ECONOMIC BENEFITS OF THE VMWARE TELCO CLOUD AUTOMATION AND HORIZONTAL INFRASTRUCTURE

SUMMARY

Network function virtualization (NFV) and telco cloud architectures are transforming telcos and enabling the deployment of next-generation 5G networks. Telco cloud architectures allow network functions to move from dedicated hardware platforms to centralized or distributed cloud infrastructure. These architectures are essential for 5G networks because most packet core technologies will not be available on traditional hardware platforms. Many of the capabilities and services promised by 5G networks are dependent on network scalability, flexibility, and agility of the cloud. For telcos to grow revenue, it is critical that the network infrastructure is agile and scalable. Our economic model shows that faster time to market for new services can result in revenue increases of 9%, higher average revenue per user, reduced churn, and increased market share, which can result in revenue increases of up to 109% for new services.

The transition from physical networks to virtual networks has been complex, and to simplify network deployments many telcos have deployed several vertical silos from different vendors that include Virtual Network Function Manager (VNFM), Virtualized Infrastructure Manager (VIM), Network Function Virtualization Infrastructure (NFVI), and all the Virtual Network Functions (VNFs) required for a specific set of network services, for example, a virtual packet core. Many telcos have multiple silos operating in their networks today. For example, a telco might have two packet cores and two IMS vendors, each with a separate silo. These vertical silos have enabled vendors and telcos to deploy NFV products quickly; however, a silo approach is not conducive to a broad integrated approach to virtualization.

Report Highlights

- 5G networks demand an end-to-end telco cloud architecture.
- Telco cloud automation provides a unified orchestration and automation across a distributed telco cloud.
- Telco cloud allows faster service creation and faster time to market for new services.
- The VMWare Telco Cloud Automation delivers an ROI of 344% and network TCO savings of 23% over five years.
- The VMware horizontal and consistent architecture provides OpEx savings of 38%.

The silo cannot be used for multivendor and open NFV deployments, which are essential to service agility and revenue growth in 5G networks. Silos also have inherently higher labor expenses because many tasks need to be replicated for each silo. Our economic model shows an operations expense (OpEx) savings of 38% and network total cost of ownership (TCO) savings of 29% for a horizontal architecture over five years.

The inherent complexity in highly distributed virtualized systems drives the need for end-to-end automation and orchestration across all layers of the telco cloud. This paper takes a deep dive into the VMware Telco Cloud Automation system, which provides end-to-end orchestration and cloud automation. Our economic model shows a return on investment of 344% and network total cost of ownership savings of 23% over five years for an investment in Telco Cloud Automation. This ROI of 344% is based purely on TCO savings and not on revenue growth, which would further increase ROI.

This paper provides an overview of the VMware approach to a unified telco cloud architecture and quantifies the benefits of the VMware Telco Cloud Automation system and the benefits of a horizontal telco cloud architecture.

TABLE OF CONTENTS

TABLE OF FIGURES & TABLES

NETWORK TRANSFORMATION

Globally, telcos are transforming their networks from physical architectures with specialized networking hardware and software to virtualized networks running Virtual Network Functions (VNFs) and Containerized Network Functions (CNFs) on cloud infrastructure. This process is being accelerated by the success and growth of public cloud service providers and web scalers. Some of the first areas in the network to be virtualized are the mobile packet core and IMS systems. However, in the coming years the Radio Access Network (RAN) will be virtualized, which will dramatically increase agility and provide an open software architecture to allow rapid innovation and introduction of new services and features at a rapid rate. In there will be a proliferation of edge services that will result in many data centers that need to be operated and managed.

TELCO CLOUD ARCHITECTURE

A telco cloud architecture provides an end-to-end solution for provisioning and operating virtual network functions across the network. It must be flexible, scalable, and agile and most importantly, provide a framework for telcos to quickly deploy new services that will be critical to growing revenue in the future.

