

Cloud Services Provider and the VMware Cloud Director Service Delivery Platform

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What is VMware Cloud Director?

VMware Cloud Director serves as a platform for delivering services by utilizing logical structures to enable the provision of virtual infrastructure resources and application services to tenants through self-service. Cloud Services Providers aim to optimize hardware assets to achieve higher profit margins and returns. To achieve this, they require a secure sharing of resources with multiple tenants, offering both private and public hybrid clouds. The expanding cloud services market presents significant opportunities for Cloud Services Providers. Although initially focused on providing Infrastructure as a Service (IaaS), VMware Cloud Director has continuously evolved and introduced innovations beyond IaaS, encompassing applications, cloud-native solutions, and accelerated computing, which will be further discussed in this document.

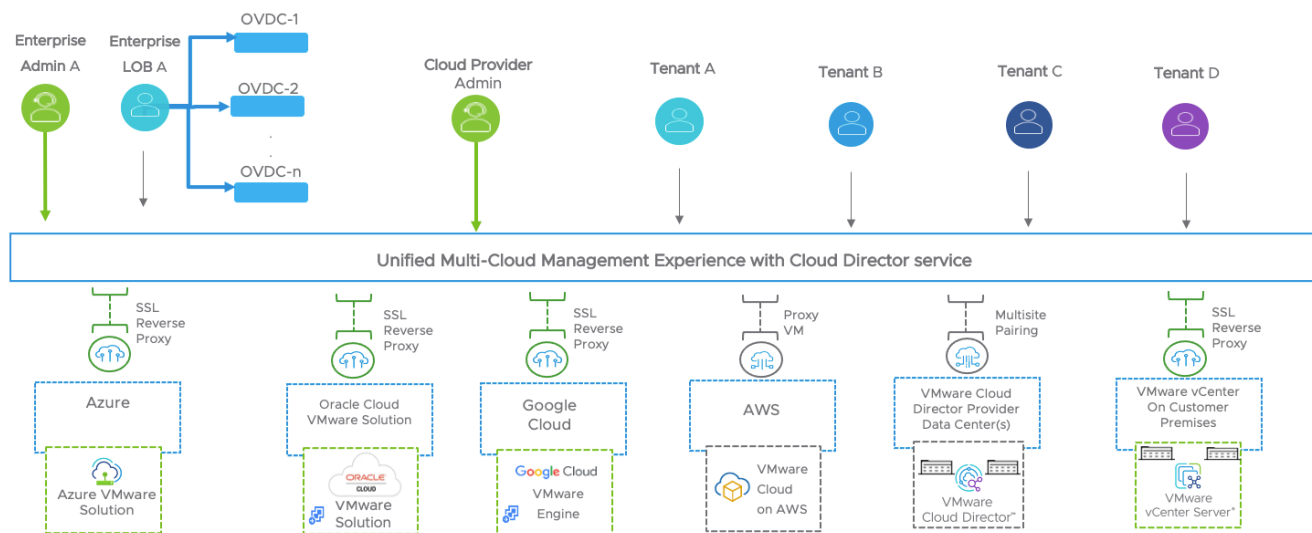
Approx. 900+ Cloud Services Provider run VMware Cloud Director managing ~610,000 customer workloads (VMware, 2023)

At its core, VMware Cloud Director transforms physical resources, such as network, storage, and compute, within a data center into flexible Provider Virtual Data Centers (PVDC). Cloud Services Providers have the capability to allocate or share resources from a PVDC to multiple Organization VDCs (Org VDCs), allowing for differentiated service levels for various customers and customer units.

As an added value, Cloud Services Providers typically offer access to secure and updated Content Hub containing operating system builds, applications, media, and container applications. Customers can then independently consume these resources through self-service across any Cloud Director data center location. Alternatively, providers can enable customers to upload their own builds and applications to the Content Hub if desired. This forms the basis of a managed service that serves as a starting point for many Cloud Services Providers to offer a wider range of services. User access and control over these services are managed through predefined limits and policy controls within the service.

How can you consume VMware Cloud Director?

The primary choice faced by Cloud Services Providers is whether to adopt Cloud Director as an asset-light software-as-a-service option, an asset-heavy in data center service, or even both concurrently.



