Improve business agility with a Telco data center

Differentiate service experiences with an eye on cloud native architecture

Abstract

Data centers have become a vital part of telecommunications providers' (telco) networking infrastructures. They deliver many types of services through central and regional locations and are beginning to push farther out towards subscribers. These telco data centers will benefit not only the service providers' subscribers, but also their operations teams. The end customers will naturally experience the advantages of enhanced quality and lower latency of the services to which they are subscribed. Furthermore, service providers will simultaneously appreciate how simplifying and automating data center management improves operational efficiency while saving on related costs.

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> "We need to transform ourselves proactively to meet the new market requirements. Cloud native architecture is necessary to achieve our business goals and positive outcomes for our customers. The technology transformation will increase our business agility, reduce cost and help us deliver differentiated service experiences. Rearchitecting our data centers is the pivot of this transformation journey."
>
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Introduction

Service providers worldwide are transforming themselves into digital telecommunications companies. These transformations aim to build more agile, flexible, and efficient infrastructures, enabling service providers to develop new services easily and effectively. With the fervent rise of 5G as one of the key components of the Fourth Industrial Revolution, or Industry 4.0, service providers are competing to be the primary driver of network transformation and service revolution. Therefore, it is imperative for providers to transform their services infrastructure to meet 5G requirements, including high data rate, ultra-low latency, and massive machine-type communication. Cloud-native architecture will be key to meeting these requirements.

In 5G, most components will be decomposed and virtualized. 5G packet core will be decomposed into User Plane Function (UPF) and Control Plane Function (CPF). The UPFs are to be distributed to edge locations so that service providers may reduce latency and offload traffic in edge nodes. 5G New Radio will be disaggregated into software and hardware. The Radio Access Network (RAN) can now be virtualized on Common Off-The-Shelf (COTS) servers, hence the name virtual RAN (vRAN).

