HOW WILL IT IMPACT OSS?
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NFV: HOW WILL IT IMPACT OSS?

Executive summary

Operators playing in the digital services market are under increasing pressure these days. In former growth markets demand for established services is stagnating. In mature markets the threat of revenue shrinkage is imminent, if not already underway. Revenue from legacy voice and messaging services is also stalling or in decline. Delivering services with traditional hardware-intensive networks is increasingly complex and costly, further impacting margins. Market competition also continues to intensify, and churn remains a problem for many operators.

As if this were not enough, traffic volume on networks is forecast to reach 1.4 zettabytes per year, or just over 120 exabytes per month in 2017. But the challenge here is not limited to volume, at least not for the operators hoping to deliver something more than commodity services. Advances in devices, video services, cloud computing and machine-to-machine communications bring a whole new set of traffic characteristics. All of these developments will force increased investment in infrastructure.

Network functions virtualization (NFV) offers a solution to some of these problems, at least from a network architecture perspective, by offering lower costs, greater agility and higher levels of service customization. But it is an initiative that will take time to deploy. NFV is not a completely new idea – some of its concepts (for example, moving network and service logic to general purpose computing platforms) were principles driving intelligent network initiatives in the circuit-switched voice network and more recently IP Multimedia System (IMS) – but the NFV approach goes far beyond earlier efforts.

Section 1 of this report takes a look at the history of the NFV initiative. It began in October 2012 with the publication of a white paper outlining the benefits, enablers and challenges of this approach to network virtualization and an announcement of the formation of the Network Functions Virtualization Industry Specification Group (NFV ISG) under the auspices the European Telecommunications Standards Institute.

Recently, the NFV ISG has published an updated white paper as well as a supporting set of technical and architectural documents. It is working with other groups, including TM Forum, to improve the documents and has initiated a global proof-of-concept initiative.

In Section 2 we look at the particular challenges NFV and virtualization in general pose for operational support systems (OSS). NFV will be disruptive to the support systems’ architecture and will require a new generation of OSS. There is a good deal of work going on now to define how OSS might work with NFV including a new TM Forum initiative. Ultimately, much of the success in implementing network virtualization hinges on the operators’ ability to upgrade the OSS environment.

In Section 3 we share insight from our own research on NFV conducted in 2013. We believe implementation will begin in earnest in the middle of 2015 when we will see control elements like policy, IMS and perhaps some edge components being the first targets, with core virtualized network functionality being adopted significantly later. We also expect NFV technology to coexist and interoperate at some level with existing network infrastructure.

Finally, in Section 4 of the report we offer some conclusions and recommendations to help operators prepare for NFV deployment and virtualization in general.
Section 1

What is NFV?

The current digital services market does not offer a lot of obvious low-hanging fruit for network operators. Even in markets that were recently considered growth markets demand for traditional services is stagnating, and in mature markets the threat of revenue shrinkage is imminent, if not already underway. Revenue from legacy voice and messaging services is also stagnating or in decline. Delivering services with traditional hardware-intensive networks is increasingly complex and costly, further impacting margins. Market competition also continues to intensify, and churn remains a problem for many operators.

As if this were not enough, traffic volume on networks is forecast to reach 1.4 zettabytes per year, or just over 120 exabytes per month in 2017 (see Figure 1-1).

The challenge is about more than volume
The challenge is not limited to volume, at least not for the operators hoping to deliver something more than commodity services. Advances in devices such as smartphones, tablets and even wearable technology, are driving traffic, and IP-based video is increasing faster than any other class of traffic.

Contextual usage factors including social networking, mobility and unbundling are deeply impacting the way consumers access and use services. Cloud services move storage from the edge to the middle of the network, impacting traffic patterns and giving consumers and enterprises ever-increasing access to data.

Machine-to-machine (M2M) applications bring a whole new set of traffic characteristics, requiring a broad range of prioritization and in some cases nontraditional upload/download balances. All of these increases in volume will force more investment in infrastructure for operators to deal with the traffic tsunami and keep their customers – and regulators – happy.

Increased infrastructure investment is not good news considering a 2012 analysis by multinational professional services firm PricewaterhouseCoopers (PWC) titled We need to talk about Capex: Benchmarking best practice in telecom capital allocation. According to the study, which surveyed 78 operators responsible for about two thirds of the capital investment in the industry, the average long-term return on investment (ROI) on infrastructure capital equipment averaged just 6 percent, which was 3 percent lower than the cost of the capital. Clearly service providers need to find ways to improve on this inadequate performance.

Figure 1-1: The predicted growth in global data traffic

<table>
<thead>
<tr>
<th>Year</th>
<th>Exabytes per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>30</td>
</tr>
<tr>
<td>2013</td>
<td>60</td>
</tr>
<tr>
<td>2014</td>
<td>90</td>
</tr>
<tr>
<td>2015</td>
<td>120</td>
</tr>
<tr>
<td>2016</td>
<td>150</td>
</tr>
<tr>
<td>2017</td>
<td>180</td>
</tr>
</tbody>
</table>

Source: Cisco VNI, 2013

NFV: HOW WILL IT IMPACT OSS?

