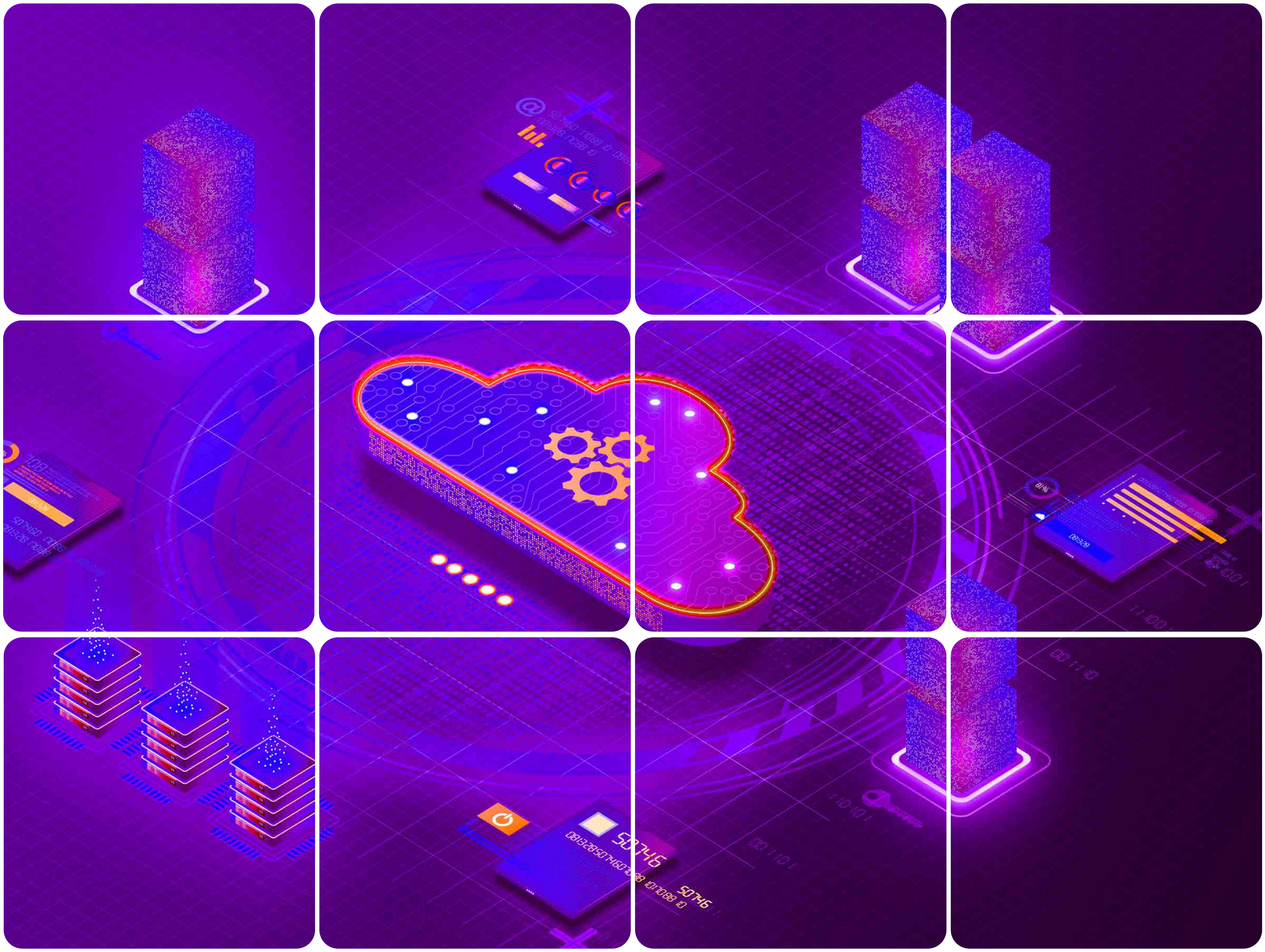

The Economic Benefits of Moving from Proprietary Cloud Silos to Horizontal Telco Cloud Networks

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Executive Summary

The telecommunications industry is facing significant challenges due to vertical silo architectures, which were initially adopted to ensure performance and reliability in virtual packet core deployments. Although this approach served early virtualization efforts well, it has become a barrier to scalability, flexibility, and cost efficiency. Communication service providers (CSPs) are burdened by vendor lock-in, operational complexity, resource inefficiency, and high costs due to the deployment of multiple isolated stacks for different applications and use cases. Additionally, when any applications not included in the silo stack need to be integrated this incurs additional professional services expenses for application on-boarding.

VMware's horizontal cloud architecture, based on VMware Telco Cloud Platform (TCP) and built on VMware Cloud Foundation (VCF), offers a transformative solution. By adopting a unified cloud platform, CSPs can consolidate siloed infrastructure, support multivendor and multifunction deployments, and reduce both capital and operational expenses. End-to-end automation and orchestration capabilities improve efficiency, reduce manual interventions, and enhance scalability while aligning with global sustainability goals through reduced power consumption and carbon emissions.