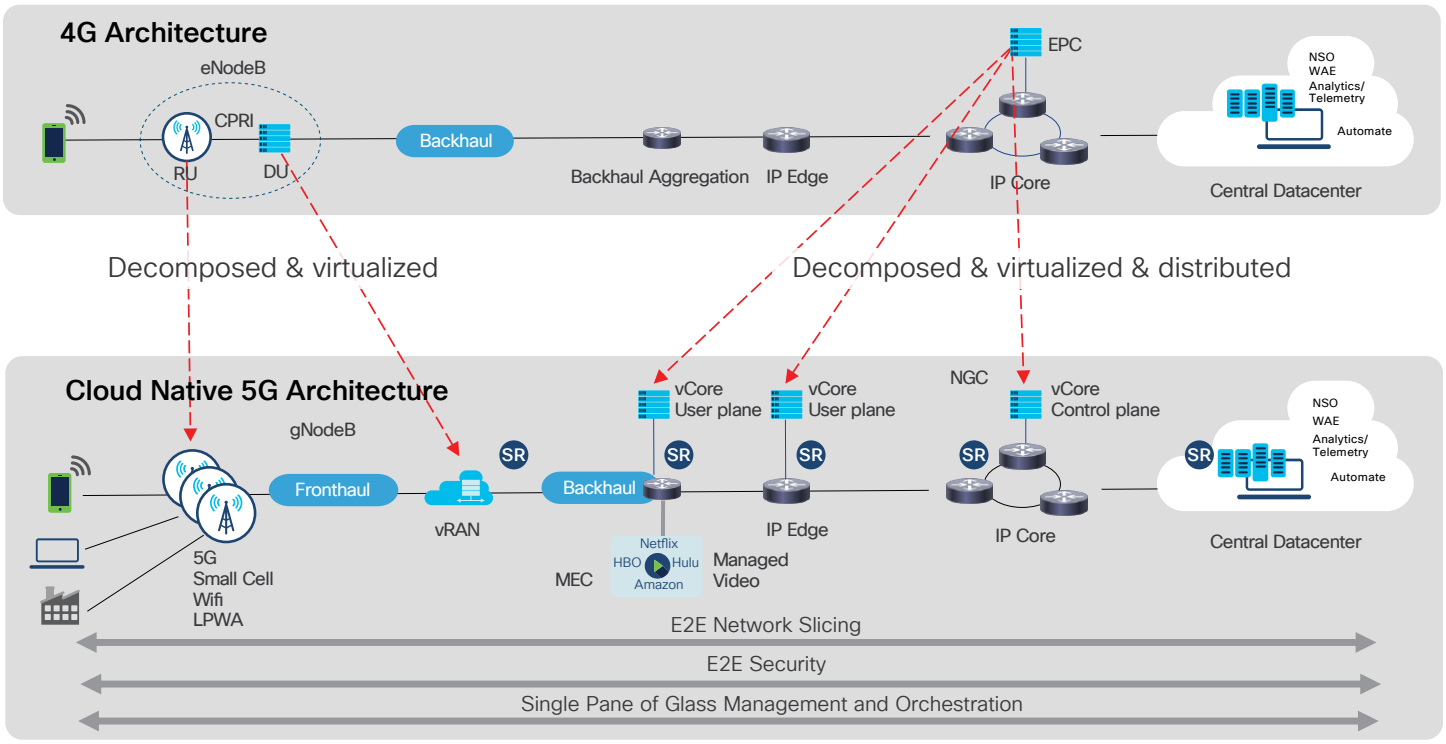

Figure 1. Cloud-native 5G architecture

Telco data center is a service delivery architecture that uses cloud design and operational principles to meet service provider business and service delivery needs. In this architecture, the network functions will be accommodated by multiple regions as a central data center and its regional/edge data centers. This is how a telco data center differs from an Information Technology (IT) data center. The former is responsible for managing network resources, such as 5G packet core and vRAN, whereas the latter is responsible for IT applications such as used by the telco enterprise, Operations Support System (OSS), and Business Support System (BSS). The components of a telco data center are resource demanding and sensitive to latency, hence the need for service providers to distinguish. The separation allows them to continue to meet the ever-increasing demands of subscribers, regulations compliancy, and service level agreements.

Telco cloud is a new model being adopted by service providers that brings a unified operational environment across their several telco data centers (central, regional, edge). Underlying the model is a cloud-native architecture. A unified operational environment is key to achieving the benefits of services transformation such that each new service and application can leverage the platform investment and operational processes can be simplified.

Challenges and requirements

The highly distributed cloud architecture across multiple locations enables service providers to deliver the differentiated service experience and capture new revenue opportunities. Nowadays, data center technology is evolving to meet service providers' requirements. When mobile operators plan to build a telco data center, the identified challenge is to find the balance between the combination of technical requirements such as telco application requirements, future key demands, and costs. Mobile operators may face the following challenges in the process of building future-proof telco data center fabric: Telco application requirements and deployment characteristics.

Telco application requirements

The nature of telco services has transformed itself from a traditional and monolithic platform into rich and distributed services. Modern telco data centers no longer provide only connectivity, but also a wide variety of applications (as depicted in Figure 2) that needs an on-demand network based on intent, multitier, and a multitenant application environment that meets specific requirements for availability, scalability, security, and performance. In addition, continuous sophisticated monitoring, troubleshooting, and adjustments are

IMS	SGW & PGW	Gi-LAN	CDN & OTT Caching
• Faster Convergence • Consistent low latency • Multiple Hypervisor • IPv4 & IPv6 connectivity	• Virtualized deployment across multiple racks for control and data plane • Failover & Redundancy • Routing with fabric	• TCP Optimizers • Deep Packet Inspection (DPI) • CG-NAT • URL Filtering • Service Chaining with multiple nodes	• Caching managed by OTT Provider • Self created Media Content • Driving 100G • Migrating to 400G interfaces

Mobile Networking Monitoring	PCRF	Voice over Wi-Fi	Assurance and Insights
• High performance data replication with scale	• IPv4 & IPv6 connectivity • Multiple hypervisor	• Faster Convergence • Consistent low latency • Multiple hypervisor	• Proactive troubleshooting • Real time visibility • Analytics • Network assurance

Figure 2. Typical services required for a telco data center

necessary to help guarantee service levels in an environment where dynamic telco application demand and characteristics are needed for mobile operators to cover these various requirements.

