How Citrix Supports Multi-Tenancy in Mobile Networks
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Introduction

Virtualization technologies are having a major impact on the design of mobile networks and telco data centers. By de-coupling applications and computing workloads from the infrastructure used to deliver them, virtualization technologies are enabling operators to simplify their networks by consolidating equipment, support multi-tenancy and deliver higher levels of performance to all customers including subscribers and MVNOs.

The result from a technical perspective is the ability to meet the capacity requirements for all tenants—applications, and enterprise and MVNO customers—while minimizing the need for dedicated hardware. From a business perspective, the impact is an unprecedented ability to consolidate infrastructure and reduce total cost of ownership (TCO).

This paper highlights how Citrix is leading the way in extending related capabilities and benefits of application delivery control by offering multiple physical and virtualized options for implementing its Citrix® NetScaler® line of application delivery controllers (ADCs).

Citrix NetScaler is an application delivery controller (ADC) built with virtualization at its core that allows operators to implement multi-tenancy and on demand scalability. Deployed in the S/Gi-LAN, control plane or data center, NetScaler optimizes application delivery availability through advanced L4-7 load balancing and traffic management, accelerates performance and substantially lowers costs by increasing server efficiency.
NetScaler options for virtualization and multi-tenant support

Keenly aware of both the trend towards Network Functions Virtualization (NFV), Citrix is leading the way in the ADC market with powerful options for virtualization and support of multi-tenant requirements.

Figure 1: NetScaler VPX and SDX multi-tenant application delivery controllers
NetScaler VPX. A virtual appliance version of NetScaler, this solution exemplifies the leadership Citrix is providing for virtualized ADCs and multi-tenant datacenter designs. Unlike many competing virtual appliance implementations, NetScaler VPX is:

- A full-featured solution that provides all ADC functionality and modules, including global server load balancing, advanced traffic management and advanced L4-L7 load balancing.
- A high-performance solution capable of operating at throughput levels of up to 3 Gbps.
- An open solution capable of operating not only on Citrix® XenServer® but also on Microsoft® Hyper-V™ and VMware ESX.

NetScaler SDX. Another innovative multi-tenant solution provided by Citrix, NetScaler SDX effectively delivers multiple virtual ADCs by enabling fully isolated and independent NetScaler instances to run on a single appliance. A significant difference compared to other implementations of the virtual devices concept, however, is that NetScaler SDX provides complete isolation—all the way to the point that memory, CPU cycles and SSL cards are allocatable resources that can be “carved up” and definitively assigned to different NetScaler instances. This characteristic—complete isolation—is actually quite important given the application-centricity of the processing NetScaler performs.

Figure 2: NetScaler Traffic Domains

- Allows service providers to use overlapping IPv4 addresses
  - Creates networking layer separation with IP address reuse
  - Visibility to Layer 7 applications and protocols
- Multi-tenancy with separate routing/traffic flows
- Segregate applications within single deployment
NetScaler Traffic Domains. This is the ability to associate different sets of policies for load balancing, traffic management and other application delivery functions with different virtual IP addresses (VIPs). Traffic domains build on this common capability by providing the means for an ADC supporting multiple tenants to ensure that communications traffic is not able to cross from one tenant’s domain to another. NetScaler uses policies triggered by a variety of Layer 2 and 3 attributes to segment traffic—an approach that supports dynamic routing and eliminates the need to create and maintain static routes for each domain.

NetScaler implementation options

With NetScaler, there are essentially two choices for physical hardware: NetScaler appliances or general-purpose hardware (GPH)—a term covering not just standard servers but blade servers and unified computing systems as well. Combined with the virtualization mechanisms, the result is four core options for implementing NetScaler ADC functionality in virtualized, multi-tenant networks and data centers:

1. A NetScaler MPX appliance running a single NetScaler instance
2. An individual NetScaler VPX instance running on GPH
3. Multiple NetScaler VPX instances running on GPH
4. A multi-tenant NetScaler SDX appliance hosting multiple NetScaler instances

Another important characteristic of the NetScaler solution is that the same binary is used for all three products. This ensures consistency, simplifies ongoing management and provides flexibility and investment protection, as configurations can easily be migrated or shared among different implementations.

