. Fifty-three percent have already developed virtual network services for switching and routing systems (39 percent plan to do this within two years), and 49 percent have already virtualized home environment appliances, such as set-top-boxes (39 percent plan to do this within two years).

Figure 1
CSP Innovators differ from others in their perceived four top value drivers for NFV/SDN



"Apart from many other benefits, saving time is the biggest achievement of network virtualization: deployment and system provisioning can now be done within minutes, whereas previously it took hours or even days."

CTO, CSP, Canada

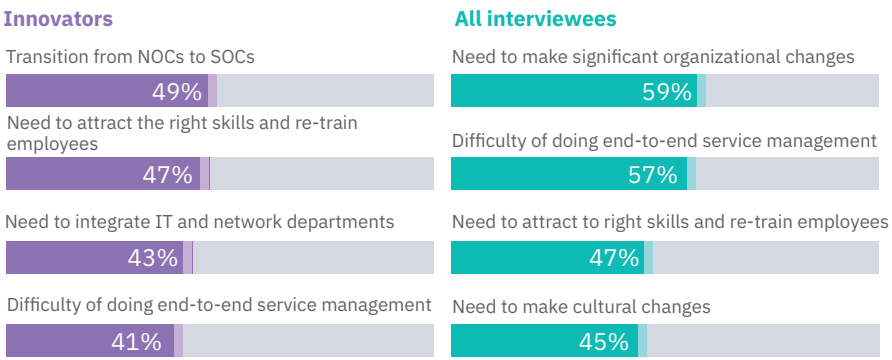
Almost two-thirds of all interviewees cited end-to-end service orchestration as a key challenge for implementing NFV/SDN. And 57 percent have worries about dealing with an environment that includes both virtual and physical resources, possibly from different suppliers. Indeed, the need to operate in a multi-vendor, multi-domain, multi-location, multi-service cloud environment that brings together virtual and physical networks is emerging as a key requirement to realizing benefits from a true network cloud.

The necessary transformation of operational and business support systems (OSS/BSS) is a key concern for 55 percent of the interviewees. Other inhibitors include security vulnerabilities, immaturity of the technology and standards not fully matured and agreed upon.

Challenges also exist from a business perspective (see Figure 2). Clearly, the main challenge is the need for significant organizational changes (cited by 59 percent of interviewees), as CSP organizations are traditionally operating in silos. Fifty-seven percent foresee problems in doing end-to-end management in the hybrid network environment.

With the adoption of network virtualization, network operations will look more like cloud operations, forcing network design, operations, IT and customer experience teams to work as one agile team. And network designers must increasingly work as software developers. Forty-seven percent of all interviewees find it challenging to attract the right combination of IT-network skills and significantly retrain employees. Forty-five percent say it will be difficult to make the required cultural changes and integrate IT and network departments.

Figure 2
The top four business inhibitors for CSPs in implementing NFV/SDN



Interestingly, the primary business challenge for Innovators is the transition from network operation centers (NOCs), which optimize the network for improved performance per network domain, to service operation centers (SOCs), which optimize the network for superior services delivery.

This shift enables CSPs to prioritize actions based on impact to services and customer experience – a key motivation for the network transition. This is further extended as the service becomes virtualized and the SOC allows the CSP to focus on the service across both physical and virtual IT and network components. The ability to visualize the service and its components – whether virtual or physical – becomes essential to understanding the managed service and how to improve its quality.

The end of network management as we know it

Virtualization and cloudification allow for an unprecedented level of network automation – especially in a world in which workloads in mobile networks are becoming increasingly dynamic and many IoT applications require low latency. Often, no time is available for human interactions.

Without a service- and customer-centric view, CSPs can't understand the customer experience sufficiently to focus resources where and when needed. With real-time inventory, analytics and AI-based machine learning, SOCs benefit from a self-learning solution that partners with humans to augment and automate operations, predict issues, scale knowledge and provide consistent resolution (see sidebar, "Automation with Telefónica's UNICA platform").