The total cost of ownership analysis demonstrates the financial and operational advantages of moving from silo-based deployments to a horizontal cloud model. With a five-year cumulative savings of 40.8%, CSPs can achieve significant improvements in resource utilization, cost reduction, and environmental impact. This transition not only addresses current challenges but also positions CSPs for future innovation and growth.

Current Industry Problem: Vertical Silo Architectures

Many virtual packet core deployments, today, use vertical silo architectures. In a silo architecture, a vendor provides all components of the stack:

- Packet core software
- Cloud software (Kubernetes and/or VIM)
- Bare-metal layer (compute, networking, and storage)

In the early days of virtual packet core deployments, vendors needed to control all the components of the stack to ensure that the system met performance specifications and KPIs and, as such, vertical silo deployments made sense. Vendors essentially replaced integrated custom hardware platforms with integrated NFV platforms. From the Communication Service Providers' (CSP) point of view, however, there was no difference because both the custom hardware and NFV systems were black boxes. Also, CSPs would typically give complete markets to specific vendors. Although using vendors to provide a complete end-to-end solution simplifies system implementation, this approach slows CSPs' deployments of multivendor networks and imposes significant cost burdens on CSPs trying to deploy multivendor cloud-native network functions.

Many CSPs operate multiple isolated vertical stacks designed for specific applications and use cases. Many of these stacks are controlled by individual vendors, leading to inefficiencies and high costs. These deployments include:

- **Vertical Vendor Stacks:** Dedicated stacks for mobile packet core, IMS, and other telco applications such as GI-LAN and SS7. Each vendor provides a full-stack solution encompassing applications, cloud software, servers, and hardware, making interoperability and resource sharing difficult.
- **IT Stacks**: These include applications for telco IT operations, operational support systems (OSS), and business support systems (BSS). Often, these stacks utilize different cloud and hardware vendors than those used in telco-specific environments, further complicating integration efforts.
- **Bare-Metal Kubernetes Stacks:** These stacks support containerized applications and cloud-native functions (CNFs). However, they do not support virtual machines or virtual network functions (VNFs), which limits their flexibility and forces organizations to maintain separate stacks for different workloads.
- **Virtual Machine Stacks:** These provide Infrastructure-as-a-Service (IaaS) to support VNFs and other applications that require virtual machines. Like other stacks, they often employ different cloud software and hardware vendors, leading to fragmentation and increased management overhead.

The fundamental problem with a vertical stack is that it is difficult to integrate other vendors' CNFs, VNFs, applications or services on a vertical stack. There are two options for addressing this problem:

1. Deploy a separate vertical stack for other applications.
2. Incur professional services expenses for integrating applications into the vertical vendor stack.

The magnitude of this problem increases as CSPs move to edge deployments, multiple vendor applications, and seek to offer a wide range of network services.

Key Challenges with Vertical Silo Architectures

1. **Vendor Lock-In and High Costs**
   - Closed vendor-controlled stacks limit flexibility for CSPs.
   - Vendors have great leverage over CSPs.
   - Proprietary dependencies drive up operational and service costs.
   - The high cost of vendor-specific upgrades and maintenance fees makes long-term sustainability challenging.

2. **Requirements for 3rd Party Software not Suited to the Silo Architecture**
   - Examples of 3rd party software required: OSS/BSS, Load balancing, Firewalls, others.
   - It is very expensive to run 3rd party applications on the silo architecture so often they are run on a separate stack using Broadcom, Red Hat or another open stack.

3. **Resource Inefficiency and High CapEx**
   - The inability to share infrastructure across applications results in low server utilization.
   - Redundant hardware investments increase overall capital expenses.
   - High upfront infrastructure costs reduce financial flexibility for innovation and expansion.

4. **Operational Complexity & High OpEx**
   - Multiple infrastructure stacks require separate management and monitoring tools, leading to inefficiencies.
   - Lack of end-to-end automation and orchestration increases operational labor costs and requires specialized expertise.
   - Complexity in integrating diverse technology stacks slows down service deployment and increases time to market.

5. **Energy Inefficiency & Sustainability Concerns**
    - Dispersed hardware deployments increase the number of servers, which leads to higher power consumption and carbon emissions.
    - Reducing server sprawl offers sustainability benefits and energy cost reductions.
    - Energy inefficiencies increase operating costs, impacting profitability and corporate sustainability goals.

6. **Limited Scalability & Elasticity**
    - Vertical silos prevent dynamic scaling and efficient resource pooling.
    - The inability to reallocate computing resources hinders disaster recovery and peak demand management.
    - Lack of unified orchestration results in inefficiencies when scaling services across different regions.

Solution: VMware TCP, Horizontal Cloud Architecture

The transition to VMware Telco Cloud Platform (TCP) horizontal cloud architecture represents a transformative shift for CSPs. By deploying a single cloud architecture for all telco and IT applications, CSPs can realize significant operational and financial benefits while improving scalability, efficiency, and sustainability.