An example of a telco cloud architecture is provided in Figure 1. This example shows a horizontal cloud solution for hosting Virtual Network Functions (VNFs) and Containerized Network Functions (CNFs) on a VMware cloud. This architecture supports distributed data centers that could include core, regional, and edge data centers. The Network Function Virtualized Infrastructure (NFVI) layer is composed of servers, network, and storage hardware that could be multivendor or white-box components.

There are two layers above the NFVI layer: Virtual Infrastructure Manager (VIM) and Container as a Service (CaaS). The VIM layer is responsible for controlling and managing the NFV infrastructure compute, storage, and network resources. There are multiple types of VIMs, which include vCloud Director or OpenStack for VNFs. The CaaS layer uses Kubernetes to orchestrate containers and CNFs.

Network functions are the primary applications used to implement the network capabilities. Examples of network functions are gateways, routers, and firewalls. These examples are horizontal architectures that support a wide variety of multivendors' VNFs and CNFs.

At the top layer of the architecture is an end-to-end automation and orchestration layer. It has two major components: xNF Management (xNFM) and NFV Orchestration (NFVO). VNFM orchestrates, manages and controls VNF/CNFs. Its primary responsibility is onboarding and life-cycle management and automation (instantiation, scaling, updating, and termination) of network functions irrespective of their technology (VNF/CNFs). The NFVO function sits at the top of the stack and is responsible for the design, onboarding, and life-cycle management of network services across a hybrid horizontal stack.

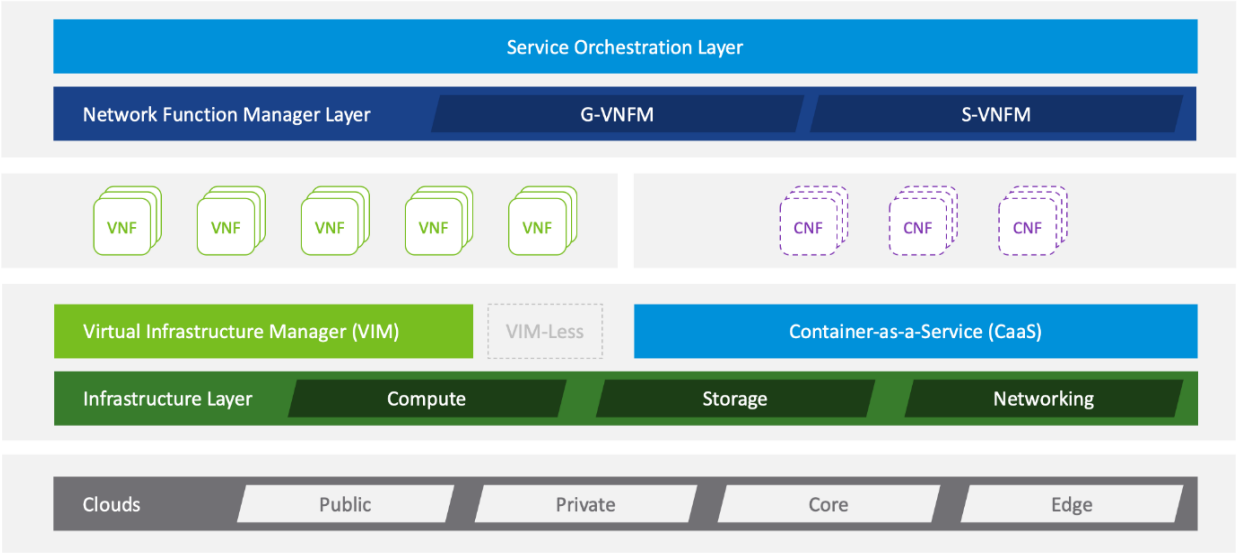

Figure 1. Telco Cloud Architecture

Unified Orchestration and Automation Benefits

Unified orchestration and automation provide a common framework for managing and automating network services and resources in the virtual domain. Unified orchestration includes the network and service levels, any vendor, any technology (VNF/CNF), and multi-cloud support across private, public, and hybrid clouds. The key benefits of the VMware telco cloud are increased service velocity, reduced capital expense (CapEx) and operation expense (OpEx), and improved customer satisfaction. An overview of these benefits is provided, and the benefits are quantified using an economic model.