NFV to the rescue
Network functions virtualization (NFV) offers a key approach to addressing some of the problems operators are facing, at least from a network architecture perspective, by offering lower costs, greater agility and higher levels of service customization through virtualized infrastructure.

There are many forms of virtualization dating back as far as the 1960s with the breakthrough of virtual memory management on mainframes, but here we are referring largely to platform and application virtualization.

This is, of course, also the basis of cloud computing, along with autonomic functions, and is the driver of much of the economic scale available in cloud. A full business case analysis of virtualization is beyond the scope of this paper, but IT organizations across many industries have achieved significant cost reduction using virtualization.

Many IT functions now run in virtualized environments, including policy control, real-time charging, and certainly customer relationship management software, not to mention broad variety applications available in commercial cloud deployments. Most operators are already dealing with virtualization in some form, which should provide a very useful learning environment, not to mention cost savings.

NFV is not a completely new idea either. Some of its concepts (for example, moving network and service logic to general purpose computing platforms) were principles driving intelligent network initiatives in the circuit-switched voice network and more recently IP Multimedia System (IMS) – but the NFV approach goes far beyond earlier efforts.

It’s also important to note that NFV is not the same as software-defined networking (SDN), although it can enhance SDN. SDN separates control and data forwarding planes to enhance performance, simplify compatibility with existing deployments, and facilitate operations and maintenance procedures. NFV can support SDN by providing the virtualized infrastructure for SDN software to run on.

Operators take charge
The NFV initiative began with the publication of a white paper in October 2012 outlining the benefits, enablers and challenges of this approach to network virtualization and an announcement of the formation of the Network Functions Virtualization Industry Specification Group (NFV ISG), under the auspices the European Telecommunications Standards Institute (ETSI). The group was founded by seven large operators – AT&T, BT, Deutsche Telekom, Orange, Telecom Italia, Telefónica and Verizon – and now includes more than 150 companies, 28 of them service providers.

The NFV ISG has several working groups including, Infrastructure Architecture, Management & Orchestration, Reliability & Availability, and Software Architecture. The group has updated its initial white paper and has published a number of other documents including:

“The NFV ISG was founded by seven large operators – AT&T, BT, Deutsche Telekom, Orange, Telecom Italia, Telefónica and Verizon – and now includes more than 150 companies, 28 of them service providers.”
Initial NFV proof-of-concept project taps TM Forum’s Integration Framework (SID)

- **GS NFV 001 – Use Cases**, which describes various categories of applications spanning the scope of work of the NFV ISG;
- **GS NFV 002 – Architectural Framework**, which delineates the different constituents and outlines the reference points between them as envisaged by the operator community, explicitly defining certain functional building blocks to facilitate multi-vendor interoperability, as well as the orchestration and management tasks necessary in the NFV framework, recognizing coexistence with external Business and Operational Support Systems (BSS/OSS);
- **GS NFV 003 – Terminology for Main Concepts in NFV**, which defines key terms;
- **GS NFV 004 – Virtualization Requirements**, which addresses a broad range of topics including portability of software-based functions, performance requirements, management and orchestration, elasticity, security, resiliency and network stability, service continuity, operations automation, energy efficiency and migration, and co-existence with existing platforms; and
- **GS NFV-PER 002 – Proofs of Concepts**, which outlines procedure and intent of POC projects.

So far one POC project has been approved: The CloudNFV group – a consortium founded by industry veteran Tom Nolle, president, CIMI Corp., and Chief Architect, CloudNFV – started work on its POC in mid-January with the goal of reporting results beginning in February and contributing four major documents to the ISG’s process through the first half of 2014.

The CloudNFV POC leverages extensions to the ETSI NFV framework based on two TM Forum guide books – the Integration Framework Suite (GB942) and the Information Framework (GB922). According to CloudNFV’s proposal to the NFV ISG, the POC’s primary goal is “to demonstrate a framework for the application of NFV principles to actual service provider service creation, deployment and management practices.” We’ll talk a little more about CloudNFV in Section 2 (see page 12).

The NFV ISG has stated that it expects to reevaluate its purpose in January 2015, two years after its first formal meeting, when it will recommend which aspects of its work must be taken forward in other standards bodies and/or whether a longer-term coordinated effort will be needed to ensure rapid maturation of NFV technology.

**NFV dissected**

To understand the potential impact of NFV, it’s important to have a clear picture of its intended structure and function. Much of this description is summarized from ETSI documents, which can be downloaded from the ETSI website (www.etsi.org).

NFV is intended change the way operators plan, design and operate their networks. Historically, networks have been largely composed of a broad collection of purpose-built, proprietary devices and appliances. To meet performance requirements within a relatively narrow range of functionality, these appliances have required specialized hardware.