Advantages of a Unified Cloud Architecture

A horizontal cloud architecture provides a consistent end-to-end cloud service layer across the entire network, eliminating inefficiencies associated with vertical silos. This approach supports multivendor, multifunction deployments, enabling CSPs to select best-of-breed products and technologies from multiple vendors.

One of the most critical advantages of the VMware TCP horizontal cloud architecture is its end-to-end orchestration and automation capabilities. By utilizing a virtualized management platform, CSPs can automate network and IT operations across all data centers, significantly reducing operational expenses. Automation minimizes manual interventions, accelerates service deployment, and enhances overall network reliability.

Cost Optimization and Sustainability Benefits

Optimizing server deployment is another crucial advantage of a horizontal cloud architecture. By consolidating infrastructure and eliminating redundant hardware, CSPs can significantly reduce expenditures on servers, networking, and storage. This results in both capital expenditures (CapEx) and operational expenditures (OpEx) savings. Furthermore, energy-efficient operations contribute to a reduction in power consumption and carbon footprint, aligning with global sustainability goals.

A unified cloud platform simplifies cloud management labor, leading to a reduction in systems integration expenses, professional services costs, and internal labor requirements. These efficiencies further enhance the financial viability of adopting a horizontal cloud model.

Key Benefits of VMware TCP

The VMware TCP solution offers a comprehensive suite of benefits, ensuring seamless operation and high performance:

- **Unified Environment for Workloads:** VNFs, CNFs, containers, and VMs can run efficiently in a single, optimized environment, eliminating the need for separate infrastructure stacks.

- **Multivendor Hardware and Software Support:** The architecture allows CSPs to deploy best-of-breed solutions from multiple vendors without interoperability concerns.

- **Consistent Architecture Across All Data Centers:** Standardized software and cloud services enable uniformity across IT and telco applications, improving operational consistency.

- **Automation with Telco Cloud Automation:** The architecture is fully automated, reducing manual configurations and improving service agility.

- **Reliability and High Performance:** Engineered for high availability, VMware TCP ensures robust performance with scalable and resilient infrastructure.

- **Broad Technical Support Base:** A large number of engineers worldwide are trained on VCF, ensuring CSPs have access to expert guidance and support.

It should also be noted that VMware's telco cloud automation is the sole solution that enables a multivendor ecosystem for both VNF and CNF, complemented by a distinctive infrastructure policy feature that significantly lowers operational expenses.

The diagram in Figure 1 provides a visual representation of how the VMware TCP and VMware Cloud Foundation framework integrates different network functions, automation layers, and cloud infrastructure. The illustration highlights:

- **The Ecosystem of Network Functions,** encompassing VNFs and CNFs.
- **Advanced Services,** including load balancing, network visibility, and distributed firewalling.
- **VMware Telco Cloud Platform,** which incorporates automation for infrastructure, CaaS, and applications.
- **VMware Cloud Foundation**, delivering a unified platform for compute, storage, and network services.
- **COTS Hardware**, ensuring cost-effective hardware deployment while maintaining high performance.

This architecture provides standard-based orchestration and automation, ensuring seamless service management while unifying IaaS and CaaS functionalities across the network.