For the Innovators, the ability to more easily scale networks and meet service expectations are key drivers for automation. The vast majority of Innovators have already automated in some form more than 30 percent of network functions, far more than their peers. Approximately four-out-of-five expect to have automated 50 to 70 percent of their network functions within two-to-three years, with an ultimate goal of 70 to 90 percent of network functions.

Automation with Telefónica's UNICA platform[9]

Telefónica keeps evolving towards the virtualization of its network, based on the UNICA project. Telefónica envisages operating a network that is fully virtualized and programmable, and which enables the company to cost-efficiently and flexibly align with demand, simplify network complexity and reduce time to market for new service delivery.

UNICA is a project that evolves to support and guarantee future network needs, providing a way to have Zero Touch operations by automating the end to end life cycle of creating and operating network services along with a smooth evolution towards 5G. Central to achieving this goal is Telefónica's efforts in leading ETSI's Open Source MANO (OSM) project.

CSPs increasingly recognize AI's central role in automating the network (see sidebar, "Automating NBN with machine learning"). Twenty-six percent of our interviewees – and 96 percent of Innovators – are using, or plan to use, some form of AI for automation. This enables faster decision making by capturing and processing network data and performance of key services in real time and by automating network functions.

Organizations can train AI systems to look for patterns – detect, predict and localize irregularities in the network – and to take proactive steps to fix them before they impact customers. AI can be combined with automation to solve problems and then apply the right resolution to reduce the complexity of operations and the number of operators needed. It can also predict and route traffic, so that CSPs are better prepared for large events, such as the world soccer games or Singles' Day in China.

Innovators realize the importance of proactive operations. Virtually all of them in our survey (versus only one-sixth of all other interviewees) are applying automated proactive operations in some form, based on predictive insights.

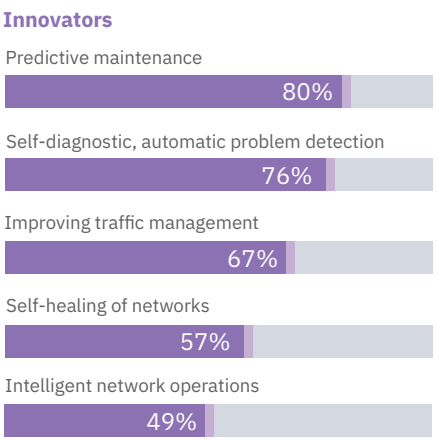
CSPs can also use real-time analytics and AI to calculate future states based on various conditions and business policies. This enables zero-touch automatic provisioning of network resources in an optimal way to help improve service. Intent-based systems can combine this capability with orchestration automation to provide closed-loop control of the service lifecycle. AI-enabled operations can then drive machine-enabled service automation to move from a current state of service to the future desired state – enabling automation in real time without having to program every option operationally.

Automating NBN with machine learning[10]

The National Broadband Network (NBN) is an Australian national wholesale, open-access data network, rolled out by NBN Co. As part of the company's transition from network builder to network operator, it is implementing a network operations automation (NOA) program to automate workflows in its network operations center. The vision is to optimize 48 full-time equivalent employees (FTEs) in conjunction with network growth and technology changes by the end of five years.

As a first step, the company updated its network management suite with machine learning capabilities and discovered that they could handle root cause analysis and patterns efficiently. This capability can be automated to significantly reduce man-hours required in this process. Next, NBN Co will start automating more parts of the assurance process, including cognitive troubleshooting and AI-driven automations to act on alarms that identify actual, actionable problems in the network.

