The Physical Reality of the Virtual World

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Today, virtual networking is the new paradigm for building networks, and it is critical to the success of 5G. In essence, it leads to a decoupling of physical infrastructure from the services that the network delivers.

Yet, virtual networking contains an inherent paradox. With virtual resources, service level management is completely separated from the underlying physical resources required for service delivery. The capacity required for a service is drawn from the capacity of the virtual resource, which is configurable at the level of the physical resource. But while the network core and other infrastructure may exist as virtual assets, a service is delivered to *something*—a device, an object or an individual.

In this article, we'll examine the paradox and discuss how service providers and telecoms operators can resolve the problem, enabling them to efficiently and effectively deliver dynamic, virtual resources.

First, a look back

To understand this paradigm shift, let's start by looking at how networks have historically been built. Generally, resources and services were tied to hardware. This approach meant that networks typically required specialist, proprietary hardware, which created lock-in, limited choice and tended to contribute to interworking issues. The growth of standards-based commodity hardware addressed this situation by providing common physical elements that could be reused for multiple use cases, but services and elements were still tied to specific resource clusters.

By and large, virtual networking is perceived as the answer to this problem. It enables resources to be created dynamically in software to reflect changes in service demands, with the support of data centers composed of commodity hardware blades and processors. If, for instance, more capacity is required for a service, it is allocated at the level of the virtual resource. When more physical capacity to deliver the virtual resource is required, additional hardware can be allocated, and vice versa.

According to SDX Central, virtual networks offer promise by enabling "the service provider network to provision the most suitable and efficient networking structure for the applications it hosts—and to alter that structure as conditions warrant, using software rather than requiring physical changes in connections to hardware."

As a result, virtual networks offer elastic flexibility. They are also fundamental to 5G, because 5G provides a completely converged network and service architecture, allowing different forms of access connectivity. Today, though, service providers are at a transition point: many providers have hybrid networks, spanning legacy physical infrastructure, as well as new virtualized elements and services. As we move to 5G and into the future, transitioning to virtual networks is key to success.

Service delivery

Networks deliver services that are consumed by people and devices. This means that if, for example, an enterprise requires more capacity to meet its evolving needs, the additional capacity will be provisioned by its service provider and will be made available

across the physical path to the location of the enterprise.

If differentiation in terms of specific services delivered across that capacity is required, the service provider will make appropriate allowances. The same is true for wireless connectivity. In short, the provider can shape the services and capacity available in each cell site and across the network.

5G changes the game

Traditionally, networks have been optimized for voice, data and messaging services. However, 5G changes things entirely. 5G networks—wireless or fiber access—are optimized for several different parallel services. These are: Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communications (URLCC), Massive IoT, and Fixed Wireless Broadband Access (FWA).

Each of these services has different performance characteristics and requirements, which may vary on a per-session, per-application, or per-user basis. All of this has been made possible by the fully virtual core architecture. And therein lies the rub.

The virtual—physical paradox

While we might describe resources as virtual, there are still physical elements to consider. A fiber can be used for connecting a property to a distribution point. A Radio Access Network (RAN) or a small cell is used to connect to devices in the vicinity, or to deliver FWA connections to a building. A cable might terminate in a rack to deliver Ethernet services.

Even if the elements that compose, manage and execute the service are virtual, there is always a physical dimension. Too often, this is forgotten.

What does this mean in practice?

The correlation of physical assets with virtual and logical resources is fundamental to the smooth delivery of all communications services. Why? The nature and location of these assets need to be clearly understood and mapped, so that they can be identified and allocated to a specific logical or virtual resource. Operators must understand all dimensions of their physical, virtual, logical and service inventory in order to allocate and manage them effectively and to correlate and coordinate their service inventory.

Similarly, the limits of absolute capacity must also be understood, so that the boundaries of resource performance can be defined. For volatile services, this is particularly important, because while capacity may be changed with virtual assets and in real-time, there are still physical constraints to consider.