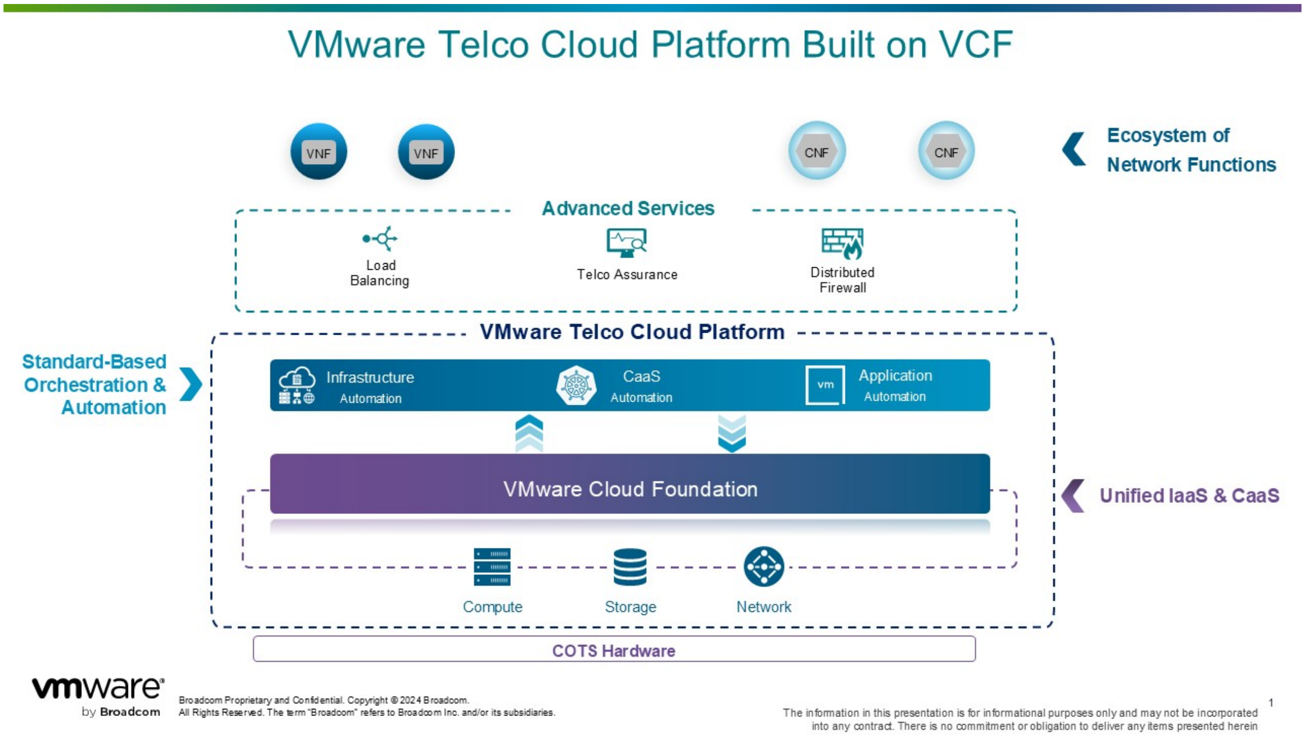

Figure 1: VMware Telco Cloud Platform

TCO Model Overview

The TCO modeling objective is to compare the cost of a vertical silo architecture with a common horizontal cloud architecture. More specifically we will compare two scenarios:

1. A vertical silo architecture
2. A horizontal architecture using VMware Telco Cloud Platform

The Silo scenario is depicted in Figure 2. We model four common silos found in many CSP networks. The silos are composed of:

- Mobile core provided by Vendor A
- Mobile core provided by Vendor B
- IMS software
- IT applications (OSS, BSS, others)

Each of the silos runs on a separate cloud stack provided by the mobile core and IMS vendors. The IT stack is typically a separate cloud stack managed by the CSP IT organization.

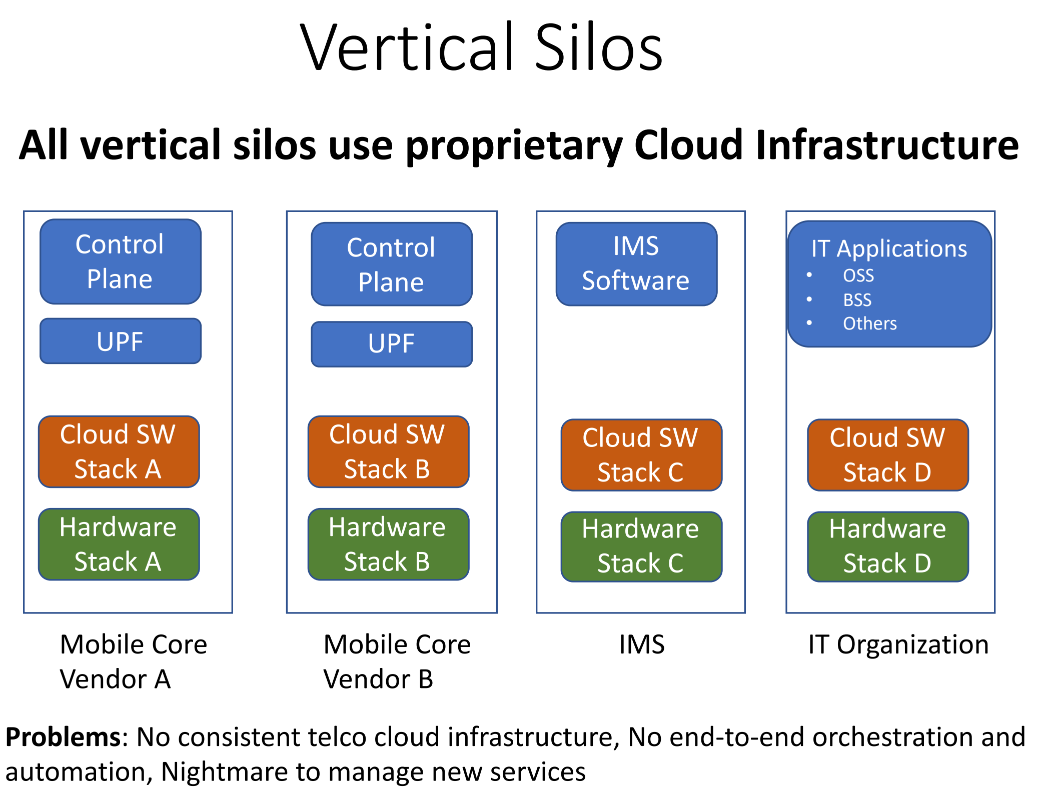

Figure 2: Vertical Silo Scenario

The horizontal architecture will integrate each of the silo stacks on TCP horizontal architecture as depicted in Figure 3. In the horizontal architecture the four stacks are integrated on a common VMware Telco Cloud Platform.