Figure 3
Areas where Innovators are using or plan to use AI to support processes and personnel



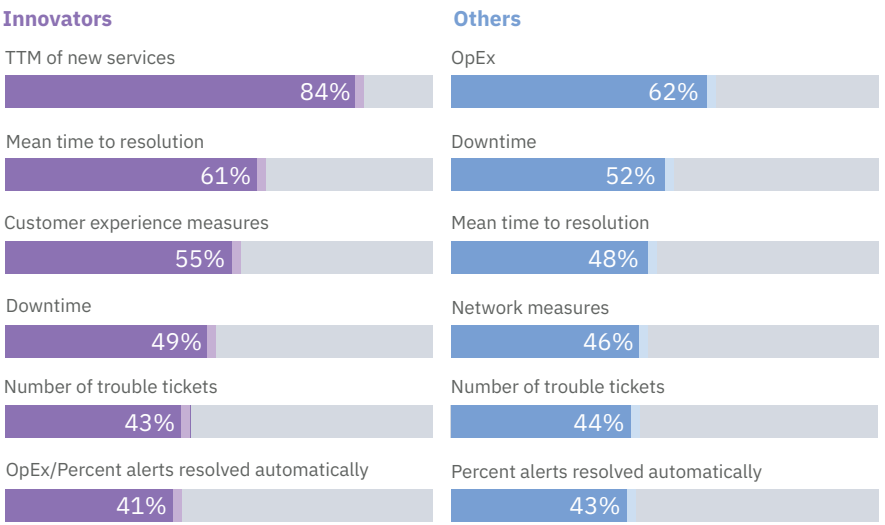
Innovators understand that proactively performing predictive maintenance on the network infrastructure and assets can yield a significant return in OpEx and customer satisfaction (see Figure 3). Other key areas they mentioned for using AI applications include self-diagnosing (such as troubleshooting and automatic detection of network problems), improving traffic management and self-healing of networks.

Supply chain automation was cited by innovators as key to improving the network, including such benefits as: greater scalability of network and performance (71 percent), reduction of disputes between players in the supply chain (65 percent) and improved traceability of assets, such as set-top boxes and smartphones (55 percent). CSPs can apply blockchain technology to enhancing the supply chain with the speed and agility needed in an NFV world.

Key performance indicators (KPIs) are essential for assessing the success of network automation initiatives (see Figure 4). For Innovators, TTM of new services is by far the most important KPI; for the others, it is OpEx. Innovators also rank customer experience measures as a key KPI. Indeed, automation can significantly reduce unpleasant experiences customers regularly have with the network.

Though automation is essential for taking full advantage of the dynamic nature of NFV and cloudification, the transition is not easy. For more than half of the executives surveyed, upfront expenses are the main inhibitor. The costly and time-consuming integration with legacy systems (48 percent) and the high learning curve due to complex technology (45 percent) are two other key inhibitors. To overcome the barrier of the high learning curve, technical training for both IT and network staff is imperative, but making network operations staff think and act like software developers remains challenging.

Figure 4
Most important KPIs for success of automation initiatives



Forty-nine percent of Innovators cite security concerns as a major obstacle. The new NFV environment is more complex and might be vulnerable to new and different types of security risks. It requires a new approach to security mitigation. CSPs should consider making machine learning a part of the automation process to dynamically adapt to these new security threats.

"Virtualization gives us the flexibility to innovate and adapt quickly to any new demand."

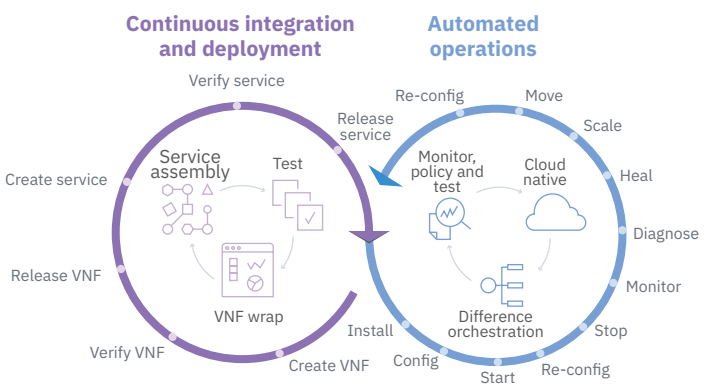
COO, CSP, United Kingdom

Building a service innovation factory

With networks increasingly becoming software-based, it can be easier and faster to create new services by assembling and chaining software components together. In fact, it allows for a DevOps-like model for network service development, network operations and end-to-end management. Network DevOps enables a lean and effective way to faster implementation of functionality – and services that can improve customer experience and drive revenue – by automating the service lifecycle and driving resiliency.