There are currently multiple vendors who have an installed base in the mobile operator network. Moving forward, mobile operators must also consider enabling an agility for lines of business by combining efficiency, speed, and security at scale. To meet this combination of technical application and business requirements, the mobile operator is expected to standardize telco data center design on an open platform, reducing risk of supply chain, and integrate a comprehensive ecosystem of solution partners supported by a flexible common policy framework.

Figure 3. Characteristics of a modern telco data center

Deployment characteristics

The current traditional data center is positioned as a centralized collection of servers, storage, network devices, and applications running independently. The modern telco application requires data center capability of accommodating distributed architecture, workload interoperability with the network function along with their management, service-lifecycle speed and agility, analytics, and assurance. It must also accommodate specific network requirements across different locations.

Building telco data center architecture of the future

It is advisable for mobile operators to adopt several key principles to build and architect the modern telco data center. The principles cover both the technical and business requirements that will efficiently help service providers embark on the data center transformation.

SDN as telco data center fabric

Bringing SDN into the telco data center is one of the foundations of the mobile operator architecture environment for 5G readiness. SDN provides a new paradigm of data center networking that solves the complexity of underlay network due to the requirements of applications deployed on top.

Clos design architecture, with spine and leaf switches as the main components, is deployed to serve the

north-south and east-west traffic. The SDN controller is used as the unified element of fabric automation and management. Aligned with its mobile operator environment, the SDN fabric should support any form of workload that is physical, virtualized, or containerized.

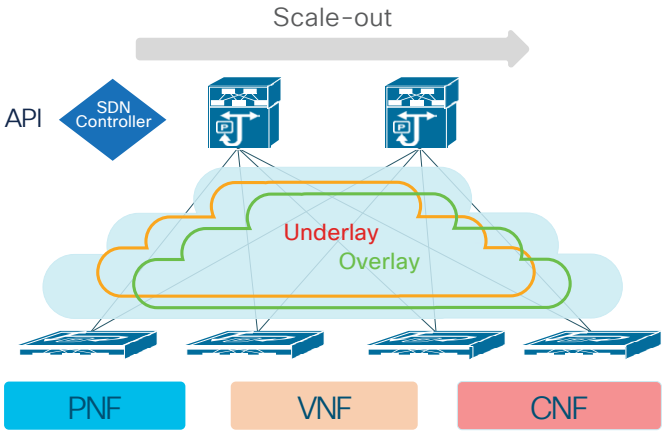

Figure 4. Generalized illustration of a Clos design architecture

- **Underlay and overlay network**

One of the key objectives of SDN is to decouple the underlay and overlay network. The underlay essentially provides the connectivity between the fabric's network elements, while the overlay ensures the connectivity between the workload. This architecture significantly reduces the inter-dependency between the network configuration and services running on top of it. In the data center domain, an overlay solution is implemented to achieve the following:

- Enforce segmentation between services and tenants
- Allow for dynamic endpoint placement across the fabric
- Support for all the above at large scale

- **Operation simplification**

Scale and complexity in the data center are growing along with the workload. To simplify operations, telco data center fabric must be equipped with tools that help users proactively find faults, troubleshoot, and perform regular operations on the network.

Telco data center SDN controller provides centralized analytics and visibility of network health as it relates to applications and tenants. The controller is designed to provide metrics at a system level in real time, such as latency details, atomic counters, and detailed resource consumption statistics.

- **Integrated security**

Security exposure is one of the key aspects when designing telco data center fabric. Therefore, the fabric must be able to limit the surface attack by implementing permit-list policies, where all communication between the workload (endpoint) is explicitly configured in the fabric. The permit-list policy model will ensure that only trusted traffic can flow within certain applications.