Accordingly, while the devices generally have been hardened for performance, they can be inflexible and expensive to own and manage. That lack of flexibility provides little investment protection in a rapidly changing technological and service-related environment.

The ETSI NFV approach aims to evolve network architecture by using standard IT virtualization technology to replace many network equipment types with network functions implemented in software on industry-standard, high-volume servers, switches and
storage. The resulting functions can then be distributed across hardware platforms in a variety of locations, including data centers and end user locations, and can be dynamically re-distributed across these locations as required, protecting the operator’s investment and increasing agility in responding to performance needs (see Figure 1-2).

The importance of advances in technology

Fundamental to NFV is the emergence of several important technological advancements: cloud computing, industry standard servers and open application programming interfaces (APIs) for the management and data planes. The scope and maturity of each of these areas vary significantly, at least relative to NFV.

Cloud computing, and especially virtualization, is really at the core of NFV, as it allows for the elasticity and flexibility that underpins the NFV business case. Virtualization also enhances the ability to consolidate infrastructure and workloads, which lowers capital, operational and environmental costs. Cloud infrastructure also provides methods to enhance infrastructure resource availability and usage, such as orchestration and management mechanisms.

Industry-standard, high-volume servers represent a key element in the economic case for NFV as well, leveraging the economies of scale of the IT industry through the use of high-volume, standardized IT components and subcomponents. This is in direct contrast to purpose-built network appliances that use custom application specific integrated circuits (ASICs).

Industry-standard servers will likely comprise the vast majority of NFV infrastructure as the price-performance gap between commodity components and general-purpose processors is widening, but ASICs-based platforms will...
Virtualized network functions need open APIs to communicate with each other and other objects.

Open APIs represent the third crucial component of NFV. Since virtualized network functions (VNFs) are software-based, combinative, and their performance is dependent on their infrastructure, interoperability and manageability, they need a set of APIs to communicate with each other, their infrastructure, management tools and other objects.

For example, the availability of open APIs resident in data plane control and orchestration systems such as OpenFlow and OpenStack should provide an additional degree of integration of NFV and cloud infrastructure, provided the VNFs have appropriate APIs themselves.

Open APIs will allow VNFs to be built more quickly and cost effectively, and to interface with a broader array of objects.

Uses cases for NFV
The ISG sees NFV as applicable to any data plane packet processing and control plane function in mobile and fixed networks. Some examples are shown in Figure 1-3 below.

As can be seen from the table, much of the network can at least in theory be virtualized, though there is some question about the ability to provide the performance, resilience and stability necessary given traditional network performance expectations.

Figure 1-3: Network functions that could be virtualized

<table>
<thead>
<tr>
<th>Network Element</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching elements</td>
<td>Broadband network gateways, carrier-grade Network Address Translation and routers</td>
</tr>
<tr>
<td>Mobile network nodes</td>
<td>Home Location Register/Home Subscriber Server, gateway, GPRS support node, radio network controller, various Node B functions, etc.</td>
</tr>
<tr>
<td>Customer premises equipment</td>
<td>Home routers, set-top boxes</td>
</tr>
<tr>
<td>Tunneling gateway elements</td>
<td>IPSec/SSL virtual private network gateways</td>
</tr>
<tr>
<td>Traffic analysis</td>
<td>Deep Packet Inspection, quality of experience measurement</td>
</tr>
<tr>
<td>Assurance</td>
<td>Service assurance, service level agreement monitoring, testing and diagnostics</td>
</tr>
<tr>
<td>Signaling</td>
<td>Session border controllers, IP Multimedia Subsystem components</td>
</tr>
<tr>
<td>Control plane/ access functions</td>
<td>AAA servers, policy control and charging platforms</td>
</tr>
<tr>
<td>Application optimization</td>
<td>Content delivery networks, cache servers, load balancers, accelerators</td>
</tr>
<tr>
<td>Security</td>
<td>Firewalls, virus scanners, intrusion detection systems, spam protection</td>
</tr>
</tbody>
</table>
NFV: HOW WILL IT IMPACT OSS?

Section 2

The OSS Challenge for NFV

Network functions virtualization (NFV) promises a long list of benefits. Most often cited are reduced equipment costs through the use of commodity hardware, ability to consolidate hardware, ability to combine IT and network functions, and faster time to market with new services.

In addition, the ability to optimize network configuration and/or topology in near real time and to scale services up or down rapidly gives operators great agility. The ability to perform software-based, remote provisioning saves time and money. Running production and test software on the same infrastructure reduces development and deployment costs and also cuts time to market and energy consumption through server consolidation and sophisticated power management.

Server consolidation also reduces the number and types of ‘boxes’ needed to manage the network, so this should lead to lower operational expenditure (OpEx) over time. Moreover, fewer types of equipment means a narrower set of skills are needed to plan, design, implement and manage the hardware components, though software complexity will certainly increase with virtualization.