Service Agility

A major strategic goal for most telcos is to increase network service revenue with 5G networks. It is estimated that $700 billion of new revenue will be generated by next-generation enterprise services by 2030[1], and $800 billion in value for society and consumers will be created by 2025[2].

Telco Cloud Automation increases service agility and service velocity increasing top line revenue.

Service agility increases the speed at which network services can be implemented. Telco Cloud Automation (TCA) significantly reduces the time to design, implement, and test services. Traditionally, telcos have a small number of network services, and service additions and changes can take months or years to implement. As 5G networks roll out it will be essential for telcos to deliver new services to grow revenue:

- IoT services for enterprises and governments
- Private mobile networks
- Fixed wireless broadband for business and consumers
- AR/VR services

[1] Ericsson 5G Report

[2] Mobile Experts Report

- Connected vehicle services
- Video game streaming services

Many of the new services can and should be monetized by telcos. Service velocity is key to growing and maintaining revenue.

CapEx Reduction

Telco Cloud Automation allows better packing of VNFs and CNFs into services improving utilization of hardware resources and reducing CapEx.

Telco Cloud Automation allows VNF/CNFs to be packed more efficiently into service, storage, and network hardware resources. The number of servers can be reduced by packing functions more efficiently, and CapEx associated with servers, network, and storage can be decreased. The packing efficiency is further important as the number of telco cloud sites is multiplying with the introduction of 5G, MEC, and vRAN. Additionally, packing efficiency increases with centralized management of highly distributed sites running a variety of dynamic services. Unified orchestration and automation functions provide the following benefits:

- Scale-out workloads when needed (versus committing resources in the planning phase)
- Elastic-based model used to scale in resources when needed
- Cloud-first synchronization optimizes placement where resources are available
- Optimize workload placement across distributed data centers
- Offload/Move workloads through in-service migration wizard
- Terminate workloads quickly and return compute resources to the pool
- Recover resources (heal) in case of failure instead of automatically allocating new resources

Automation reduces manual tasks, which reduces OpEx while decreasing errors and improving service availability.

These functions provide more data center resource efficiency, which effectively reduces CapEx.

OpEx Reduction

Centralized and unified automation transforms traditional processes and reduces manual tasks required at three operational levels: infrastructure, applications (network function), and network services. The improved efficiency reduces OpEx. The packing of VNF/CNFs into servers also helps reduce OpEx because efficient packing results in fewer servers, which in turn lowers power expenses and all the other OpEx, such as maintenance, associated with servers and software.

Improved network reliability and availability result in better customer experience and lower churn rates.

Customer Experience

Telco Cloud Automation is a key factor in improving network and service resiliency and reducing MTTR. These improvements lead directly to improved customer experience, which leads to increased market share and reduced churn. TCA also improves customers' experiences by enabling customizable services and on-demand service delivery while supporting better quality of service.

Horizontal Architecture Benefits

Many service providers have deployed vertical silo NFV architectures delivered by vendors as completely integrated systems. Vertical silos are depicted in Figure 2 and contrasted with a horizontal solution. This has been an expedient approach to deploying NFV; however, these approaches are not substantially different from legacy physical network functions. The vertical silos are closed systems that only support the specific applications provided by the vendor, for example, a packet core or IMS system. Additional silo architectures each have unique infrastructure and orchestration implementations. Telco teams responsible for managing a silo must replicate many tasks for each silo. These tasks include on-boarding new hardware, on-boarding xNFs, security management, configuration management, fault management, service instantiation, and engineering and planning.

A horizontal telco cloud architecture provides a consistent and open framework for deploying VNFs, CNFs, and services across the network.