Asset Heavy:

Since its establishment in 2010, VMware Cloud Director has been accessible to Cloud Services Providers for deployment within their own data centers. Over the years, it has undergone significant transformations while consistently maintaining a presence within the data center environment. As part of the Core Flex 7.7 m-point bundle, all Cloud Services Providers now have access to VMware Cloud Director. This implies that even if not actively utilized, Cloud Services Providers in the program are already paying for VMware Cloud Director. Additionally, VMware Cloud Director can be utilized to manage customer VMware vCenter environments, offering a unified access point for overseeing customer services and connectivity.

Asset Lite:

The Software-as-a-Service (SaaS) version of Cloud Director is referred to as "VMware Cloud Director service." It offers the same features of multi-tenancy and security but in an asset-light environment. In other words, there is no requirement to purchase, run, or operate any assets within a provider's data center. The VMware Cloud Director service is built on the same code base as VMware Cloud Director, ensuring identical functionality to the on-premises version. As long as the VMware Cloud SDDC endpoint is accessible, the features of the VMware Cloud Director service can be utilized. Moreover, the Cloud Director service can also establish connections with existing in-data-center Cloud Director instances, either for isolated environments or to support legacy purposes.

Why do you need VMware Cloud Director?

Are you experiencing any of the following symptoms?

- ⇒ Excessive discounting on services.
- ⇒ Not enough differentiation in your portfolio.
- ⇒ The lack of multi-tenanted hardware is affecting your sustainability capabilities.
- ⇒ Unable to address app modernization projects or platforms in your data center for customers.
- ⇒ Hard to introduce new products to your portfolio.
- ⇒ Slow delivery of services.
- ⇒ No ability to multi-tenant services, including accelerated computing.
- ⇒ Too many errors in manual delivery.
- ⇒ Challenges meeting a customer's agile demands.
- ⇒ No room to manoeuvre in existing contracts.

How Cloud Director addresses efficiency:

Cloud Services Providers currently utilizing VMware Cloud Director have consistently reported operational enhancements, improved sales attach rates, and substantial scalability without a corresponding increase in operational costs. VMware Cloud Director streamlines a significant portion of the manual processes associated with service delivery, regardless of the specific service. By automating existing operational scripts within the robust workflow system of VMware vRealize Orchestrator (an essential element of VMware Cloud Director), operational tasks can be efficiently delegated to resources with lower skill levels and cost.

51% Faster to deliver compute,
31% more efficient IT Infrastructure,
54% faster to delivery new network capability

VMware Cloud Director incorporates a comprehensive IP allocation system called IP Spaces that effectively tracks IP usage and automates the provisioning of essential virtual resources for the service. Security measures, whether at the Edge perimeter or for individual virtual machines (micro-segmentation), are diligently managed and upheld through dynamic group or individual policies. These policies can be extensively automated, ensuring ongoing compliance while enabling customers to prioritize their business objectives rather than being consumed by security concerns.

VMware Cloud Director offers an extensible platform that allows for easy deployment of additional plugins using the HTML5 framework. One such plugin is VMware Chargeback, which grants both providers and tenants

access to performance and billing dashboards. Providers have the flexibility to customize these dashboards to align with each tenant's specific requirements. With appropriate permissions, customers can view their usage data and a wide range of metrics sourced from VMware vRealize Operations, all accessible within the VMware Cloud Director interface. This streamlined access enhances troubleshooting capabilities and provides visibility into their cloud services. Furthermore, providers have the option to expand their service portfolio to include managed services and deliver easily accessible managed reports through the same user interface, covering both applications and infrastructure.

The majority of customers require a certain level of organizational control, ranging from read-only access to full administration privileges. VMware Cloud Director and VMware Cloud Director service go beyond vCenter and VMware vSphere, offering self-service capabilities and extending services such as networking and security through VMware NSX-T. Additionally, advanced load balancing for modern applications, now accessible in Cloud Director, along with Backup and Disaster Recovery from Cloud Director Availability, are available to customers without any adverse effects on other users or customers.

Customers have diverse and often fluctuating requirements, which may necessitate manual adjustments to allocate additional resources for a specific duration. However, VMware Cloud Director now offers an automated solution through virtual machine autoscaling (subject to application support). This feature brings substantial efficiency benefits for both the customer and the provider. Customers can have confidence that resources will be dynamically allocated to their applications when required, eliminating concerns about availability. Simultaneously, providers offering this autoscaling service no longer need to be concerned about the burden of manual configurations, as VMware Cloud Director handles it seamlessly.



