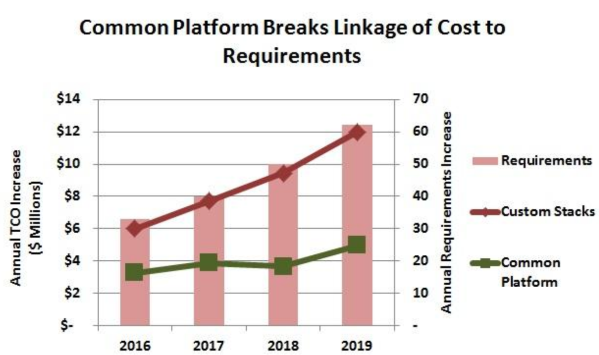
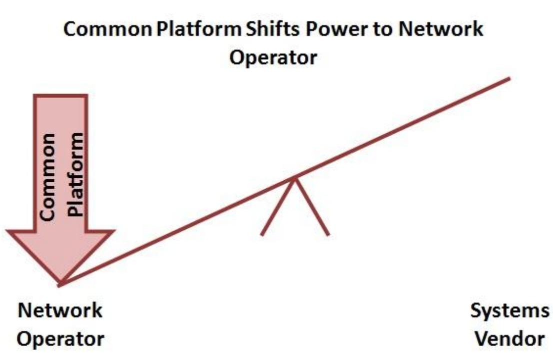
Executive Summary

When looking to expand existing services deployments or deploy new services, communications service providers (CSP) have a choice between continuing with traditional appliance-based solutions, moving to a vendor-supplied integrated network function virtualization (NFV) custom stack, built with a vendor-specific software and supporting a finite range of VNFs or deploying a common NVF platform that is independent and designed to support any VNF from any vendor. Operationally, there are benefits in all models, but financially, there is a clear leader in the common platform.

This whitepaper considers the two primary models of NFV deployment being considered: custom (software) stacks and common (virtualization) platform. By modeling the two virtualization approaches against a traditional appliance-based architecture, the paper asserts that both virtualization approaches have short-term benefits over the status quo but that the common platform approach is uniquely able to support a sustainable business model whereas the traditional appliance-based and NFV custom stacks approaches are likely to fail.



- Custom stacks TCO tracks requirements growth
- Common platform TCO increases at **half the rate** of requirements increase
- 62% lower TCO than traditional appliance approach
- 33% one-year and >350% five-year ROI for phased deployment



- Operator has total control—vendors integrate to operator's platform
- VNF vendors compete for operator's business
- Best-in-class deployments and control of price points

Introduction

Network operators are facing an uncertain future with over-the-top (OTT) providers competing for customers' wallet share and the rising cost of infrastructure fueled by high rates of traffic growth, which show no sign of declining (See Table 1).

Five-Year CAGR			
Network Type	**Throughput**	**Connections**	**Transactions per Second**
Fixed	36%	6%	10%
Mobile	44%	7%	13%

Table 1 – Growth Rates of Functional Requirements Drivers for Broadband Networks[1]

Traditional network architectures with their long deployment times and the resulting complex manual and proprietary systems interfaces required to support them have been identified as the root causes of high-cost, poor capacity scaling, and long innovation cycles. Operators are required to make large and expensive capacity additions to their infrastructure well in advance of demand and on a service-by-service basis (See Figure 1).