On the other hand, there are challenges associated with network virtualization.

Portability and interoperability are crucial if virtualized network functions (VNFs) are to offer the operational flexibility expected. The use of industry-standard hardware may cause a decrease in performance. Security and resilience are also huge issues which must be addressed.

Since NFV will co-exist for the foreseeable future with legacy systems both will have to interoperate at some level, and management considerations will be important as well. Moreover, the combined old and new infrastructure will likely need to jointly address the performance issues discussed above.

NFV will require a high degree of automation and will have a high dependency on operational analytics if it is to perform as expected. Finally, to meet OpEx goals, NFV operations will need to be simplified. These are big challenges, given the scale and complexity ultimately expected of NFV.

OSS disruption

NFV is going to be disruptive to the Operational Support Systems (OSS) architecture and will require a new generation of OSS. TM Forum recognizes this and has created a new program called to tackle the difficult back-office integration issues associated with virtualization (see panel on page 11).

“Several sources said they doubt the ability of today’s heavily process-oriented OSS to keep pace with the more dynamic NFV environment.”
NFV is disruptive to current OSS architecture and will require a new generation of systems

TM Forum sets up new NFV-focused program

TM Forum aims to rewrite the rulebook for business operations for the digital world. It aims to do this by bringing together the best-in-business to work together and create a living blueprint for the next generation of service providers’ support systems. The plan is to make all types of service providers true agile and provide expert guidance on how to navigate the complex journey to becoming so.

Our NFV work will complement ongoing work within ETSI and other groups to provide the management platform and transformation guidance to support successful deployment of virtual networks and services.

TM Forum is recruiting dynamic, enthusiastic volunteers from member companies to participate in a range of roles including executive sponsors, advisors and advocates, network and IT architects, operations experts, and enterprise and IT architects.

To learn more and get involved, please contact Ken Dilbeck, Vice President, Strategic Programs at kdilbeck@tmforum.org

The NFV architectural framework identifies a Management and Orchestration (MANO) domain, which includes three management components (the NFV Orchestrator, the VNF Manager, and the Virtualized Infrastructure Manager) that complement the functionality of current OSS. The ISG suggests that to obtain maximum benefits from NFV automation and agility, current OSS and NFV interfaces, associated information models and business processes (for example, fulfilment, assurance, billing, security) must be aligned so that both traditional and virtualized infrastructure can be managed simultaneously.

Different situation

The ISG correctly recognizes that the level of impact on the OSS will be highly dependent on the existing OSS environment for each operator, ranging from simple existing tool configuration to complete change or roll out of new OSS components, including potentially incorporating element management systems (EMS) functionality, service management or network management control into management and operations.

Accordingly, expectations that operational complexity and associated OpEx will be reduced may be true for some, but again this will vary greatly based on the operator’s current portfolio, the aggressiveness and depth of their migration and their ability and willingness to invest in appropriate systems and platforms for OSS functions.

We are currently in the early days of detail definition of OSS for NFV. At the time of publication, the ISG’s MANO requirements had not yet been published, but the current architecture seems to show each VNF having its own set of functions (for example, fault, configuration, accounting, performance, security) as part of its EMS, which in turn will communicate with operators’ OSS.

Whether this architecture will stand over time remains to be seen, but nearly everyone interviewed for this report expects significant change, and several sources said they doubt the ability of today’s heavily process-oriented
NFV: HOW WILL IT IMPACT OSS?

OSS to keep pace with the more dynamic NFV environment. Certainly OSS will continue to play a critical role in resource planning, service fulfillment and assurance, federation of various databases, and reporting. There will also likely need to be real-time OSS components to manage the vast array of VNFs, either directly or through the EMS – depending on the evolution of the MANO specs and acceptance by operators.

One of the more interesting developments in this area is the adoption of TM Forum’s Integration Framework (GB942) as part of the CloudNFV POC (see page 7 for more information about CloudNFV). The Integration Framework, which can be used for both management and orchestration functions, is a blueprint for designing and implementing the integration of management systems in service provider operations (see pages 13-14).

Reducing software development time
It was created with the goal of reducing software development time and lifecycle costs by creating a common, shared integration environment that can be used repeatedly and is well understood for integration across systems, improving quality, consistency and interoperability. It achieves this by allowing for the definition of standardized templates for the development of new interfaces and by providing the Integration Framework tooling for implementing the interfaces.

The Integration Framework “proposed to integrate data, process, and service events in a single structure,” Tom Nolle, Chief Architect, CloudNFV, wrote in a blog in January.

“Events would be handed off to processes through the intermediation of the service contract, a data model. If we were to put this into modern terms, we’d say that GB942 proposed to augment basic contract data in a parametric sense with service metadata that described the policies for event handling, the links between services and resources, etc. While I certainly take pride of authorship for the framework of CloudNFV, I’ve always said that it was inspired by GB942 (which it is).”