Distributed data center fabric

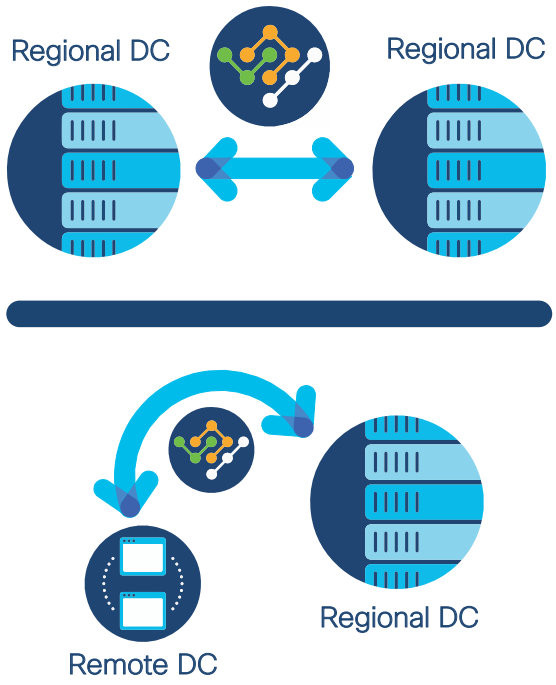

Figure 5. Two models of data center deployment

Telco application has also reshaped its architecture into a more distributed system in virtualized and containerized forms. With control and user-plane separation, telco application has been pushed and deployed in multiple sites, closer to the end user and away from centralized deployment.

While service providers are adopting this architecture, its SDN also has addressed this requirement by designing different types of deployment. Generally, the requirement

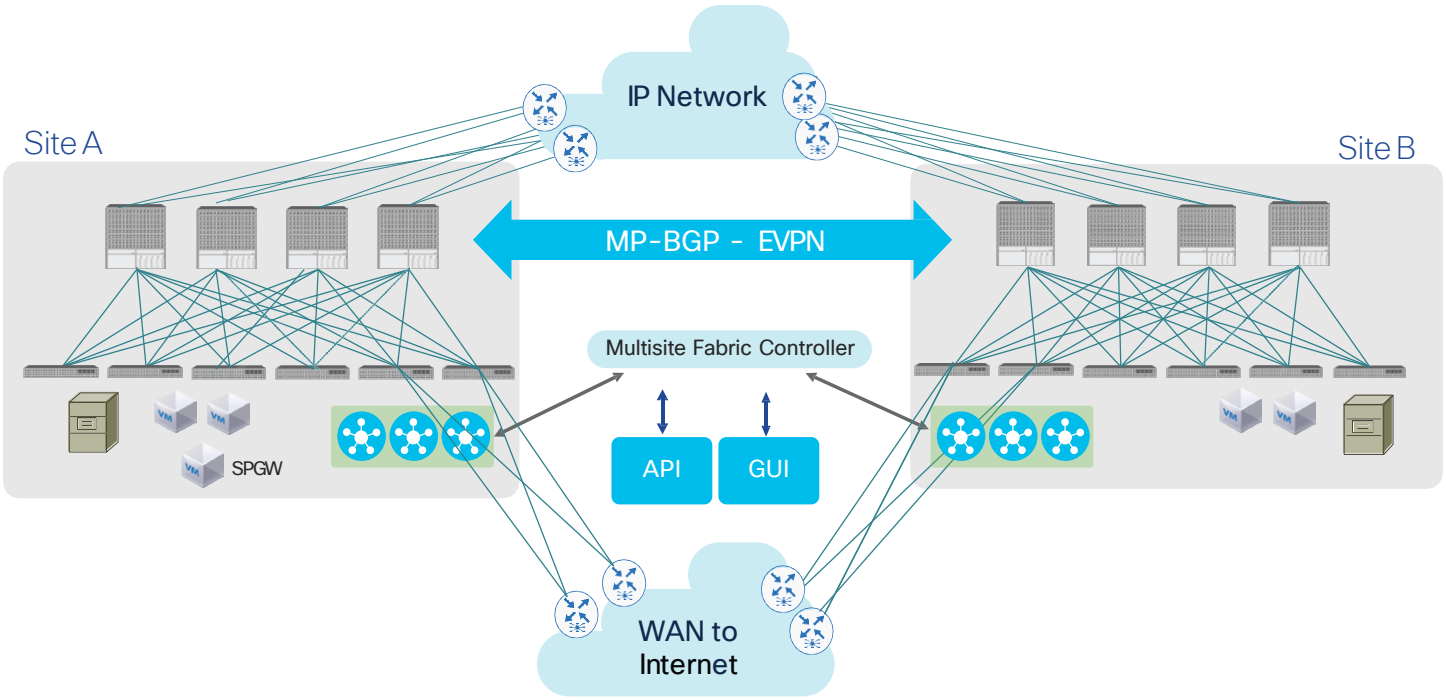

Figure 6. Simplified topology of a multi-site data center fabric consisting of two independent regional sites

can be grouped into two models: multiple regional data center-to-regional data center and multiple regional data center-to-remote data center.