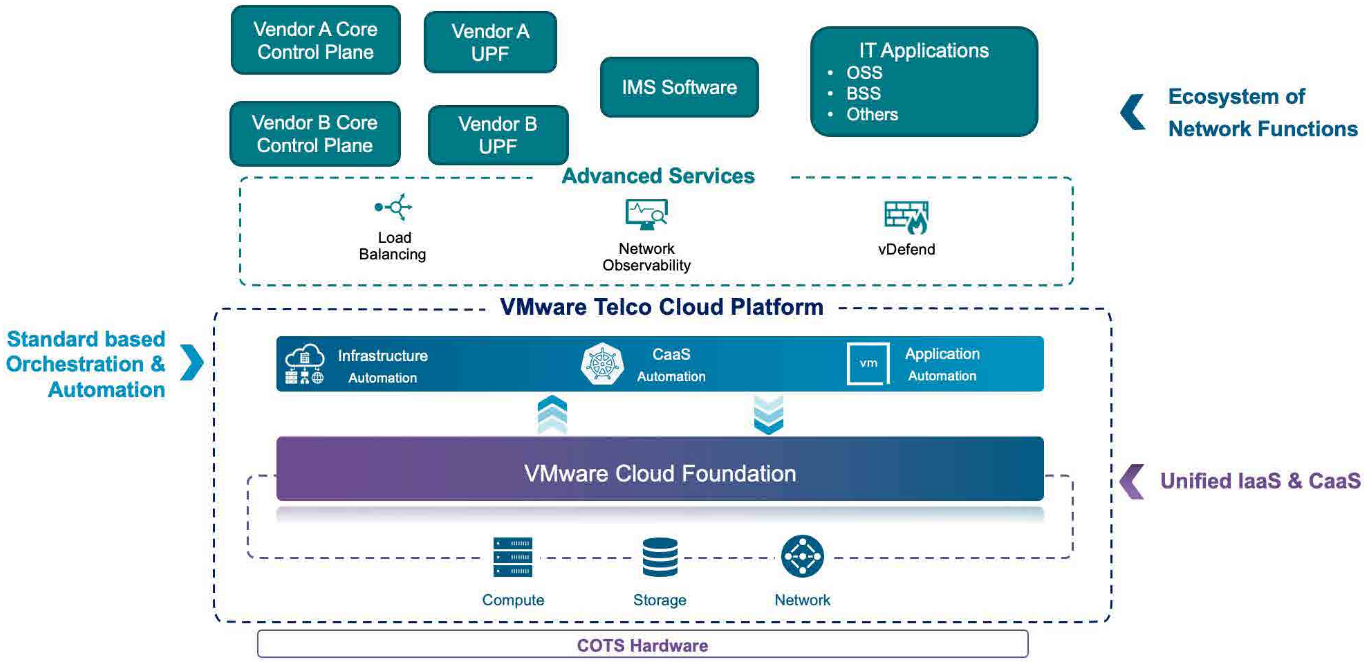

Figure 3: Horizontal VMware TCP Scenario

For this model we assume a greenfield network that grows over five years. The number of servers in the network is driven by 5G user equipment (UE), IMS UEs, IT virtual machines, and application server capacity requirements. The number of UEs and virtual machines starts at zero in Year 1 and grows to the specified values in Table 1 in Year 5.

Application	Quantity
IMS UEs	1,500,000
Vendor A 5G Core UEs	7,500,000
Vendor B 5G Core UEs	7,500,000
IT Cloud Virtual Machines	15,000

Table 1: Number of 5G UEs and IT VMs Driving Network Requirements

TCO Model Expense Considerations and Assumptions

The TCO model includes network CapEx and OpEx. The CapEx includes:

- Server costs
- Server installation expense
- Switches, racks, and cabling
- Software licenses
- Professional services

OpEx includes:

- Power & cooling
- Facilities expenses
- FTE labor expenses

For network OpEx, we model labor expenses to provision and operate infrastructure and network functions and services. The horizontal architecture combined with Telco Cloud Automation (TCA) provides significant reductions in labor expenses. Based on interviews with CSPs that previously deployed VMware Telco Cloud Platform with TCA we estimate the labor savings presented in Table 2.

Labor Category	Savings due to TCP Automation
Hardware Installation	50%
Cloud Platform Installation	80%
Production Network Testing	80%
Engineering & Planning	50%
Lab Test & Certification	80%
Hardware Upgrades	50%
Software Upgrades	80%
Fault Management	80%
Performance Management	80%
Configuration Management	80%
General Management	40%
Deployment & Provisioning	80%
Life-Cycle Management	50%

Table 2: Categories of Labor and Assumptions for Savings due to TCA Automation

Additionally, VMware Telco Cloud Platform with TCA integrates with 3rd party tools and automates most processes end to end. This simplifies installation and life-cycle management and reduces 3rd party professional services. In vertical silo architectures professional services expenses must be incurred for integrating all 3rd party products. These expenses can run from $3 million to $10 million. Also, professional services expenses are on-going due to constant changes in network configurations, software, and devices.