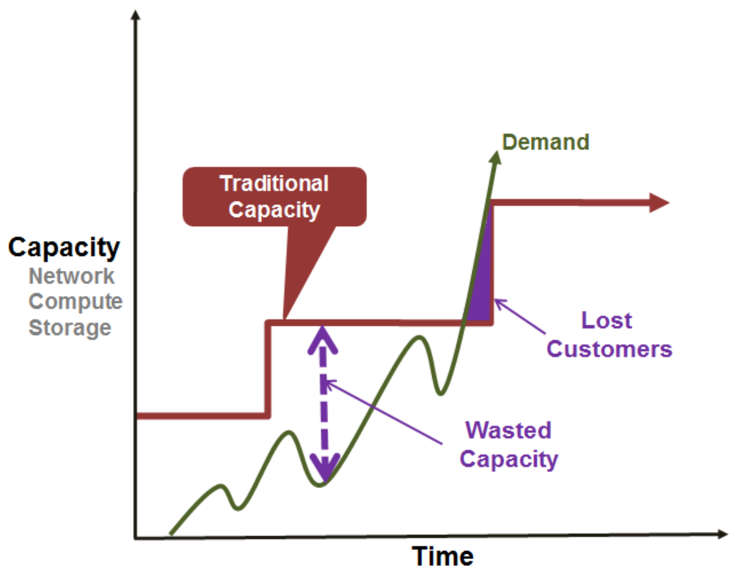


Figure 1 – Traditional Capacity Additions

In addition to investment inefficiencies, traditional appliance-based solutions are unable to react quickly to new and changing service opportunities and needs, limiting incremental revenue opportunity and increasing customer churn. Also, the need to deploy multiple technology silos to deliver a mixed portfolio of services, together with the operational implications of multiple specialist teams, adds further operational expense. Traditional architectures, consequently, are not capable of delivering a sustainable business model.

[1] See http://acgcc.com/wp-content/uploads/2015/03/Forecast-of-Mobile-Broadband-Bandwidth-Requirements_ACG.pdf and http://acgcc.com/wp-content/uploads/2014/12/Forecast-of-Residential-Fixed-Broadband-Requirements-2014.pdf.

To address these challenges operators are turning to Network Functions Virtualization (NFV)[2] as an enabler of new services, short service innovation cycles, and as a means to radically reduce the operational cost of new and existing services.

NFV is explicitly designed to reduce cost and increase network scalability and agility. Figure 2 shows that the agility of NFV has the potential to supply capacity that closely tracks demand and does so across multiple services.

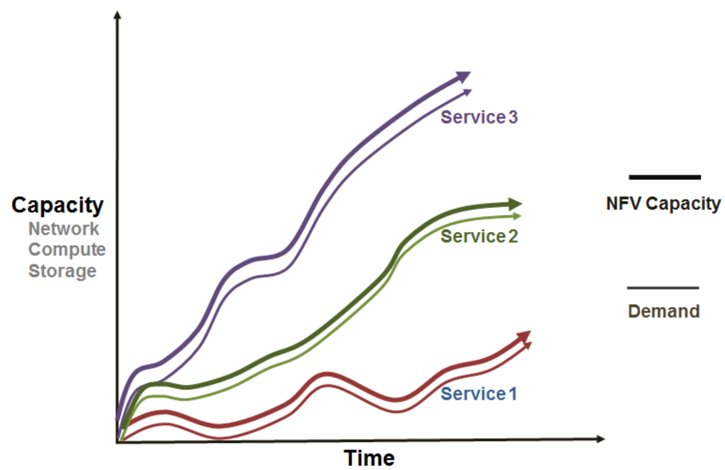


Figure 2 – NFV Capacity Additions

The potential of NFV to improve service agility and reduce total cost of ownership (TCO), however, requires a platform approach that allocates hardware, software, and human resources to meet the requirements for all services from a large pool of generally available resources in an on-demand fashion. These criteria are used to evaluate two NFV platform approaches:

1. Custom software stacks that aim to integrate as much of the model as possible into a single solution by a vendor.
2. A modular approach based on the deployment of a common virtualization platform where multiple VNFs and other NFV components are provided independently.

Each platform approach is evaluated by comparing its TCO to the TCO of the traditional (appliance-based) approach where all approaches are serving identical functional requirements demand.

Custom Software Stacks

The custom software stacks approach is often considered as a first step in virtualizing network functions. A particular network function, vEPC for example, is chosen and then a vendor is selected to create custom software stacks that replace the existing network appliances. This approach makes it easy to get started with network function virtualization because the existing organization has the authority, responsibility, and experience to make the move from appliance-based functions to virtual functions. Once the initial function has been virtualized, the organization will begin virtualizing other functions. This approach leads to the deployment of multiple software stacks, each stack representing a different primary vendor for a service.

[2] Network Functions Virtualisation–Introductory White Paper https://portal.etsi.org/NFV/NFV_White_Paper.pdf.

Figure 3 shows a schematic of the custom software stacks approach supporting three functions.