A telco cloud horizontal architecture provides an open system that allows for a mixture of VNFs and CNFs from multiple vendors or open-source communities. It also has a framework for centralized and distributed network functions and provides management and orchestration services across many data centers and public cloud resources. A horizontal architecture is a consistent infrastructure and orchestration system that is deployed across an entire network. 5G networks will demand fast rollouts of new services, a wide range of software and hardware, and edge computing capabilities. These goals cannot be achieved without a horizontal architecture. Horizontal architectures also reduce OpEx because tasks do not have to be replicated for each vendor silo.

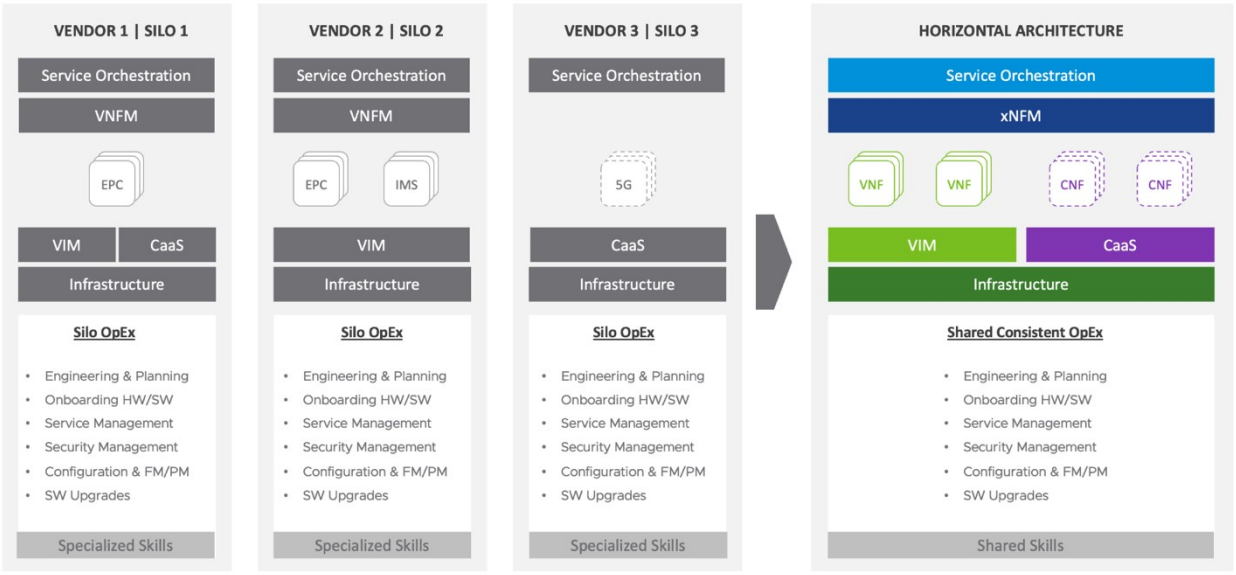

Figure 2. Silos versus Horizontal Architecture

Economic Benefits

An economic model is used to quantify the benefits of these solutions. Two models have been used to analyze benefits:

- Service agility revenue model
- TCO and ROI model to show cost reductions

Service Agility Model

Service agility improves the time to market for new services. We expect that as 5G networks roll out a key success factor for telcos will be their ability to monetize new services for both enterprises and consumers. Improving time to market can have a dramatic impact on new service revenue, profitability, and growth. Some of the key impacts of faster time to market for new services are:

- Faster time to revenue
- Greater number of services deployed in each time frame
- Higher customer satisfaction and lower churn rates
- Higher average revenue per user (ARPU) due to being first to market
- Greater market shares due to being first to market

The service agility economic model incorporates all these factors and forecasts revenue improvements over three years.