Adopting a DevOps methodology for network operations is crucial to the evolution of future networks. It provides an environment for continuously engineering (building, onboarding, testing and managing) new services – and integrating ongoing updates of existing services – in a lean, fast way (see Figure 5). Automating the entire service lifecycle reduces introduction of services from years or months to weeks or days.

Figure 5
End-to-end DevOps chain from initial onboarding to operational lifecycle management

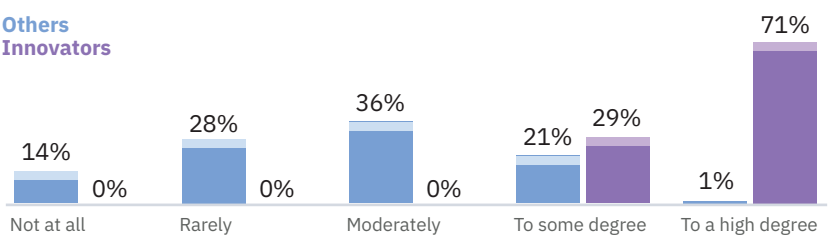


Deploying DevOps makes network design and operations more like IT. It requires significant cultural and mindset changes, and the education of network design and operation staff to adopt a software approach in developing and operating network services. This must be done in close cooperation with IT and customer experience teams.

Although two-thirds of the executives we surveyed have not – or have only moderately – adopted DevOps in their organizations, Innovators have clearly made more progress; all in our survey say they have significantly adopted a DevOps methodology in their organization. In fact, 71 percent of Innovators are already using DevOps to a high degree for onboarding and testing network services throughout the service lifecycle (see Figure 6).

Figure 6

Extent to which CSPs have used DevOps for onboarding and testing throughout the service lifecycle

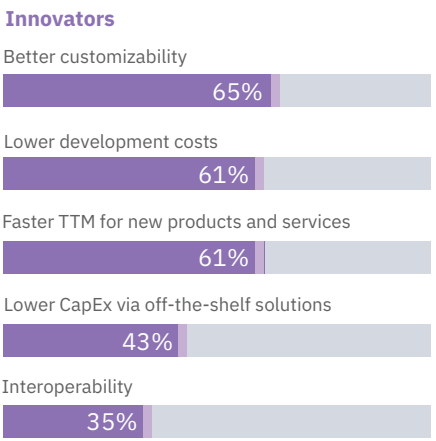


Open source for NFV development[11]

CSPs are increasingly adopting open-source software, disrupting the traditional business model of vendors selling proprietary "black box" products. NFV/SDN-related initiatives have been accelerated in the last year, in particular around OpenStack (an open-source community), the Open Network Automation Platform (ONAP, which is now a part of Linux Foundation Networking) and open source Management and Orchestration (OSM).

CSPs use OpenStack at the virtual infrastructure manager layer to give a standardized interface for managing, monitoring and assessing all resources within the NFV infrastructure. Tier 1 CSPs use code from both ONAP and OSM to build management and orchestration (MANO) platforms. While OSM focuses on implementing the ETSI MANO specifications, ONAP has gone beyond MANO to embrace design and run side of the operational requirements. ONAP has received significant acceptance, but OSM also is finding its way in CSP networks.

Figure 7
Advantages of open source for network virtualization



The success of VNF lifecycle automation using DevOps depends on standards for modelling and packaging VNFs. Standards have always played a key role in telecommunications technology adoption, and this holds true for VNFs. Standards enable interoperability and portability and help create an ecosystem from which end-users and vendors alike can benefit. Standardization in network virtualization contributes to a more effective end-to-end-management model and to better opportunities for automation, according to the majority of survey participants.