The integration of sustainability into the supply chain is now a significant priority for nearly all customers. As a result, Cloud Services Providers must prioritize their sustainability efforts and carbon footprint initiatives. Cloud Director, being a multi-tenant product, offers enhanced hardware optimization capabilities without sacrificing security. By utilizing Cloud Director, providers can optimize their customers' infrastructure, leading to hardware savings and subsequently reducing their carbon footprint. To explore how Cloud Director can assist in planning customer estates and achieving hardware savings, I recommend using the [provided calculator](#). It will enable you to assess the potential carbon offset and plan your sustainability initiatives effectively.

How Cloud Director addresses increasing revenue:

During the duration of a contract, the speed at which a customer utilizes your services has a direct impact on the revenue you generate. This effect on overall revenue is substantial. By employing VMware Cloud Director Availability, a native solution that combines Disaster Recovery and Migration as a Service, you can facilitate faster and more efficient onboarding. This solution enables customers to take control of the onboarding process through self-service or allows you to offer a managed service. With the added benefit of layer 2 configuration capability within VMware Cloud Director Availability, customers can migrate their applications with minimal time delays and ensure the stability of the migration process. This, in turn, leads to a quicker path to revenue when it comes to cloud consumption.

32% higher annual
revenue with services
supported by VMware
Cloud Director
(IDC) with VMware Cloud

Developing your own services can be a challenging and lengthy endeavor. It involves integrating various operational systems, permissions, and capabilities, which often require additional training and orchestration. However, VMware Cloud Director and VMware Cloud Director service offer a solution by providing Infrastructure as a Service (IaaS) and other services pre-configured through a flexible plugin architecture. These plugins are designed to seamlessly integrate with VMware Cloud Director, creating a cohesive user experience. As a result, your customers won't need to acquire new skills since everything is accessible through an interface, they are already familiar with.

Often building a cloud is a time-consuming task, with months of architecting, complex inter-operability, and custom work, which denies valuable revenue. Well, no more! [VMware Validated Designs](#) make the cloud simple, and with VMware Cloud Director VMware Validated Design for Cloud Services Provider, a lot of the heavy lifting is done for you already. You can also use a [VMware Cloud Foundation with Cloud Director and Tanzu](#) already out of the box and ready to go.

With the integration of VMware Cloud Foundation on VxRail, VMware Cloud Director enables the swift and effortless establishment of a cloud infrastructure. This streamlined process significantly minimizes the time required to generate revenue and facilitates a consumption model that encompasses both hardware and software layers. Moreover, VMware Cloud Director now offers a simplified deployment experience. Extensive development efforts have resulted in a new deployment user interface (UI) that presents a straightforward workflow for various deployment scenarios.

In addition to boosting revenue, you have the opportunity to reduce service delivery costs by leveraging VMware Cloud Director. By already benefiting from cost savings in operational expenses through VMware Cloud Director, where else can you achieve further savings?

Traditionally, most customers are accustomed to host-based services. However, the advent of cloud computing has introduced a paradigm shift that offers numerous optimizations through a secure shared infrastructure, known as cloud economics. Nevertheless, the rising demand for pay-as-you-go and consumption-based pricing models necessitates providers to share the risk of underutilization. While the benefits of shared infrastructure can be passed on to customers, providers must effectively manage performance and service level agreements (SLAs). VMware Cloud Director and NSX-T services address these concerns by offering logical segmentation of tenants, distributed firewalling (micro-segmentation), and dynamic membership for distributed firewalls. This



ensures the protection and isolation of every workload, whether it's a virtual machine (VM) or a container. Furthermore, the utilization of storage IOPS policies and existing Compute Flex policies enables providers to mitigate issues related to noisy neighbors, which are often associated with public cloud environments. Additionally, the integration of the VMware Chargeback with vRealize Operations provides comprehensive compute management for service providers while offering tenants access to dashboard views of their service and associated costs.