Figure 3 – Custom Software Stacks

In the custom software stacks the NFV vendor has abstracted the VNFs to run over commodity software and hardware. Standardized frameworks, such as OpenStack, are used to create an open software stack. The approach also includes NFV Management and Operations (NFV M and O) services. The use of virtualization and abstraction principles by the custom software stack and its use of APIs instead of custom scripts and manual processes do much to improve agility and reduce cost as compared to the network appliance approach.

Standardized frameworks, however, require the vendor to make many unique design choices to create the vertical software stack. In order to deliver the full capability of a virtualized solution, less mature implementations may require the integrated MANO functions as a necessary component of the operation of the underlying NFVI. This prevents a modular approach. Also, the commodity hardware and associated software is frequently implemented on racks dedicated to a specific VNF. Traditional technology is upgraded to virtualized technology but relatively little modification is made in the business processes; the location of the hardware (it may remain in central offices or POPs rather than be moved to cloud data centers) and staff and their roles and responsibilities remain unchanged. The custom stacks create functional silos where the network function, the software and hardware used to host the function, and people are dedicated to serving each function. This is a source of vendor lock-in; it hinders and restricts communications across the organization and limits the ability to pool assets and staff resources across all network functions.

NFV Common Platform

The common horizontal platform approach goes beyond simply replacing traditional appliances with virtualized technology. It creates a horizontal platform as part of a modular deployment that eliminates the organizational and technology silos that are implicit in the custom software stacks approach. This gives the network operator total control of the platform with vendors integrating to the network operator's platform rather than the historical approach of a network operator implementing vendor-based service silos. This creates an environment where the network operator induces VNF vendors to compete for the network operator's business and produces best-in-class deployments and control of the price points. Conversely, deploying vendor-specific complete solutions (custom stacks) blurs the boundaries among the modules and locks out competition.

Figure 4 provides a schematic of the common platform.

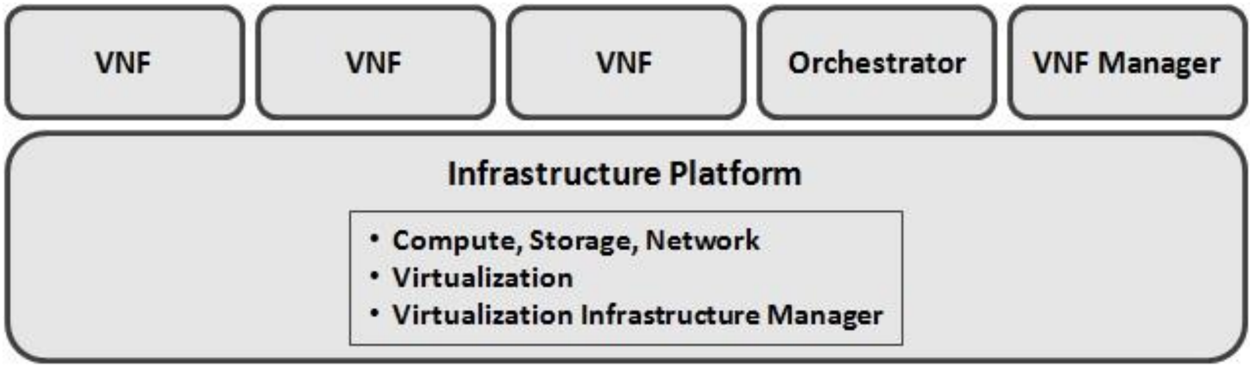


Figure 4 – NFV Common Platform

This approach provides a NFV common platform where the virtual network functions are served as multitenants of the common platform and the virtualized infrastructure that uses a service-oriented approach to serve the VNF tenants. A fundamental principle of the common platform approach is that the NFVI, MANO, and VNFs are established as modules with sharp boundaries among them. This eliminates the barriers to resource sharing that are built into the custom stacks and appliance-based approaches. It also allows the network operator to move quickly to NFV without limiting choice. There is short time to benefit, because each module is developed separately and the modules stay within the principles of the NFV approach.

TCO Comparison of Network Function Deployment Approaches

The total cost of ownership of the custom stacks and common platform approaches are compared to that of the traditional approach for a large-scale deployment of NFV control and data plane nodes for five years. In the first year the traditional approach has 50 control nodes and 75 data nodes.