TM Forum has a long history of helping operators develop collaborative solutions to improve their businesses, and we are committed to helping them make the necessary changes to the operational environment to take advantage of emerging NFV technology. In the coming months we will provide updates on our progress with the new NFV program as well as additional research on virtualization and software-defined networking.

“One of the more interesting developments in NFV and OSS is the adoption of TM Forum’s Integration Framework as part of the CloudNFV proof-of-concept project.”

2www.tmforum.org/GB942
3http://blog.cmicorp.com/?p=1591
What’s new in Frameworx 13.5 and how can it help you?

Frameworx 13.5 centers around the crucial issues facing service providers of all kinds in an open digital economy which are reflected in TM Forum’s three Strategic Programs:

- Agile Business and IT Program focuses on improving operational agility while reducing cost and risk;
- Open Digital Program is designed to drive new digital services’ revenue growth; and
- Customer Engagement Program targets better market share retention and greater growth.

Frameworx was created by and is constantly evolved to meet changing needs of TM Forum’s members. They include all sorts of service providers, software suppliers, integrators, universities, and enterprises. Members set priorities and lead collaborative project groups to implement the work and create updates to the standards and best practices.

While Frameworx major releases are published every six months, some features in Frameworx 13.5 were developed in short-term agile-style development projects and have been made available to the broader membership several months in advance.

Frameworx releases cover the full suite of TM Forum’s best practices and standards including our core Frameworks – Business Process, Information, Application, and Integration – as well as our Business Metrics and our broad range of best practices. Frameworx 13.5 is no exception with 47 new items introduced across the full range.

Facts about Frameworx 13.5:
- 27 projects were chartered to create this release;
- 141 companies participated in creating the deliverables;
- About 380 individuals joined projects in the community – approximately 40 percent of them were active contributors, while the rest had the opportunity to observe and review, comment or ask questions.

New B2B best practices and APIs
TM Forum has defined a comprehensive set of Accelerators – tools, methodologies and standardized interfaces for creating and managing partnerships in a B2B2X environment with multiple partners, in a repeatable manner, and at industrial scale. They include new REST 2 application program interfaces (APIs) for catalog management, trouble ticketing and partner ordering.

Big Data Analytics Guidebook
Unleash the power of big data held by service providers using the new reference model, methodology and more than 30 use cases. This document defines a crucial linkage between business value that analytics can unlock and the big data technologies and information sources represented in the document’s Big Data Reference Model.

Threat Intelligence Dashboard and ROI Calculator
The Cyber Security Readiness Dashboard uses newly defined metrics to communicate Cyber Security readiness for C-Level management. The dashboard reduces risk by providing insight into issues that could have financial, legal/compliance and human safety impacts.

Customer Experience Management
Take a new approach to managing customer engagement with integrated Maturity Model, Lifecycle Model and Metrics. This new version of the Guidebook (incorporating 250 new metrics) marks the first step in the transition from managing customers’ experiences in a snapshot piecemeal way toward managing engagement with the customer across their entire lifecycle.

Core Frameworks Enhancements
There have been key new additions to all four Frameworks to extend their application and make them more immediately useful. For more information about how they apply to you and your business, please see www.tmforum.org/Frameworx13.5
NFV: HOW WILL IT IMPACT OSS?

Section 3

What do operators think about NFV?

Clearly, network functions virtualization (NFV) has great potential to help operators lower capital and operational costs, reduce complexity, bring new services to market more quickly, provide more flexibility in delivering services, and simplify operational procedures. However, we cannot overstate the fact that these are early days for the technology and many challenges remain, most having to do with architecture or technology, which is, of course, a subset of the overall issues operators will face with NFV rollout. Moreover, since we are still largely at the architectural specification stage, it’s tough to predict how quickly things will happen, though the ISG is moving with real determination.

With that in mind, we take a look now at some additional issues that will influence the rollout of NFV, and we hear from the service providers themselves through research we conducted in 2013.

Service provider adoption

Most of the service providers we’ve interviewed recognize that there is real and significant potential value in NFV. Their perception of value can be seen in our survey results from May 2013, originally published in an Insights Research report, Control is the Key: Policy, self-service and software-defined networks. We include some of the most significant findings again in this section. We surveyed a small number of operators, so the results are somewhat anecdotal but still indicative of operator opinion when it comes to virtualization and software-defined networking.

The leading benefit is operational and capital expenditure (OpEx and CapEx) savings, with about 75 percent of operators surveyed placing it among their top three choices (see Figure 3-1).