Integration with NSX-T and Advanced Load Balancer in VMware Cloud Director is a game-changer. Not only are there huge benefits from deploying NSX virtualized networking and appliances, saving hardware costs and vendor licensing costs. There are huge new security offerings, and security is the number 1 buyer requirement (IDC: U.S. Buyer Requirements for Managed Cloud Services and Expectations of Managed SPs). NSX-T and VMware Cloud Director provide dynamic policy-driven and – importantly – hybrid security, addressing the real need for customers to use multiple clouds securely. Multiple Clouds means Multiple Applications and App Modernization projects mean the app world is constantly evolving. Cloud Director can now deliver Advanced Load Balancing services for applications such as Web App and container ingress firewalls to meet ever-changing dynamic environments.

Were you aware that by leveraging NSX-T distributed firewalling, whether at layer 4 or layer 7, a substantial amount of edge network traffic can be alleviated? This is accomplished by transferring routing tasks from the Edge to the ESXi hypervisor. As a result, inter-application traffic becomes more efficient, faster, and inherently more secure, regardless of where the application is relocated. In the era of multi-cloud environments, it has become practical and feasible to migrate workloads across various clouds, including data center clouds. However, it is of utmost importance to ensure that such workload placement changes do not compromise

security. The most reliable method to guarantee this is by employing distributed firewalling alongside dynamic membership, utilizing static or dynamic characteristics such as tags. By doing so, security measures remain intact, regardless of the shifting nature of workload placements.

How Cloud Director addresses differentiation:

Research conducted by analysts (451 Research Cloud Price Index) reveals that cloud customers are inclined to explore different options and are not likely to remain loyal to cloud service providers who offer a limited range of services. Simply put, customers do not perceive value in paying for services that are essentially the same across different providers. Consequently, certain services that have become almost commoditized may experience excessive discounting and a decline in customer retention. To mitigate this risk, cloud service providers must differentiate their service portfolios.

Are your customers currently engaging developers who are exploring public cloud services? It's important to be cautious about this approach due to the proliferation of unvalidated open-source applications and the intricate pricing models associated with public cloud developer services. VMware Cloud Director offers an enhanced application platform-as-a-service capability through Content Hub and App Launchpad. This empowers tenants to self-serve a curated selection of services and applications, including those available in the VMware Cloud Marketplace, as well as third-party and custom applications, virtual machines (VMs), vApps, and containers utilizing Helm charts.

The inclusive integration with the VMware Cloud Marketplace and Bitnami is provided at no additional cost, ensuring securely tested and validated applications. The VMware Cloud Marketplace offers a diverse range of third-party applications, all of which can be set to auto-sync to ensure customers have access to the latest and most advanced versions, thus enhancing safety and providing a wider choice. As a result, VMware Cloud Director facilitates the delivery of application platform-as-a-service (PaaS) offerings and promotes increased consumption, as customers are relieved from the need to comprehend the underlying infrastructure or security aspects, as these are already managed.

To cater to your customers' App Modernization initiatives, VMware Cloud Director provides native Kubernetes services, including Tanzu-based offerings, as well as Accelerated Computing capabilities featuring NVIDIA GPUs. The provision of GPU as a Service presents a significant growth opportunity for partners. The market is witnessing a surge in the establishment of data centers due to the continuous digitization efforts across various industry sectors. These industries are adopting predictive analytics tools and other services that rely on the unique capabilities provided by GPUs.

This trend is generating a multitude of business prospects for GPU as a Service consumption. Traditionally, AI and ML applications demanded high-performance computers equipped with advanced GPUs. However, with the introduction of GPU as a service (GPUaaS) in Cloud Director, customers can now leverage cloud technology to access the processing power of GPUs without the requirement of purchasing high-end GPU hardware themselves. Service providers have the ability to offer pre-configured vApp Templates that include all essential Nvidia drivers, sizing policies, placement policies, assigned GPU profiles, and VM configurations with guest operating systems optimized for GPU usage, along with pre-installed and configured drivers.

VMware Cloud Director enables the delivery of Kubernetes cluster services directly from its platform, supporting both native Kubernetes and Tanzu Kubernetes Grid Multi-cloud (TKGm) options (deployable on vSphere only) as well as vSphere (TKGs). These services are fully isolated and segregated using NSX-T, ensuring robust security measures. These services also support auto-scaling should a K8s fail. This comprehensive solution allows Cloud Services Providers to offer a complete package: a development-ready cloud environment coupled with a target platform for running containerized applications. In essence, this empowers Cloud Services Providers using VMware Cloud Director to cater not only to developer personas but also to provide Platform-as-a-Service (PaaS) offerings while ensuring that applications remain securely scalable within the VMware cloud.