In this context, we need to explore different domains and also consider the difference between passive and active components.

Inside and outside plant

Inside plant (ISP) relates to physical inventory deployed in a facility. These are active components and include assets such as central office equipment, DSLAMs, main distribution frames, power supplies, and optical equipment.

Outside plant (OSP) spans solutions such as underground ducts and conduits, repeaters, poles, manholes, cables, and cell towers. These are typically passive components, and understanding their location is essential for the service delivery and activation chain.

Potential problems

Imagine that a service is delivered across optical fiber to a customer’s premises. If an alarm is generated, testing through OTDR (optical time-domain reflectometer) can provide an estimate of the distance to the break. Only clear understanding, however, of the physical location and the connectivity involved can pinpoint the problem.

This knowledge matters because many disruptions happen in the field with OSP. Operators must have clear understanding of not only the virtual resources required for a service but also the physical and logical assets that underpin them. Correlating this information and mapping it to the location of assets is crucial, as doing so can accelerate problem identification and resolution.

Similarly, if an operator wants to deploy a new service to a customer, knowing which assets are involved and where they are allows the provider to understand how the service can be delivered—and whether there are sufficient physical assets to deliver the virtual service offered.

SD-WAN and virtual deployments

SD-WAN technology brings the benefits of virtualization to business customers. It enables operators to deliver new, more flexible managed services, often with additional capabilities, such as application awareness and traffic shaping.

While the services and policies are delivered virtually, they are enabled across physical connections, including routers, servers, end-devices and the like. To correctly provision such services, the location of all physical elements required to support service delivery must be known. This applies to both delivery to a new customer and changes in service performance for an existing SD-WAN location.

As such, correlation between physical, virtual and logical resource inventory and assets must be achieved, so that service changes and new service activation can be applied quickly and effectively—without service disruption.

RAN virtualization

Just like the next-generation core network, the new RAN elements of mobile infrastructure are virtualized. This allows more flexible allocation of resources, dynamic scalability and reduced energy consumption. This is critical, as the new mobile network demands a significantly (>10x) expanded access point footprint.

Importantly, there is already increased diversity in terms of radio assets, as operators supplement classical base stations with small cells, micro cells and Wi-Fi hotspot coverage.

o the miTo achieve the desired dynamic coverage, operators must understand what physical resources are available, where they are, and be aware of any constraints they impose on capacity. Adding network slicing—which dedicates specific network resources to a specific customer or user—complicates the situation further.

Many operators expect the majority of 5G revenues to accrue from business customers, so the ability to deliver the desired service is essential to future success. This cannot be achieved without a comprehensive and dynamically adaptable view of inventory. The reality is that network slicing can only become viable with highly efficient, scalable OSS that allows for repeatable, dynamic resource allocation.

Network Extension

Many operators are extending their fiber footprint and other connectivity options through overhead, underground or other operations. Each time they do so, they must ensure alignment with the existing network as well as effective recording of each new asset, so that it can be assigned correctly when activated.

This requires the ability to maintain and grow an up-to-date inventory of all resources

so they can be correlated with the services delivered across the infrastructure. As services are activated, the associated resources must be logged and, when the service changes, they need to be reallocated appropriately.

Conclusion

Service delivery involves a complex chain of resources, which must be coordinated carefully to ensure that promised capabilities are delivered to customers. Although networks are steadily moving toward a fully virtualized architecture, physical infrastructure remains of critical importance. Virtualization tears apart traditional models. As such, it is essential for operators to be able to understand and correlate physical, logical and virtual resources in order to deliver and manage the services they offer.

Network inventory is a dynamic, constantly evolving challenge and requires continuous management. The advent of 5G and SD-WAN technologies complicates matters further, as this extends virtualization into the last mile and even into customer premises. To be successful, operators must ensure that they have a complete, end-to-end picture of inventory, across all classes of assets.