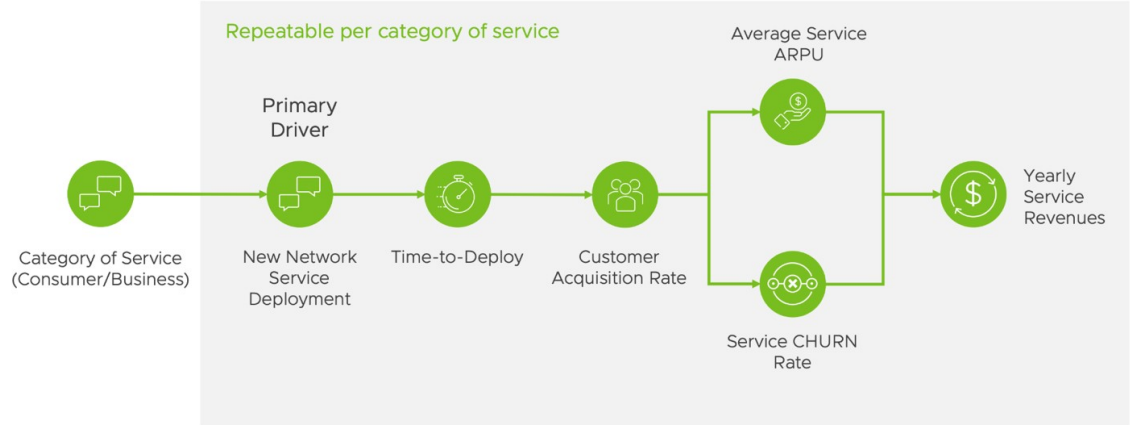

Figure 3. Service Agility Economic Model

The driver of revenue improvements is faster time to market for new services. Estimates for the time to deploy new services is based on the number of days required for each step of the service deployment process as represented in Table 1. It should be noted that there is a wide variation between different services, but on average TCA will improve service velocity by 31 to 53%.

Operations	Initial Instance Improvement	Secondary Instances
Service Planning	*Low/Medium*–Automation requires more advanced planning as NSD, and artifacts must be created at this stage.	High: Reuse of available template with minor configuration updates.
Deployment Preparation and Activation	*Medium to High*–Automation enables the provisioning and configuration of all the underlying network function, CaaS, and infrastructure following template requirements.	High
Service Delivery	*High*–Automation enables the provisioning of network service instantiation based on NSD requirements.	High (same as initial instance).
Service Tuning	*High*–Automation enables Day 1 and 2 operations such as software and package upgrade automation on activated instance (CI/CD).	High (same as initial instance).

Table 1. Benefits at Each Step of the Service Deployment Process

We consider two scenarios. In Scenario 1 we assume that new service deployments are identical between a network with automation and one without; however, there is a difference in time to market. In Scenario 2 we also consider that being late to market will also cause other problems: launching fewer services, higher churn rates, an ARPU discount, and loss of market share.

The graph in Figure 4 shows service revenue for Scenario 1. In this case the only difference between a telco with automation and without is the time to market for services. The chart depicts the exact same ramp up for services for both telcos; however, the telco without automation ramps up revenue later.

The graph in Figure 5 depicts the revenue for Scenario 2. In this case there is a delay in the start of service revenue, but there is also lower service revenue because of fewer services being launched, higher churn rates, lower ARPU, and loss of market share.

Service agility can increase revenue by 9% and further benefits include reduced churn, lower ARPU, and increased market share can increase revenue by 109%.

For Scenario 1 the effect of time to market alone results in an 9% increase in service revenue over three years. If we consider the adverse effects of being late to market using the assumptions in Scenario 2 the difference in revenue is much greater. The results show a revenue increase of 109%. Time to market clearly has a significant impact of service revenue and is an essential element in deploying new services.