Delivering a seamless and positive customer experience is crucial for Cloud Services Providers, and VMware Cloud Director facilitates this by allowing providers to brand and customize the user interface to align with their own branding. This customization process is straightforward and sustainable, enabling providers to deliver their services to customers with a consistent look and feel. Moreover, VMware Cloud Director offers extensibility options, such as context menus or iframes, creating a centralized platform where Cloud Services Providers can publish VMware Cloud services, third-party services, and their own services. This level of customization extends to the entire user experience, ensuring a tailored and comprehensive solution for customers. See more details in the blog [here](#) and the technical video [here](#).

The extensibility framework within VMware Cloud Director allows for the seamless integration of third-party solutions and your own custom solutions into the user interface, all included as part of the solution without any additional costs. These integrated solutions can be designed to match the existing platform's look and feel, ensuring tenants have a consistent and cohesive experience. Furthermore, these solutions can be whitelisted and made easily accessible to tenants through a simple dropdown menu when they opt to purchase the additional service from the Cloud Services Provider. Many of the latest services offered in Cloud Director leverage this extensibility framework, including K8s Cluster services (with TKGm and native Kubernetes), Object Storage services, and the Autoscaling plugin.

In VMware Cloud Director, we have expanded our support for S3 Object Storage solutions, now covering Cloudian, Dell ECS, native AWS S3, and Ceph. This means that tenants can choose and consume storage services of their preference within their Virtual Data Center in VMware Cloud Director. This enhanced flexibility empowers tenants to leverage storage solutions that best suit their specific requirements, further enriching their experience within the VMware Cloud Director environment.

Get ready to experience the unparalleled power of the VMware Cloud Director family of services. It stands alone as the ultimate platform that brings an unmatched level of service relevance directly to cloud consumers, all within the comfort of your own data center. Prepare to be amazed by the limitless possibilities and extraordinary capabilities that VMware Cloud Director has to offer.

Prepare for a world of effortless flexibility with VMware Cloud Director! Tenants can embark on their IaaS journey with ease, choosing from a diverse range of options. Whether it's the dynamic pay-as-you-go public cloud, reserved allocations of private cloud for added control, or dedicated allocations for enhanced performance, VMware Cloud Director has you covered. Enjoy the convenience of centrally controlled operations and full self-service capabilities, tailor-made to suit your preferences.

But that's not all! Discover a treasure trove of cross-sell services seamlessly integrated into VMware Cloud Director. Take advantage of Disaster Recovery replication provided by Cloud Director Availability. Unlock the potential of resource pools in VMC on AWS, Google Cloud VMware Engine, Azure VMware Solution and Oracle Cloud VMware Solution under the guidance of VMware Cloud Director service, or tap into resources within your other data centers. Say goodbye to the hassle of navigating different systems - Cloud Director effortlessly associates with other Cloud Director instances, granting tenants simplified access to geographically dispersed resources.

With these incredible features, tenants and providers alike have fallen head over heels for VMware Cloud Director. The combination of user-friendly on-premises capabilities for managing tenants, alongside seamless self-service onboarding to the cloud, is what makes Cloud Director an unrivaled favorite among users. Get ready to embrace a world where simplicity, scalability, and customer satisfaction reign supreme – all thanks to VMware Cloud Director.

From the tenant's perspective with VMware Cloud Director, differentiation is at your fingertips, as you tailor the offering to match the unique needs of your tenants. Provide unparalleled access, support various consumption models, and complement the experience with a wide range of managed and professional services.

Beyond the foundational Virtual Data Center (VDC) service in VMware Cloud Director, you can elevate the tenant's experience with a plethora of additional offerings. Empower them with self-service appliances for Edge virtualization, leverage the software-defined NSX Advanced load balancer for optimal traffic management, and

ensure robust security with dynamic firewalling and micro-segmentation. Enhance IP services with options like public IP and NAT services.