Standards can help accelerate the adoption of virtualized networks, and open-source technology can play a crucial role. With open source, CSPs can implement a given standard to speed adoption and create a consensus in the software community in development of NFV and associated tools (see sidebar, “Open source for NFV development”). For 65 percent of the Innovators, better customizability is open source’s number one benefit: open source projects provide the code that they can build upon and/or modify to create market-differentiating products and services (see Figure 7). Lower development costs and faster TTM for new products and services are seen as two other key advantages.

Forty-five percent of Innovators work with a supplier or integrator to develop the solutions for network virtualization and/or automation together. The key reason to turn to an external supplier is to realize implementations that help reduce OpEx and CapEx. For organizations that haven’t started implementing NFV solutions yet, another key reason is to gain access to the required skills and expertise.

The way forward

To thrive in a 5G world and reap the benefits of the network cloud, we recommend CSPs pursue infrastructure agility as follows:

Overcome immense costs and navigate new revenue streams.

- Start the journey to cognitive- or AI-enabled network operations, if you haven't already. Apply automation with AI to offload the need to determine and program every possible option for service operations automation. Utilize the machine learning and enablement of best practices – yours and those of other vendors – with automation. Empower the operations staff with AI to bring the information needed together, so your operations staff can then be "as good as your best."
- Enable a service focus versus a network-component-availability focus to increase quality of service, quality of experience and performance management. A better customer centricity focus lays the foundation for tomorrow's cloud-based networking environment and new revenue growth.

Dial in to innovative services.

- Utilize software-based versions of the next service or release of services. Determine how to lay the first building blocks of the foundation of a network cloud, instead of cloud appliances, so you have path to a multi-vendor, multi-function, multi-domain cloud-based networking environment that doesn't lock you into a vendor or a technology and highly optimizes the cloud infrastructure.
- If you have already started to virtualize services, use one network hybrid cloud and tune for the type of environment that brings together the current and future network, so you can realize benefits now and not be locked into siloed solutions of virtualization and sub-optimized cloud environments.

Methodology

We interviewed 200 CSP executives from 24 countries in Europe, North America, Latin America, Asia, China, Japan, the Middle East and Africa. The group included 71 CxOs, of which 26 were CTOs. The interviewees were all familiar with their organizations' NFV/SDN strategies. Expertise of surveyed executives spanned technologies (49 percent) and business value (37 percent); 17 percent were proficient in both.

All organizations were exploring, piloting or implementing NFV/SDN. The organizations' size by annualized revenue ranged from under USD 500 million to over USD 10 billion.

Ready or not?
The following questions can help determine if you are ready to move forward with network virtualization.

How do you provide service assurance in a multi-vendor, multi-service cloud environment that brings together virtual and legacy networks?

What role do you foresee for machine learning as part of the automation process for operations? For lifecycle management?

How do you simplify and manage network operations efficiently with accelerated DevOps, augmented by AI and automation?

What actions have you taken to transform the workforce to help make sure you have the skills crucial for network virtualization?

In addition to bringing operational benefits, how are the new service capabilities being translated into new revenue streams?

– Activate machine-enabled automation of the services lifecycle, so you can create a network cloud environment that can not only scale, but can migrate and heal a service across the domains from which it provisions and allows for rapid innovation. Lifecycle automation reduces the staff required to operate the hybrid network needed to support 5G.

Seize upon an agile network DevOps culture to stay a step ahead of the inevitable.
– Implement services using cross-functional teams. Utilize agile DevOps methods and team alignment that allow for rapid services enablement and methods and knowledge sharing across teams. During the development process, automate the testing and test management of not only the initial service, but also software updates and upgrades in the network.
– Treat the shift to agile DevOps as an organizational change management process from the top down to drive the vision, find the quick hits, and communicate success and learnings on an ongoing basis. Enabling teaming, testing and leadership will not only help facilitate customer-centric services, but also help to continually update and integrate new capabilities and changes.

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