Node requirements are determined by the prescribed throughput, concurrent connections or transactions per second needed by a specific network function and the type of service being offered. For example, value-added video service function capacity is determined because video streams are throughput dependent. Machine-to-machine services capacity requirements, however, are determined by the number of connections because very large numbers of devices are active, but data payloads are small and signaling transactions are infrequent.

Table 1 (See Introduction) tabulates typical five-year compound annual growth rate (CAGR) for the most common drivers of network functional requirements for broadband services.

The number of fixed and mobile broadband connections is projected to continue growing at moderate rates because both markets are mature. Throughput, however, is growing rapidly on both networks. The shift from watching broadcast TV to unicast video streaming is causing this explosive increase in the throughput requirement. Transactions per second per connection are rising in the mobile broadband market as older technologies are upgraded to 4G because the 4G signaling protocol is much chattier than its predecessors. Fixed broadband transactions per second per connection also are expanding because network operators are developing value-added service offerings in an attempt to boost average revenue per user. Value-added services require more signaling transactions than do basic services.

The modeling scenario projects NFV control and data nodes to grow at 25 percent CAGR. This represents a composite of the growth rates for throughput, connections, and transactions per second.

Elements of Total Cost of Ownership

Capital (capex) and expense items associated with the NFV infrastructure are modeled as annual recurring expense. This includes all physical hardware; software required for virtualization, management and orchestration of the NFV infrastructure; vendor support/maintenance fees; energy; floor space; and engineering, management, and maintenance expenses incurred by the network operator. The cost of VNF software and all associated operation expense items is excluded from the analysis.

Hardware and software prices are based upon market (street) prices as estimated by ACG Research.

TCO Comparison Result: Buyer Beware

Figure 5 compares the five-year TCO of the three approaches to network function deployment, and Table 2 tabulates the five-year percentage cost savings compared to the appliance approach for each TCO category.

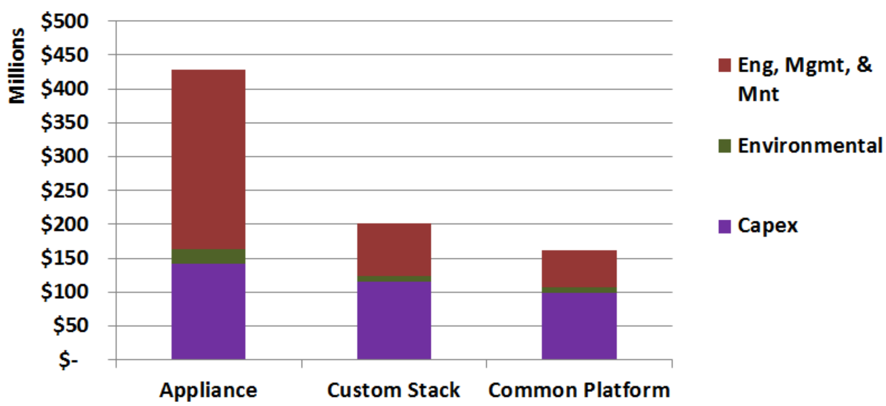


Figure 5 – Five-Year Single Service TCO Comparison

Five-Year Expense Savings Compared to Appliance Approach		
Expense Category	**Custom Stacks**	**Common Platform**
Capital	19%	30%
Environmental	60%	66%
Engr, Mgmt & Mnt	71%	80%
Total TCO	53%	62%

Table 2 – Five-Year Single Service Expense Savings Compared to the Appliance Approach

Both the custom stack and common platform approaches significantly reduce TCO as compared to the appliance approach. The cost savings are especially large for the engineering, management, and maintenance expense category. These savings are caused by the application of the abstraction and automation capabilities of both the custom stacks and common platform approaches. Capex and environmental expenses also are reduced because COTS hardware is more cost and energy efficient than purpose-built hardware. However, the example may be misleading as it represents only a single service/single vendor deployment. To fully understand the TCO of the deployment options it is necessary to model a deployment of multiple services spanning multiple VNF vendor (and potentially orchestration vendor) solutions. When multivendor services are modeled the common platform shows fundamental financial benefit over both traditional appliance and custom stack deployments by breaking the linkage between the infrastructure capacity growth and the infrastructure cost growth.