- **Multi-site telco data center fabric**

Referring to the typical telco data center, it is recommended to design for having pairs of independent regional sites (A, B), where the region within its pair can be used as a backup to provide high availability in case of regional outage.

In this architecture, regional data centers will each have their own cluster of controllers maintaining their own set of fabric policies. Centralization framework can be realized by the integration of each controller in the higher layer using multisite orchestrator. It will provide a single point of tools to provision the controller and their fabric in different sites so it can maintain policy consistency.

- **Edge data center**

Edge data center is another type of architecture deployed in modern telco data centers. It is mainly used for small-scale platform where it would normally be deployed in the remote area as an extension of the regional data center. Due to the nature of its scale, service providers are expected to deploy a small-scale

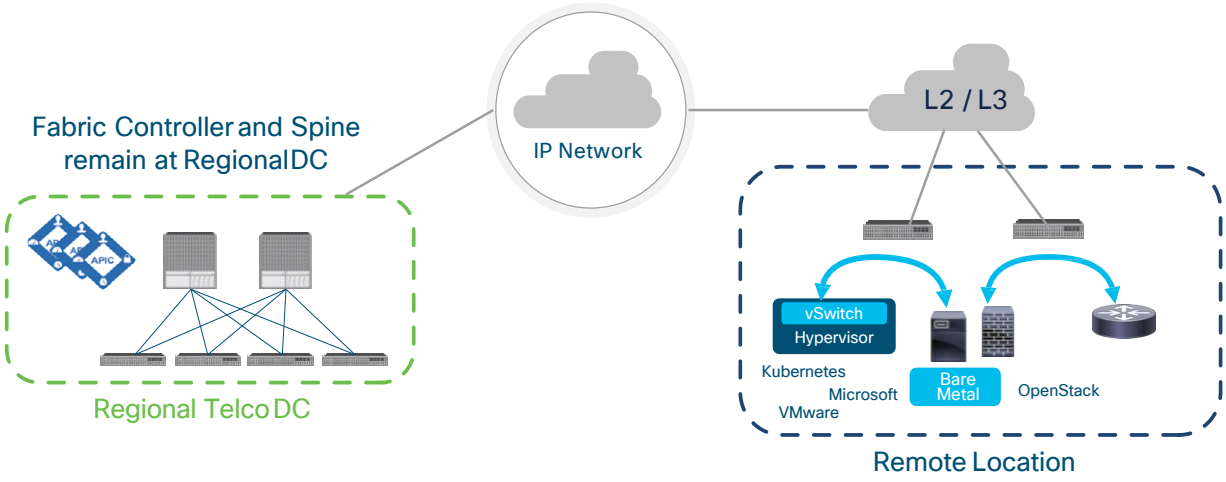

Figure 7. Illustration of a remote data center connected to a larger regional data center, with the remote location consisting only of leaf switches and servers offering various applications and services

SDN platform while maintaining its policy consistency, scalability, security, and high availability.

Service chaining

One of the most important use cases in modern telco data centers is service chaining. Traffic needs to go through a chain of devices before it exits the data center. In a traditional network, service chaining is based on node-by-node Policy-Based Routing (PBR) and Access Control List (ACL) configuration.