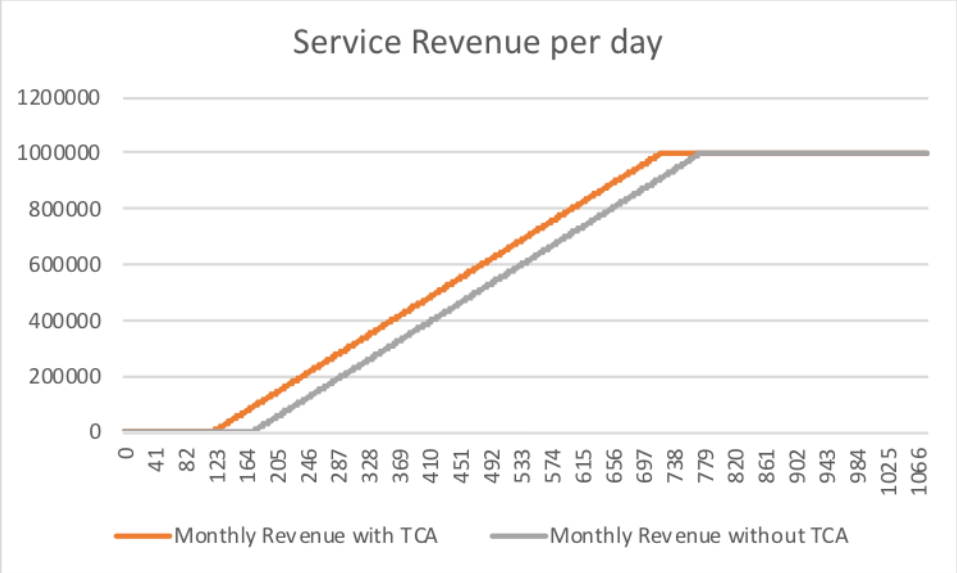

Figure 4. Scenario 1

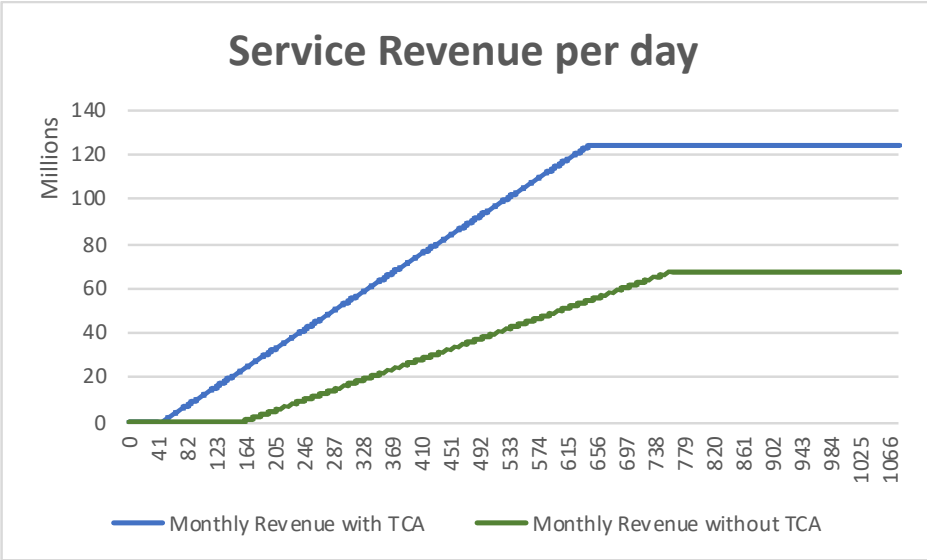

Figure 5. Scenario 2

TCO and ROI Model

An overview of the TCO and ROI model is presented in Figure 6. The model is driven by workload demands, specifically VNFs and CNFs that are distributed in both regional and local data centers. The workload demand drives the configuration of servers in each data center. We model workload growth over five years. The components of CapEx considered in the model are:

- Server CapEx
- Network CapEx
- Storage CapEx
- Software perpetual licenses

The categories of OpEx considered in the model are:

- Software support
- Software annual licenses
- Power and cooling
- Facilities expenses
- FTEs for NFVI/VIM management
- FTEs for NFVO/VNFM and application management