Common Platform Wins in Multivendor, Multiservice Deployments

The common platform significantly extends savings through its horizontal integration approach across all resource categories and vendors by delivering a truly shared resource environment. A common platform breaks down the service procurement (deployment, support and evolution silos created by traditional architectures and perpetuated by the custom stack) and thus enables more extensive pooling of human resources and network function virtualization infrastructure.

The common platform is the only approach that achieves a key goal of the NFV initiative, the goal of breaking the linkage between cost growth and requirements growth. Figure 6 shows that the annual TCO increases of the custom stacks approach track closely with that of the requirements increases; the TCO of the common platform barely increases.

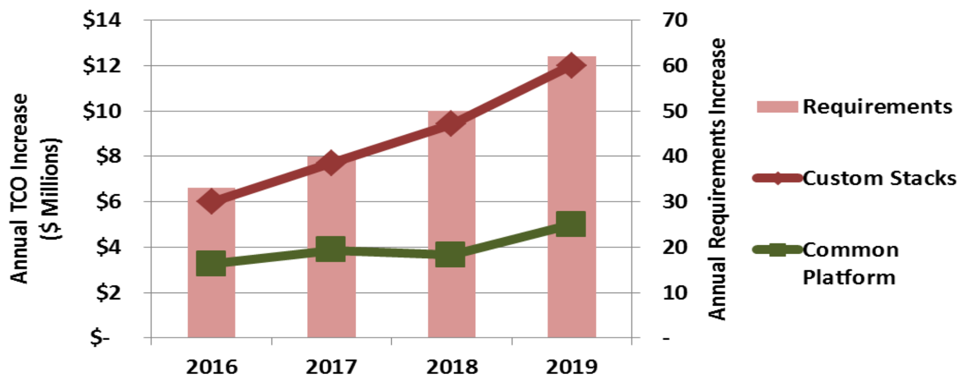


Figure 6 – Common Platform Cost Grows at Half-Capacity Growth

Each incremental increase in requirements drives a corresponding incremental increase in custom stacks capex: there are no economics of scale because infrastructure is not shared across the stacks. Custom stacks labor costs do not scale because staff is dedicated to each vertical stack (silo). In contrast, the common platform enjoys strong economies of scale and scope because its resources are pooled and made available to all VNFs.

Additional Benefits of the Common Platform Approach

The common platform approach has additional benefits and advantages when compared to the other approaches:

- **Continuous asset efficiency increases (7 percent CAGR):** All available compute, storage, and networking resources are shared across all network functions. This permits an increase in asset utilization without compromising service level agreements. Resources are shared for activities such as development testing, high availability, and disaster recovery services. The cost of software vendor support services are reduced through use of common software throughout the infrastructure. Energy and floor space costs are reduced because asset utilization is increased.

- **Continuous labor productivity increases (10 percent CAGR):** The high levels of automation and common operating procedures across the NFV infrastructure break the 1:1 linkage between increased systems under management and the number of full-time equivalent support staff required to operate and manage the NFV infrastructure[3]. Related costs such as training also are reduced through continuous productivity improvements.

- **Decreased time-to-market and increased service agility:** The cloud-based operational model and the flexible deployment of multivendor services is the source of decreased time-to-market, increased service agility, and operational savings. Further operational savings are realized through the replacement of per-vendor hardware support contracts with uniform routine maintenance schedules. Open innovation is achieved through rapid onboarding and service chaining of new service functions through a common, multivendor virtualized platform. Asset efficiency is maximized through the deployment of commodity hardware with no over-provisioning required: all services access a common pool of spare capacity.

- **Increased network flexibility and responsiveness:** The increased flexibility and responsiveness, and lower cost delivered by the common platform also create more revenue opportunities and increased revenue growth rates. The lower cost point of the common platform stimulates service demand by allowing profitable operation at lower price points. Increased agility allows network operators to make trial service introductions more quickly and with a lower go-to-market cost. This permits more trial services to be introduced within a fixed marketing budget while increasing the probability of identifying viable new service offerings. Increased agility also enables creation of differentiated service offerings to meet the unique needs of niche markets quickly and at low cost. Time-sensitive services such as bandwidth on demand, bandwidth calendaring, and even short-term service sales are made feasible by network responsiveness.