Telco data center SDN also has consideration within the fabric that the fabric can cover the service chaining function with sophisticated features such as:

- Ease of configuration, as service nodes are handled in a group rather than as individual nodes
- Easy expansion by simply adding devices in a group without service policy modification
- Automatic load balancing of traffic across service nodes
- Automatic symmetricity of traffic
- Health check of service nodes and automatic rebalancing of traffic across the remaining nodes
- Bypassing and reinsertion of the service group in a chain, based on threshold

Telco data center – Segment Routing on MPLS integration

As mobile operators are building 5G transport domains, they will also need to adopt Segment Routing (SR)-MPLS handoff from the service provider data center, across the transport, to the provider data center edge. Utilizing Segment Routing to build a single data plane across a network of data centers enables service providers to design efficient 5G networks. This SR-MPLS handoff should seamlessly scale, automate, and allow them to integrate their infrastructure from the edge to the central data center and across the transport network. An End-to-End (E2E) programmable SDN enabled approach is required to provide simplification to manage across the data center applications and service provider transport backbone.

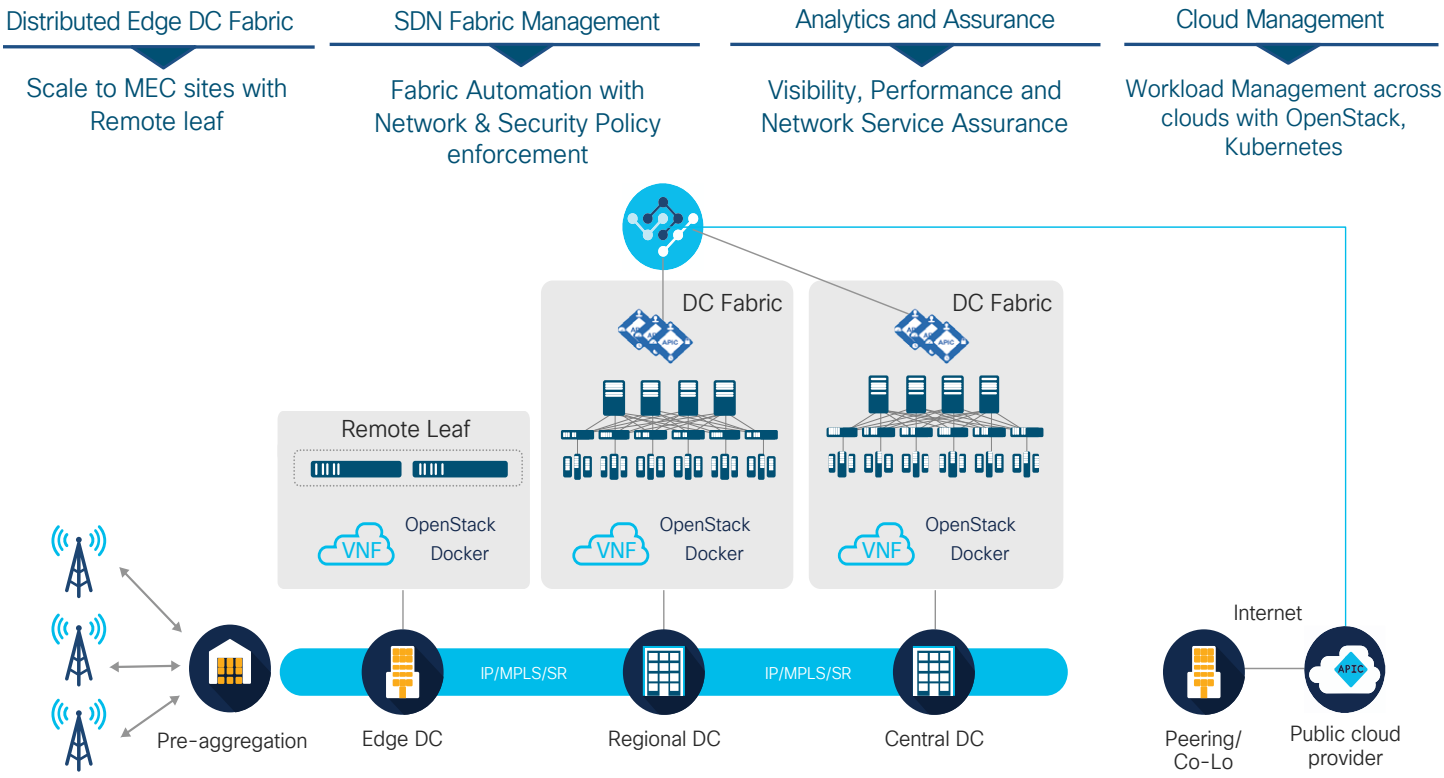

Figure 8. Integration of SR-MPLS onto a data center network

Analytics and assurance tool

Another requirement for mobile operators to prepare for 5G readiness consideration is an analytics and assurance tool as part of the telco data center design concept on their modern telco data center. This is necessary to support operation efficiencies and simplification based on telemetry. It helps operations teams shift from a reactive to proactive-based approach and provide operational efficiency.