Figure 3-1: How service providers view the benefits of virtualization

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpEx/CapEx savings</td>
<td>80%</td>
</tr>
<tr>
<td>Greater management flexibility</td>
<td>60%</td>
</tr>
<tr>
<td>Better network performance</td>
<td>40%</td>
</tr>
<tr>
<td>Better customer exp and self service</td>
<td>20%</td>
</tr>
<tr>
<td>Faster new service rollout</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
</tr>
</tbody>
</table>

Source: TM Forum survey May 2013

Clearly this will be an important driver of the rollout, as cost savings are easier to control than something like revenue gains from new services.

In our conversations with operators, we have seen two camps emerging. The first, which is generally made up of larger and more progressive operators – especially those with significant cloud operations – seem to be leaning toward a strong architectural view and high degrees of integration with the network and computing infrastructure, and related new service realization/enablement. Operators with less experience or more conservative attitudes are focused more on cost savings.

Focusing on cost savings naturally leads to an emphasis on the business case as the primary driver, so the question becomes: How much is enough? While we spoke with only a small number of service providers, many of them

4Please see www.tmforum.org/controlisthekey. The report is available free to all employees of member companies and may be purchased by non-members.
Service providers recognize significant potential value in network virtualization estimated that a 25 to 35 percent reduction in costs would be the minimal acceptable range to drive the change. Virtualization studies we have seen on the IT side of the house have easily reached or exceeded these numbers, based largely on savings driven by server consolidation leading to lower capital, facilities and power consumption results.

Proof-of-concept (POC) exercises should be able to quantify potential savings, assuming there is a critical mass of POCs. Our conversations, while anecdotal, have also shown more confidence among respondents that CapEx reductions are more achievable than OpEx, at least in the early stages. Capex tends to apply to off-the-shelf platforms, whereas the rework of processes and retraining of personnel may well eat up any savings from operations in the short term, and the state of the Operational Support Systems (OSS) installed base will add significant complexity.

**Savings might take longer**

Some operators pointed out that due to long term coexistence scenarios, the OpEx savings may take significantly longer to achieve. While operators would be delighted if the installed base of OSS could manage both the old and the new infrastructure, they have little confidence that it can or will be able to adapt. This is consistent with what we found in our May survey as well, when we asked about inhibitors. As is shown in Figure 3-2 below, operators indicated lack of management tools as being the top inhibitor of progress.

One respondent summed it up this way: “The key here will be operationalization and automation of the cloud. Early cloud players like Amazon or Google have a solid vision for delivering new services quickly and flexibly, but they aren’t oriented toward the ‘five nines’

“Something has to give here – either we adjust our expectations, or we’ll have to find a way to radically improve performance while managing costs.”

---

*Figure 3-2: Network virtualization inhibitors*

- Lack of standards
- Cost
- Routers/switches
- Lack of management tools
- Lack of legacy vendor support
- Hype exceeds deliverables
- Complexity of network evolution
- No adequate benefit
- Market/customer confusion

0% 20% 40% 60% 80%
mentality of our industry. Something has to give here – either we adjust our expectations, or we’ll have to find a way to radically improve performance while managing costs. This will require solid tools and high levels of automation. And the regulators will have to cooperate as well if we are going to relax performance standards.”

We should also note here our belief that NFV is about much more than lowering cost: It is about delivering new services more quickly and being able to dynamically reconfigure them to deliver on performance and personalized/customized requirements, ultimately providing a better customer experience. So while the accountants are focusing on the savings, the marketing organization needs to quickly gain an appreciation for what can be delivered. While software is innately flexible, marketers still have to formulate services and offers that will sell. Of course, it will most likely be the cost side of the equation that will drive early product sales. We will be conducting more extensive research on the business cases for virtualization during 2014, so stay tuned for the results.

It won’t happen overnight
The transition to NFV is significant and complex, and even if the business cases are strong, it will take time to gain the appropriate skills and to sort out the complexity. It will also take time for vendors to come to market with products. (We discuss vendor response more on page 18.) Our research shows that most service providers put their implementations out in the two to four year range, which means mid-2015 to mid-2017 (see Figure 3-3). Moreover, several operators said they view this as a 10-year transition cycle for the infrastructure as a whole, especially in the core network.

Two important issues that must be addressed are skills and organization. The transition to virtualized infrastructure and network functions implemented in software requires more of an IT skillset than a classic ‘big iron’ network skillset. This, in turn, implies that the operators’ network and IT groups should be working much more closely together, especially if the more progressive view of a seamless network and compute infrastructure is to be realized. We are aware of a few operators looking to merge the two groups, but those are forward-thinking operators; the broader community isn’t considering merging network and IT as of yet. The organizations delivering carrier cloud services will need to be closely linked as well.
The transition to NFV is complex and will take years to implement.

We also asked operators which functions they plan to virtualize first. Again while the base was small and response therefore anecdotal, most respondents mentioned high-volume, simple platforms, like consumer platforms at the edge of the network as a likely starting point. The ability to quickly implement and update software-based access routers, firewalls and set-top boxes at the edge was most often cited. Others discussed ‘control plane’ functions like policy management, not surprising given the compute-intensive nature of these functions.