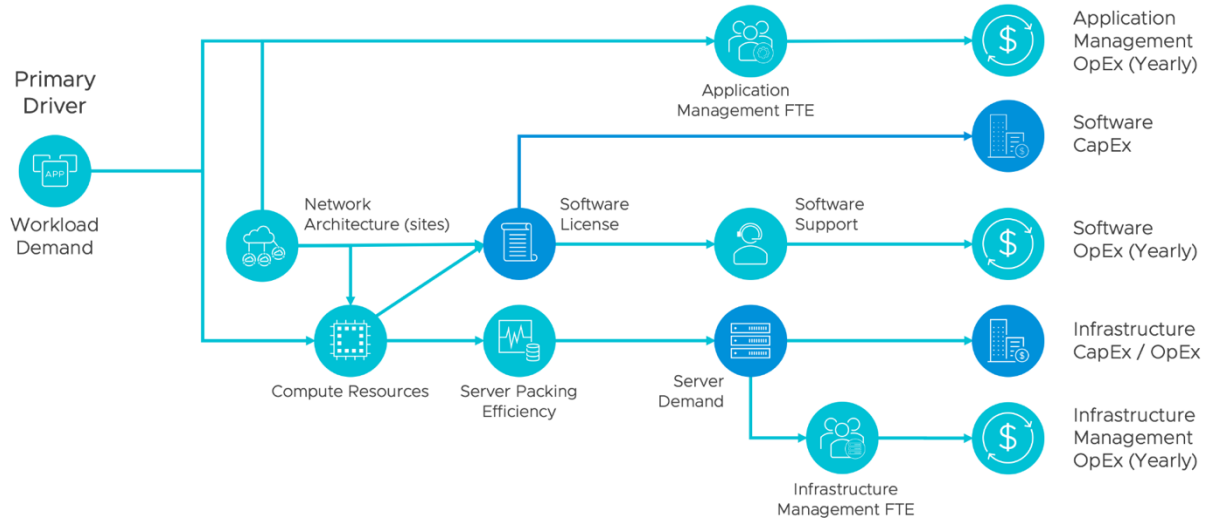

Figure 6. Economic Model

Key Assumptions

The assumptions in this model are based on modeling work done with several telcos. The key modeling assumptions fall into three categories:

- Demand forecast
- FTE labor assumptions
- Hardware and software pricing assumptions

Demand Forecast

The demand forecast is driven by applications, both virtual network functions running on virtual machines and container network functions running in containers. The VNFs and CNFs drive the demand for CPU cores that in turn drive the demand for servers. The VNF/CNFs are distributed in both large regional data centers and edge local data centers. The demand forecast is specified in Tables 2 and 3.

Data Centers	2020 QTY	2021 QTY	2022 QTY	2023 QTY	2024 QTY
Regional DCs	10	15	25	30	35
Local DCs	20	40	80	140	250
Total DCs	**30**	**55**	**105**	**170**	**290**

Table 2. Data Center Demand Forecast

Application Demand	2020 QTY	2021 QTY	2022 QTY	2023 QTY	2024 QTY
Local DC CNF	5	6	7	8	10
Regional DC CNF	5	10	30	40	40
Local DC CNF	4	4	4	4	4
Regional DC VNF	70	80	90	95	100

Table 3. Application Demand Forecast

FTE Labor Assumptions

Telco Cloud Automation and horizontal architectures both contribute to savings in labor expenses. Our economic model estimates labor expenses for infrastructure management functions (NFVI/VIM layer) and service and application management (VNFM/NFVO layer). The labor expense is considered in this model as proxy to efficiency gains. The categories of labor and labor tasks for applications management are:

- General management
- Engineering, planning, and on-boarding
- Deployment and provisioning
- Life-cycle management

Telco Cloud Automation increases server efficiency and reduces total servers by 19%.

The categories of labor and labor tasks for infrastructure management are:

- On-boarding new hardware
- Security management
- Configuration management
- Fault management
- Software upgrades
- Engineering and planning
- SDN management

Telco Cloud Automation and horizontal architectures contribute to labor savings and reduced OpEx.

The improvements in efficiency results from process re-engineering enabled by centralized system management, tasks simplification, and automation.