TCO Results

In the TCO analysis we consider:

- CapEx and OpEx savings
- Savings in power consumption and reduction in CO2 emissions

There are three key areas of savings:

1. Reduction of servers due to better server utilization in horizontal architecture,[1] which reduces both CapEx and server-related OpEx, (i.e., power).
2. Telco Cloud Automation reduces costs of FTE labor expenses due to automation and orchestration.
3. Telco Cloud Automation packs servers more efficiently with CNF/VNFs, which leads to further reductions in servers.

In our analysis there is a five-year cumulative TCO savings of 40.8%. A comparison of the five-year cumulative CapEx, OpEx, and TCO of the silo and horizontal architectures is presented in Table 3 and an annual TCO comparison is provided in Figure 4.

Scenario	CapEx	OpEx	TCO
Silo Architecture	$93.1M	$99.9M	$191.2M
Horizontal with VMware Telco Cloud Platform	$84.6M	$28.7M	$113.3M
Horizontal Savings	7.4%	71.3%	40.8%

Table 3: Five-Year Cumulative TCO Comparison of Silos with Horizontal TCP Architecture

[1] Note that silos do not allow sharing of servers between silos, which leads to lower server utilization and therefore more servers are required in silo architectures.

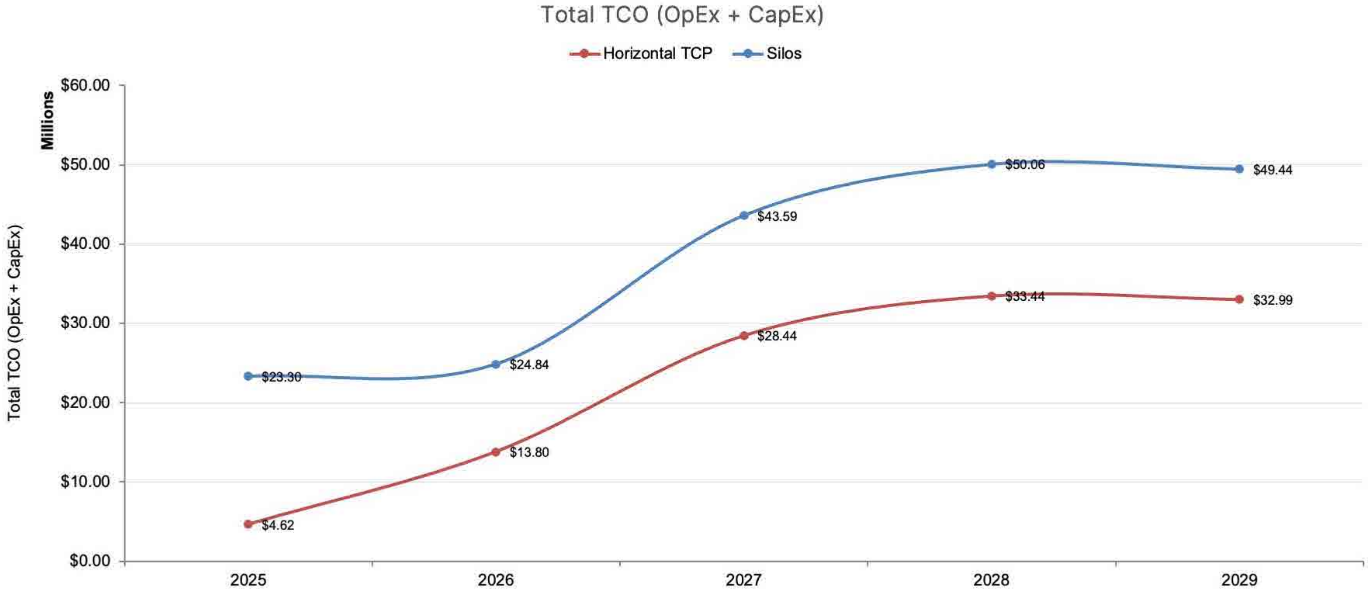

Figure 4: Annual TCO Comparison of Silos and Horizontal TCP Architecture

A key area of savings moving from vertical silos to a horizontal telco cloud is reducing the number of servers, which is due to sharing servers between different vendors and xNFs. The number of servers for each of the six vertical silos is presented in Table 4. The number of servers in the horizontal telco cloud is presented in Table 5, and a comparison of the number of servers is presented in Figure 5. The reason that fewer servers are required in the horizontal architecture is that a common pool of servers is used to support all workloads regardless of the applications, vendors or operating system requirements. Also, VMware Telco Cloud Automation allows for more efficient packing of servers. In the silo architecture each silo has a separate pool of servers, and therefore there is a much lower efficiency of allocating server resources to applications.