Return on Investment (ROI) for Phased Transition to NFV Common Platform

An ROI analysis compares the investment in a phased transition from an appliance-based (traditional architecture) to NFV using the common platform with the savings (avoided cost) produced by operating on the low-cost common platform. The scale of operations is the same as for the TCO comparison (previously) with the same 25 percent CAGR in traditional node requirements. Figure 7 shows how the transition from traditional nodes to NFV nodes is phased over eight years.

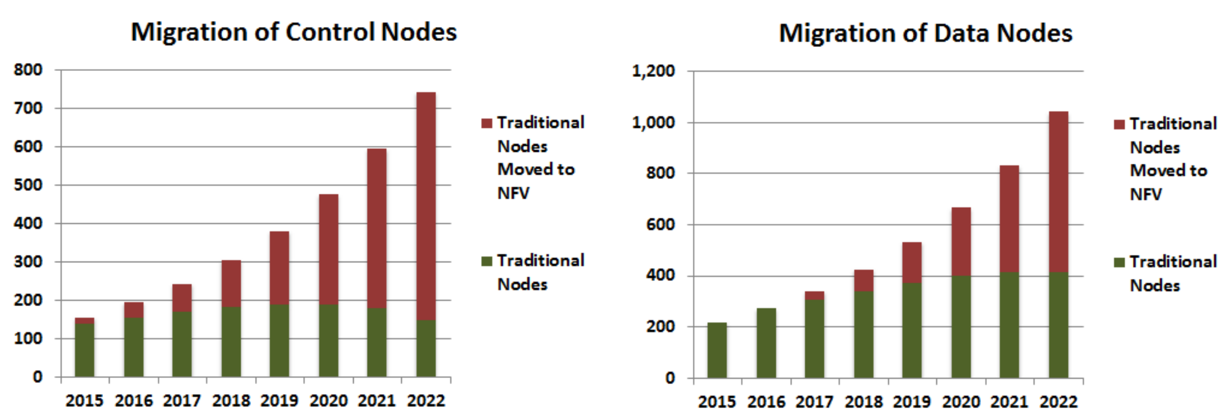


Figure 7 – Replacement of Traditional Node Capacity with NFV Common Platform

[3] One large data center operator reports that it manages and operates 50,000 virtual machines that host 5,000 applications with a staff of 20 employees.

NFV common platform nodes are deployed to accommodate a portion of total capacity growth requirements in the early study years; in the later study years they are used to accommodate all capacity growth and to retire some of the traditional nodes. Deployment of NFV control nodes begins immediately, but deployment of NFV data nodes begins in the third study year.

Annual total cost of ownership includes annual depreciation for hardware and software capex and annual operation expense. Transition costs are the costs of moving from the traditional nodes to the NFV common platform:

- Migration cost: The cost of moving a workload from a traditional node to a NFV node. There are three categories of migration cost:
  1. Active migration: A traditional node that is not end-of-life is replaced with a NFV node. Active node migration is costly.
  2. Passive migration: A function that is on a traditional node that is end-of-life is moved to a NFV node. Passive node migration costs little and may even produce a net savings.
  3. New function: A new function is implemented on a NFV node rather than a traditional node.

- Project cost: The cost of setting up and making annual improvements to the NFV infrastructure common platform:
  - The initial project cost to set up the NFV infrastructure including the cost to build the infrastructure and setting up connections to other systems and EMSs.
  - Annual cost to improve the NFV infrastructure including adding new functionality to the infrastructure and connecting to more systems and EMSs.
  - Annual license cost of connectors between the EMSs and the infrastructure.
  - Annual staff reduction cost: The cost to reallocate or outplace staff that is no longer needed to build, manage or operate the traditional nodes.

- Education cost: This is the cost of the initial training of staff that is new to the NFV environment.

Hardware and software prices and labor rates are identical to those used in the total cost of ownership analysis previously presented.

ROI for Phased Transition to NFV Common Platform Results

Figure 8 shows the annual TCO of the appliance-based approach, the total TCO of the phased move to the common platform, and the savings (avoided cost) produced by the move to the common platform.