In addition to the modern telco data center assurance and service level assurance solution, it is imperative to have a fabric analytics and traffic insights engine which gives the operations team traffic insights and correlated analytics of every flow that is going through the platform. The fabric analytics platform extends machine learning capability to provide actionable insights into network performance yield across a wide array of diagnostic capabilities. The platform provides network insights capability that enables operations teams to better visualize network communication characteristics for mission-critical applications in the telco data center network. This ability should stretch across vendors, and physical and virtual devices.

A form of analytics tool sits behind mobile operator telco data center fabric. This tool receives telemetry data from the network fabric entity (SDN controller, spine, and leaf) and transforms the data into its intended use. This helps operations teams gain visibility of their network fabric in real time to identify anomalies, run root-cause analysis, and manage capacity planning. The analytics tool should be further supported by an assurance tool which is intended to provide continuous verification of data center network state and policy, enabling mobile operators to predict outages and vulnerabilities, accelerate changes, and ensure compliance.

Benefits of telco data center SDN fabric

SDN-based telco data center fabric provides policy-driven automation through an integrated underlay and overlay, is hypervisor agnostic, and extends policy automation to any workload – including virtual machines, physical bare-metal servers, and containers. It offers a set of capabilities that enable seamless connectivity between the on-premises data center, remote small-scale data centers, and geographically dispersed multiple data centers under a single pane of policy orchestration. In the future, these capabilities will extend to the public cloud as well.

There are three key benefits of SDN telco data center fabric: Optimizing your network, protecting your business, and accelerating the path to multi-cloud performance.

Optimize your network

- Operational simplicity, automated network connectivity with consistent policy, management, and operation models across application, network, and security resources
- A flexible, highly available, and scalable network that allows agile application deployment to evolve and grow within a site, across sites, and across global data centers, while removing the need for complex Data Center Interconnect (DCI) infrastructure
- Centralized network management and visibility with full automation and real-time network health monitoring
- Seamless integration of underlay and overlay
- Open northbound APIs to provide flexibility for DevOps teams and ecosystem partner integration
- Simplify interoperable solutions from open ecosystem partners for Layer 4 through Layer 7 services
- A cloud ready SDN solution
- Common platform for managing physical and virtual environments

Protect your business

- Business continuity and disaster recovery
- Secure networking with a zero-trust security model and innovative security features such as micro segmentation
- Security at cloud scale, accelerated by hardware

Accelerate path to multi-cloud performance

- Single policy and seamless connectivity across any data center and public cloud
- Any hypervisor, any workload, any location, any cloud
- Cloud automation enabled by integration with vRealize, AzurePack, OpenStack, OpenShift, and Kubernetes

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Conclusion

Telco cloud built with telco data center design is the key foundational architecture to enable new services made possible by 5G that are specifically application driven, agile, and mobile. This provides the best experience for the end user, and it optimizes and reduces bandwidth occupancy on the network transport side. Telco cloud technology presents an opportunity to provide services that maximize revenue opportunities with OpEx savings. It helps profitability to deliver converged broadband and multi-access edge computing. This will result in an improvement of service velocity, agility, and operational efficiency that service providers can pass on to their consumer and business customers.

Especially for 5G, service providers are looking for operational simplification by adopting E2E service orchestration. Service providers want to enhance the subscribers' experience by deploying E2E network slicing to deliver differentiated services for multiple end customers. Cisco integrates E2E slicing in multiple domains with differentiated services mapped in the data center domain, thereby delivering consistent experience throughout the network. This can also be fully automated, allowing operators to make changes quickly and easily with optimized costs.