One place we do not expect virtualization to appear first is in the core network. One operator clearly stated that the core infrastructure is no place to be experimenting with immature technology, a point that is well taken.

Vendor response: a mixed bag

NFV won’t take off if vendors don’t deliver the products operators need to accomplish network virtualization. While many vendors are supporting the European Telecommunications Standards Institute (ETSI) NFV initiative, we have seen few concrete examples – only one proof-of-concept (POC) project has been approved so far (see page 7). Moreover, we see little incentive for aggressive action by the ‘big iron’ incumbent vendors, most of whom have large installed bases of traditional networking equipment. It will be interesting to see how quickly they move in this space, either through organic development or more likely though acquisition of smaller players with innovative technology.

For those smaller players, NFV could provide an opportunity to take a bite out of incumbent market share. There are some agile players in the policy control space with virtualized platforms that are either already commercially available or are in trials. There also has been some early movement in the area of charging functions, and some players are dabbling in the virtualized network functions/NFV infrastructure space as well. These players may be attractive to larger incumbent suppliers. Keep in mind that emerging software-defined networking companies were acquired to the tune of $1.6 Billion in 2012, and the POC process could be a launching pad for more promising newbies.

Other products may come from companies working on the IT side of the industry. Besides providing compute infrastructure – servers, storage and hypervisors – IT and cloud vendors have software development acumen and with an injection of know how could easily become NFV players.

They have some application management experience which could be useful in the development of new OSS. And with operators looking to expand their service portfolios, migrating apps to play in this environment seems like a natural progression.
NFV: HOW WILL IT IMPACT OSS?

Section 4

Conclusions and recommendations

Without a doubt, network functions virtualization (NFV) has the potential to revolutionize how operators manage their networks and operational support environments, but the technology is in its infancy and the challenges won’t be easy to overcome. Still NFV, and certainly virtualization in general, has gained early momentum with products beginning to appear and proof-of-concept (POC) projects getting underway.

Virtualization offers strong benefits to operators who can implement it well: It can lower capital and operational costs, reduce complexity, bring new services to market more quickly, provide more flexibility in delivering services and simplify operational procedures. With that in mind, we offer the following recommendations for service providers:

1. **Start virtualizing now.** Real products and solutions for virtualizing some network components are available today, and the business cases for cost reduction can be quite compelling. Operators can gain experience managing a small-scale virtualized environment internally with a relatively ‘friendly’ customer base. Operators do not need to wait for NFV standards to be complete to benefit from virtualization.

2. **Make NFV education and participation a priority.** The NFV Industry Specification Group (ISG) is moving aggressively to put meat on the architectural bones of NFV. Operators should decide on a level of participation — this may include joining the 28 operators already in the group or simply monitoring developments and deliverables. Operators should also get involved with associated groups such as TM Forum’s new NFV initiative (again, see panel on page 11), and they should consider participating in an NFV POC project.

3. **Begin internal planning and education.** Operators should be looking for opportunities to educate their organizations, develop a strategy relative to virtualization and begin to plan for implementation.

4. **Assess organizational impact.** NFV and virtualization’s impact will be felt far beyond the network organization. Understanding the skillsets, organizational interfaces and cross-domain processes necessary for success is a critical part of the planning process, as well as assessing organizational needs, aptitude and readiness and setting initial goals and roles.

5. **Work with marketing to identify new services enabled by virtualization.** Virtualization is not just about cost savings’ it’s about development and flexible delivery of a whole new set of applications. Some interaction around creating early business cases may also be valuable here in that it can speed business case creation as new capabilities become available.

6. **Communicate with vendors.** As part of the planning process it is important to work with vendors to understand their plans and commitment to virtualization in general and to NFV in particular. It’s also important to understand their view, strategy and roadmap relative to coexistence and migration, as traditional platforms will be around for a very long time and will need to coexist and interoperate with the new technology in an efficient manner. Operators should be looking for products that are open, interoperable, based on standards and allow for multivendor solutions without high customization or integration costs. Finally, operators should cast a broader net than usual in evaluating vendors. Virtualization opens the door to a broad variety of suppliers with who may bring new perspectives and ‘out-of-the-box’ thinking.
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Network Functions Virtualization (NFV) discussions are maturing. The dialogue has shifted from understanding NFV and how it drives CAPEX and OPEX savings, towards how NFV can drive service agility benefits through support for new business models.

**Virtualized Business-to-Business (V-B2B)** and **Virtualized Business-to-Consumer (V-B2C)** models are helping evolve traditional business-to-business (B2B) and business-to-consumer (B2C) models. This article will offer best practices for implementing NFV, along with how they impact on new business models that can deliver on the service agility benefits that service providers’ desire.