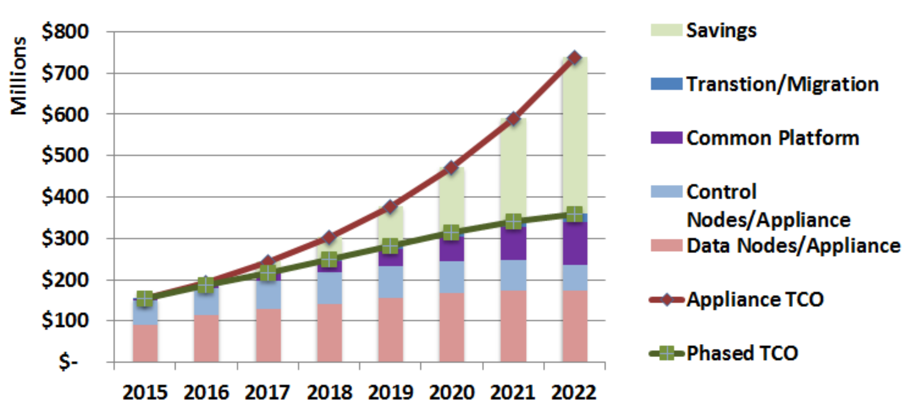


Figure 8 – TCO Comparison of Appliance-Based Approach with Phased Move to the Common Platform

The figure shows that the common platform approach breaks the linkage between requirements growth and cost increase. The linkage break is produced by the much lower cost of NFV nodes as compared to appliance-based nodes, the annual asset efficiency gains of the common platform, and the annual labor productivity gains of the common platform.

Breakeven Point in Less Than One Year for Phased Move to the Common Platform
Figure 9 shows the ROI of the phased move to the common platform.

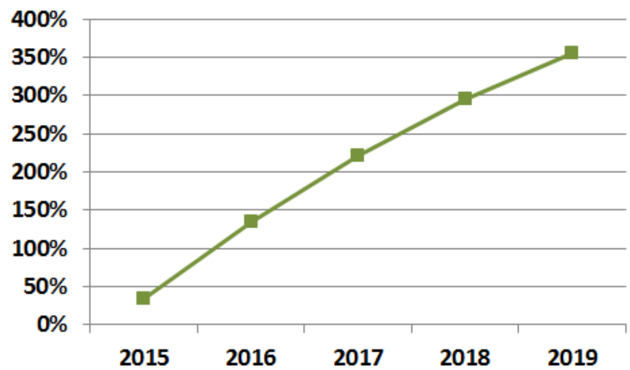


Figure 9 – Return on Investment of Phased Move to the Common Platform

The breakeven point for the move to the common platform is less than one year. ROI is 33 percent in the first year and grows to more than 350 percent by the fifth year. The rapid and high returns produced by the gradual move to the NFV common platform reduce the financial risks of the transition to NFV and give network operators the freedom to transition at a pace that best fits their operational capabilities.

Conclusion

The common platform approach alone breaks the link between growth in network requirements and cost. Though the custom stacks approach produces an immediate cost reduction compared to the appliance approach it is fundamentally flawed in that its costs continue to track requirements growth. Its cost reduction delays the collapse of the network operator’s business model, but a custom stacks does not prevent it. The common platform approach creates an operating environment and NFV infrastructure platform that supports a sustainable business model.

An ROI analysis demonstrates the rapid payback and high ROI of a phased move to the common platform from the appliance-based approach. The low-cost NFV nodes of the common platform and ability to produce sustained labor productivity and asset efficiency gains are shown to achieve payback in under a year and produce more than 350 percent ROI over five years.

ACG Research recommends that network operators consider the modular deployment of the ETSI framework (common platform) approach, ensure that each module (NFVI, MANO/VIM, and VNF) is truly modular, and can be integrated within a multivendor environment. This approach, however, goes beyond the simple change-out of a legacy technology for new virtualized technology. It requires rethinking (redesign) of fundamental business processes and the organizations that support them.

About ACG Research: ACG Research is an analyst and consulting company that focuses in the networking and telecom space. We offer comprehensive, high-quality, end-to-end business consulting and syndicated research services. www.acgcc.com.