In addition to automation improvements the horizontal architecture also improves the efficiency of NFVI management tasks. In vertical silo architectures each of these NFVI tasks needs to be replicated for each separate silo. To account for economies of scale we assume that for each separate silo 50% of the labor required for the first silo is replicated for each additional silo. In this model we assume the service provider has four separate silos. In cases with more than four silos this problem of growing labor expenses becomes worse.

Economic Benefits of Unified Automation and Orchestration

Telco Cloud Automation provides end-to-end automation and orchestration across multiple layers of the stack and across regional and edge data centers. The key benefits of automation are:

- Optimization of servers and infrastructure
- Improved efficiency translated in reduction of infrastructure management labor expenses
- Improved efficiency translated in reduction of service and application labor expenses

A key challenge in large, distributed telco cloud systems is packing servers efficiently with VNFs and CNFs. This is a special form of the knapsack problem,[3] which is a resource allocation problem. If

[3] https://en.wikipedia.org/wiki/Knapsack_problem

applications are allocated to servers manually many servers will not be efficiently packed with applications. Multicloud orchestration provides the ability to optimize the placement of applications into available server resources and ultimately reduces the number of servers required. This is aligned with the benefits in server optimization gained years ago with server virtualization. Unified automation and orchestration extend the benefits achieved by virtualization by providing an efficient method of optimizing resource usage across a large and diverse network. The results of our modeling for servers across sites over 5 years reaches about 19%. As demand grows and the network footprint is augmented, efficient packing of servers becomes increasingly more important over time.

A horizontal architecture combined with Telco Cloud Automation provides OpEx savings of 38% and TCO savings of 29%.

Labor expenses are calculated based on the number of FTEs. The savings with TCA are more significant for application management, as expected, but there are also savings in NFVI management.

The cumulative savings and ROI are depicted in Table 4. The result of efficient server packing and labor savings results in a 23% network TCO savings and a 344% ROI on the automation investment. The TCO savings applies to the overall infrastructure and software TCO. Telco Cloud Automation is only one part of the infrastructure considered in the TCO model.

Telco Cloud Automation Cumulative ROI & Savings	Five-Year Cumulative
ROI	**344%**
CapEx Savings (%)	**7%**
OpEx Savings (%)	**34%**
TCO Savings (%)	**23%**

Table 4. Telco Cloud Automation ROI and Savings

Economic Benefits of Horizontal Architecture

Telcos can get additional OpEx benefits moving from a vertical silo architecture to a horizontal architecture. One key benefit is reducing labor expenses for NFVI management. The tasks for managing an NFVI infrastructure need to be replicated for silos; in a horizontal architecture the management tasks are uniformly applied to a consistent integrated infrastructure. Our economic model shows an additional OpEx savings of 38% and network TCO savings of 29% for a horizontal architecture with TCA over five years.

Conclusion

Unified orchestration and automation is a critical success factor in telco digital transformation. Large distributed virtual networks with hundreds or thousands of edge data centers pose a great management and operations challenge. This challenge must be addressed by a consistent, horizontal infrastructure with unified orchestration and automation. VMware Telco Cloud Automation allows telcos to bring new services to market faster, which increases revenue. It provides more efficient packing of VNFs and CNFs in servers, reducing the number of servers required, and it provides automation to maximize operational efficiency for managing the network. A VMware horizontal architecture also maximizes efficiency and

OpEx required to manage infrastructure. The economic model shows an ROI of 344%[4] for an investment in Telco Cloud Automation.

Peter Fetterolf, Ph. D (pfetterolf@acgcc.com) is CTO with ACG Research. His primary focus is developing business models for next generation networks which includes IP transport, SDN, NFV, vEPC, vRAN, and optical transport networks. He is also responsible for software development of the Business Analytics Engine (BAE) software network economic simulation tool.

[4] This paper used a detailed financial model developed by ACG Research and VMware. This model can be used by telcos for custom modeling engagements. For more information contact your VMware sales representative.