Guidelines for selecting an implementation option

The issue that naturally arises next is determining which implementation option is most appropriate for any given scenario. In general, this requires evaluation of several factors and tradeoffs—the most significant being the degree of separation, or isolation, that each configuration provides. Another way of thinking about this is in terms of which resources are being shared by different tenants and how. Specific considerations include:

• The degree of fault isolation. Does a process failure (or shutdown for maintenance purposes) for one tenant impact the availability of services for other tenants?

• The degree of functional isolation. Can different tenants run different firmware versions? For example, what if one tenant needs to run the latest version of application firewalls to obtain access to new functionality? Is it possible to accomplish that without forcing all other tenants to upgrade to the latest version of software as well?
• **The degree of performance isolation.** Can one tenant’s consumption of resources impact the performance of other tenants, or is it possible to establish definitive allocations?

• **The degree of data isolation.** If and how one tenant’s data is kept separate from another’s is especially relevant for MVNO implementations.

• **The degree of administrative isolation.** To what extent can the management functions for different tenants be separated and delegated?

The NetScaler SDX addresses all five areas. Dedicated NetScaler VPX or MPX instances provide maximum separation of tenants – although at the cost of reduced physical consolidation.

A handful of other technical factors are also relevant to the evaluation process:

• **Tenant density.** By itself, an individual NetScaler SDX appliance can accommodate as many as 80 separate NetScaler instances

• **Hardware platform.** Although general-purpose hardware generally costs less, NetScaler MPX and SDX appliances have the advantages of eliminating hardware selection issues, supporting SSL acceleration, delivering proven performance up to 120 Gbps.

• **Virtualization objectives and benefits.** In general, a greater degree of virtualization will translate into a greater degree of physical consolidation, TCO reduction, flexibility, portability and network agility.

Finally, it is necessary to acknowledge that macro-level business issues may also come into play. An MVNE or MVNO host operator may want to offer full isolation for each of its MVNO customers or to simplify S/Gi-LAN infrastructure and lower overall costs.

**Implementation scenarios for virtualized multi-tenant networks**

Several sample configurations are provided below to demonstrate how the various options can be employed to meet the unique requirements of different scenarios for operators.

• **Multi-tenant Services Layer.** This configuration is for a network design that incorporates a designated services layer and entails operating multiple instances of NetScaler SDX at mobile core to address the application delivery needs of all tenants (e.g. MVNO customers, VAS applications). Typically, this layer would support applications that run on bare-metal and in the near future as virtualized functions to extend multi-tenancy to the application layer.
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Small to Mid-Sized Networks: A redundant VPX/GPH instances with or without Traffic Domains will typically be sufficient to meet the needs of small or mid-size operators and involve only a handful of tenant applications.

Whichever options are selected in any given scenario, the same code base used across NetScaler MPX, VPX, and SDX ensures consistent functionality and provides the flexibility to easily accommodate changes if the organization’s needs evolve.
Conclusion

Operators are looking to gain network flexibility and agility in order to accelerate the new service introduction and innovation in their network services. Leveraging cloud-based architectures, operator networks will evolve over time to incorporate cloud-based architectures that lower TCO while gaining substantial improvements in performance and adaptability to changing business conditions.

To maximize these gains it is necessary to make the deployment flexibility and multi-tenancy capabilities enabled by virtualization available for ADCs. To this end, Citrix has developed an innovative and market-leading set of virtualization and multi-tenancy options with NetScaler VPX virtual appliances, and the NetScaler SDX virtual device platform. Mobile operators are assured of a best-fit solution for essential application delivery services to fit the topology requirements of their mobile packet cores and S/Gi-LANs.