Server Name	2025	2026	2027	2028	2029
Vendor B Core Server	7	37	108	182	244
Vendor B UPF Server	4	21	59	99	131
Vendor A UPF Server	4	21	59	99	131
Vendor A Core Server	7	37	108	182	244
IMS Server	78	355	846	1170	1270
IT Server	57	262	624	863	938
Total	**157**	**733**	**1804**	**2595**	**2958**

Table 4: Number of Servers Required in the Silo Architecture

Server Name	2025	2026	2027	2028	2029
Horizontal Shared Servers	111	526	1304	1891	2173

Table 5: Number of Servers Required in the Horizontal Architecture

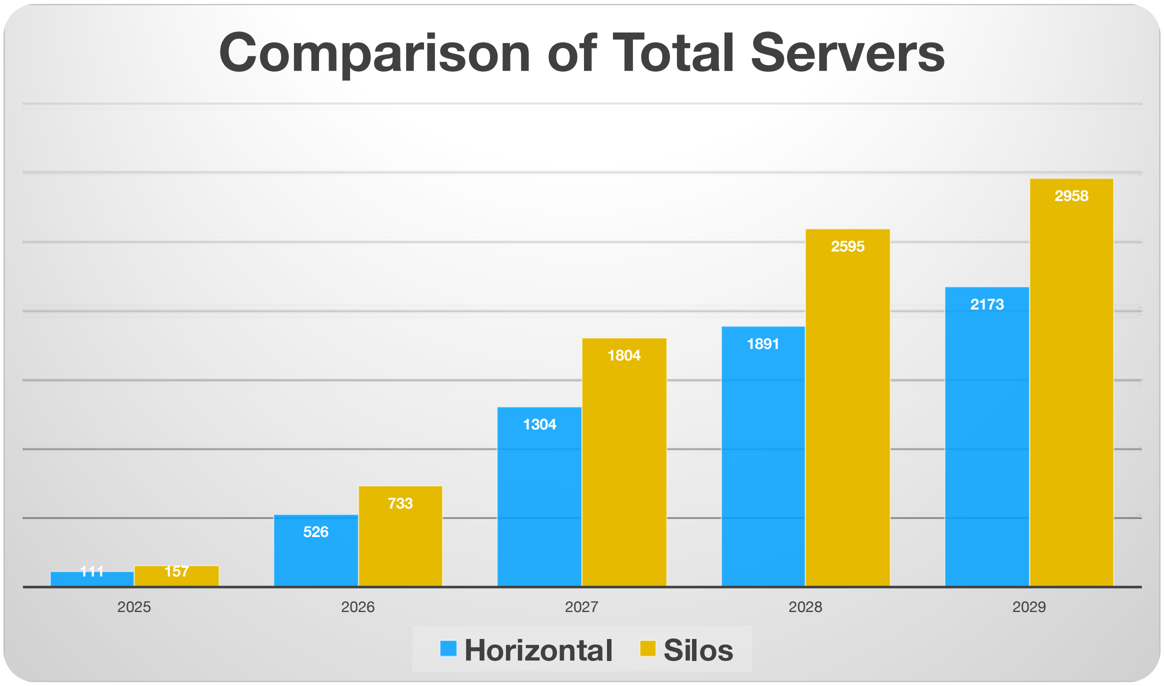

Figure 5: Comparison of Servers Required in the Horizontal Versus Silo Architecture

Reducing the number of servers required in the network also reduces total power consumption and carbon emissions. Many CSPs have made carbon emissions reduction a strategic priority. The total power consumed by network servers is presented in Figure 6 and the associated carbon emissions is presented in Figure 7. It should be noted that power savings and carbon reduction increase as the number of subscribers and network capacity grows over time.