**Best Practices for Implementing Virtualization**

With virtualization of the control plane as an initial step to NFV, there are a number of best practices to consider in implementation:

1. **Adopt a Framework**
   Service providers need to adopt a framework that allows their NFV strategy to evolve based on changing technology and commercial needs. There are many uncertainties in the future; being able to adapt as technology and the market change is critical.

2. **Create an Organizational Structure**
   Service providers must ensure that they have an organizational structure across the network that truly embraces the software-centric vision of NFV. Communication between various internal departments is a prerequisite for sharing infrastructure and processes to really reap the benefits of NFV.

3. **Identify Lead Applications**
   Identifying the lead applications, such as policy control, to virtualize is critical, as these are applications that make workflows and new service introduction more agile, efficient and profitable. Service providers should think in terms of developing a hybrid architecture that comprises a mix of virtualized applications and classic, bare-metal systems.

4. **Identify New Service Opportunities**
   Service providers must identify service opportunities and new use cases that are enabled by NFV, and make this central to their strategy. Cost savings and efficiencies are valuable, but the programmability and flexibility of software-centric networks, and the ability to rapidly reconfigure assets to support new use cases and services, will also determine success.

5. **Align Vendor Roadmaps**
   Finally, ensuring that vendor roadmaps have clear and committed paths to virtualization and will be able to support the service provider’s pathway to virtualization is critical in driving successful implementations.

These best practices are key to driving the benefits that service providers are looking for from NFV. If we now consider these best practices in relation to the new business models that virtualization enables, we can see immediate synergies.

**Support for New Business Models**

If we consider the B2C and B2B business models, we can see how virtualization drives new possibilities in each of these cases to enable a new set of service offerings for consumers and business alike.

The diagram below shows some possibilities for V-B2C and V-B2B.
service provider. This includes targeted offerings, and network-aware offload.

**Targeted Offerings**
Virtualization enables the ability to define specific, targeted offerings tailored to meet the needs of specific subscriber groups. Consider, for example, the upcoming World Cup in Brazil. Having the flexibility to allocate resources to support video streaming and live game updates at key venues would be a natural feature of virtualization and would enable service providers to capitalize on new revenue opportunities.

**Network-Aware Offload**
Marrying a broader network-awareness with virtualization enables service providers to drive more intelligent offload decisions and to make decisions about where and how to re-allocate network resources to service the changing network conditions and usage patterns of their subscriber base. Resources that are prone to congestion, like a soccer stadium, could be blanketed with alternate access (Wi-Fi) and the service provider could proactively offload certain gold subscribers to premium Wi-Fi networks when congestion occurs. This would ensure that no subscriber experiences poor quality of service.

**V-B2B**
In addition to the consumer business model examples we just considered, there are a number of business-to-business opportunities that service providers can take advantage of to drive further monetization of their network.

These models can apply to a range of businesses/operators – including venue owners, promotional partners, virtual operators, over-the-top (OTT) partners, roaming partners and of course, enterprises from the small-to-medium business (SMB) segment, to very large enterprises with multi-national footprints.

The following are some of the offerings defined in this market segment that are enabled through virtualization.

**Virtual Enterprise**
If we consider the communications needs of today’s enterprise – they typically have multiple departments, each with varying policy rules – things like network access, quality of service (QoS) requirements and virtual private network (VPN) security requirements.

Consider, for example, the financial industry, where certain employees are generally restricted from accessing the Internet while trading is happening, and the enterprise needs specific policies and rules in place to ensure that the appropriate communications restrictions are placed based on time of day. In this industry, it’s feasible that certain employees have priority QoS on some of their communications, and have limits or restrictions placed on other messaging capabilities.

These requirements can be addressed through private networks and security controls today, but the opportunity that virtualization provides here is to create a virtual private network for each enterprise customer through partitioning. This enables the operator to meet the security, access and privacy needs of key enterprise verticals, without having to add hardware or software for each enterprise customer. It also enables delegated administration to the enterprise, giving them the ability to manage their own services and resources.

**Public Safety Network**
If we consider another example of a V-B2B model, we can look at public safety networks. Instead of deploying private Long Term Evolution (LTE) networks, public safety agencies are looking at sharing radio access networks with other agencies, and in some cases, with commercial carriers. Virtualization enables this sharing of network and control plane resources across agencies.

The opportunity for virtualization in this context is to enable a hybrid model whereby public safety agencies can manage and control their own virtualized core network while leveraging common radio access. Virtualization allows agencies to meet their security, privacy and performance requirements, while being able to scale on demand, according to time, location, or state of emergency requirements – which is critical for public safety services.

The service agility benefits and new business models that virtualization can support are just starting to be explored. Virtualization will:

- Accelerate the launch of new services
- Support new business models for increased revenue share
- Target service introduction, based on customer sets or geography

Virtualization is a step on the path to full NFV and SDN, and Amdocs believes that the opportunity for service providers to start driving new and innovative offerings based on the new architecture is now.

For more information on the new business models enabled by NFV, visit www.journeytovirtualization.com

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