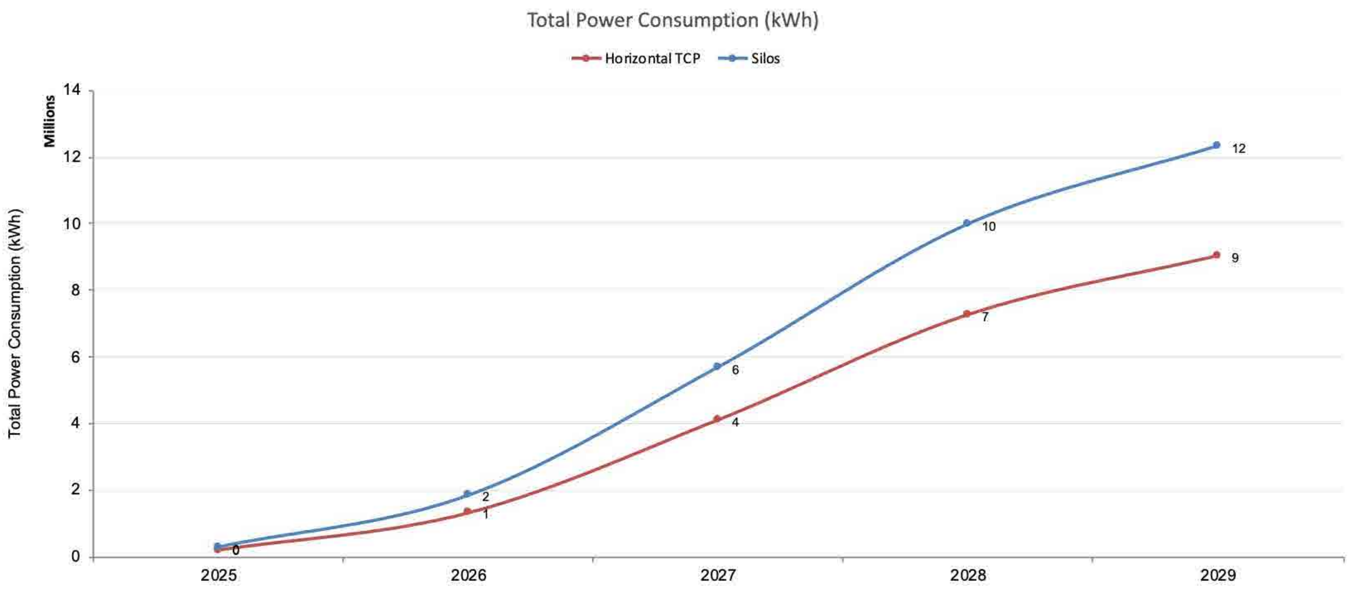

Figure 6: Total Network Power Consumption

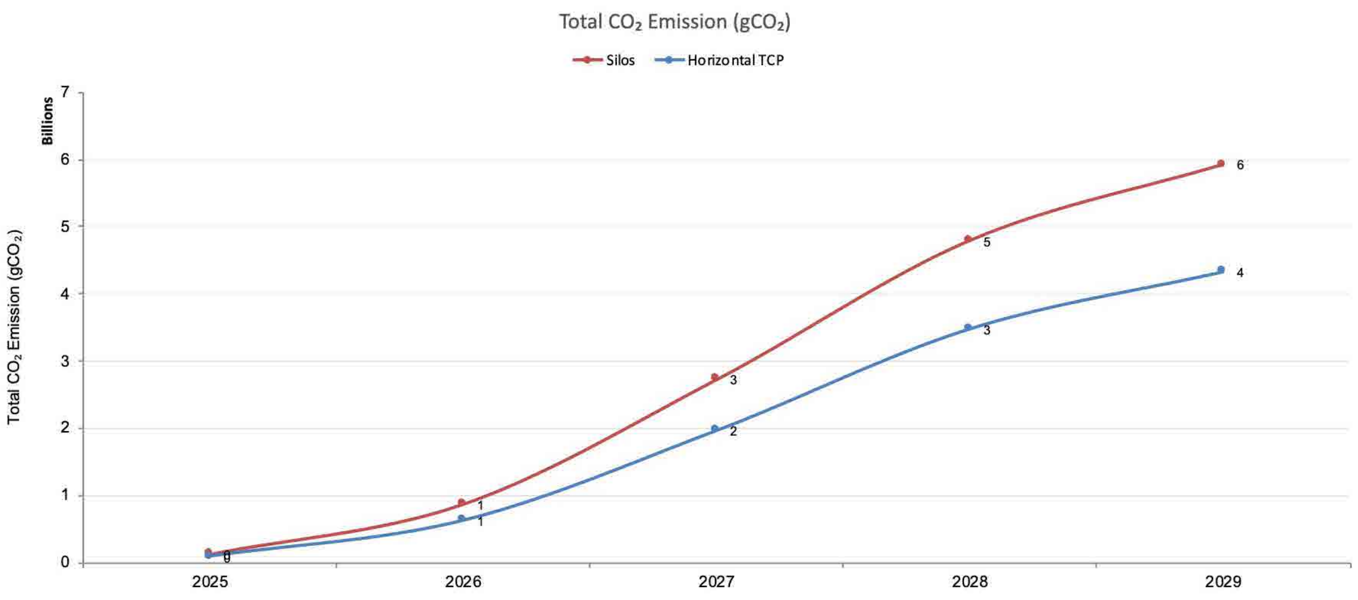

Figure 7: Total Network CO2 Emissions

Conclusion

Vertical silo architectures have served the telecommunications industry well in the past but are now a roadblock to the flexibility and efficiency required in modern networks. CSPs are constrained by high costs, vendor lock-in, and resource inefficiency, particularly as they expand services to edge deployments and multivendor networks.

Although some vendors can provide a complete cloud infrastructure, others cannot. For example, the small niche OSS/BSS, charging, and security NEPS. For those that cannot, the service provider still needs to maintain a vertical cloud infrastructure. Therefore, Broadcom is the only company that offers a single solution for all NEPS, which will help reduce both opex and capex.

VMware TCP horizontal cloud architecture presents a path forward. This approach enables CSPs to unify their IT and telco environments, reduce operational complexity, and achieve substantial cost savings through automation and resource sharing. The TCO analysis confirms the compelling financial and sustainability benefits of this transition. By adopting a horizontal cloud model, CSPs can meet the demands of the 5G era and beyond, achieving enhanced performance, reduced environmental impact, and improved long-term business viability.

Peter Fetterolf, Ph.D. is an expert in network technology, architecture and economic analysis. He is responsible for financial modeling and whitepapers as well as software development of the ACG Research Business Analytics Engine. Dr. Fetterolf has a multidisciplinary background in the networking industry with over thirty years of experience as a management consultant, entrepreneur, executive manager, and academic. He is experienced in economic modeling, business case analysis, engineering management, product definition, market validation, network design, and enterprise, and service provider network strategy.