For a truly secure cloud environment, VMware Cloud Director and NSX-T offer exclusive value-added services. Stand out from the competition with features such as Layer 4 and Layer 7 Distributed Firewalling, Storage VM encryption, FIPS support, and VPAT compliance. These offerings help differentiate your services and provide a comprehensive solution for secure cloud environments.

But that's not all! Many customers desire managed services alongside self-service capabilities, and VMware Cloud Director excels in this area as well. Take on the role of managing the customer using the native capabilities within the solution stack. Offer services such as Web Application Firewall and container ingress services with NSX Advanced load balancer, advanced networking options like EVPN, varied pod offerings for CPU or RAM-intensive workloads, managed Disaster Recovery testing with VMware Cloud Director Availability, managed reporting with vRealize Operations, and a whole lot more.

With VMware Cloud Director, you have the power to deliver an exceptional tenant experience with a comprehensive suite of services and managed offerings. Elevate your cloud service and set yourself apart from the competition.

Elevate your tenant experience with a range of supplementary services available through the VMware Chargeback dashboards. Gain valuable insights into your organization's service performance through out-of-the-box VDC reports or customized reports tailored to your managed services. These reports, collected using the latest vRealize Operations, provide comprehensive visibility into your services, enabling you to make informed decisions.

But that's not all! The VMware Chargeback also offers visibility into metered cost chargeback, seamlessly integrated and configured within the user interface. This means you can effortlessly track and manage costs, ensuring transparency and enabling efficient resource allocation. Enjoy a seamless user experience as you access these monitoring, reporting, and cost management features, all within the intuitive VMware Cloud Director interface.

How Cloud Director addresses risk reduction:

Risk is expected in all businesses. How a business deals with risk is important, especially when you are a provider of services. Most Cloud Services Provider deliver services with a lot of operational overhead due to

their existing tools needing to be integrated and because they typically use outdated, manual processes that expose risk.

There is an 80-20 rule to consider. You could create your own DIY solution (we have seen examples many times in Cloud Services Provider costing well over 1\$m), but it will quickly become out of date and require constant operational cost to manage and improve. Or you can utilize off-the-shelf software such as VMware Cloud Director, get 80% of what you need out of the box and use the supported extensibility framework to provide the other 20% you need (if at all). Using the public APIs in offerings such as Container Services and App Launchpad, you can further minimize risk, programmatically driving most tenant and service provider functions. VMware Cloud Director is an API-first product, and although there is a lot of UI, it is self-consuming, and all the ancillary services from Container Service Extension, Object Storage Extension, and App Launchpad, API is central to allowing providers to programmatically reduce risk and deliver touchless services if required.

Of course, it doesn't stop there, many of these APIs can be provided to tenants, such as the vCloud Director Terraform Provider which, as an open-source project, is simple for a tenant to use and for a provider to offer, delivering infrastructure as code services, pulling through more consumption, and driving down risk of misconfigurations.

With the introduction of [Service accounts in VMware Cloud Director](#), it is an alternative to user accounts, which allows standalone access for automation and third-party applications/tools (e.g. plugins) to VMware Cloud Director. This feature is built on top of API Token infrastructure which adopts OAuth standards.

Also, with the introduction of **Virtual Trusted Platform Module** in VMware Cloud Director you can now rest assured that your guest operating system is more secure than ever. You have the ability to add a TPM device to any new or existing VM as long as certain prerequisites are met by both the VM Guest OS and the underlying vCenter Server infrastructure. Plus, you'll be pleased to know that most VCD workflows for Virtual Machine, vApp, and Templates now support TPM. Upgrade your VM security with VMware Cloud Director today! See more detail in [Deep Dive into Virtual Trusted Platform Module \(vTPM\) in VCD blog](#).

However, risk is inherited in any Cloud. Simply put, as a customer, running your business on someone else's hardware is a risk, and you are at risk all the time from malware and security vulnerabilities. For a Cloud Services Provider to run in an asset-light model with Hyperscale providers or Google Cloud VMware Engine, VMware Cloud on AWS and VMware Cloud Director service, naturally, this presents a tradeoff between the risk of outsourcing the hardware infrastructure to someone else, which decreases your control and flexibility vs. the cost of doing it yourself – 'build-or-buy'. In risk management, there is always a tradeoff. However, having a Service Level Agreement such as is offered today in VMware Cloud on AWS and with VMware Cloud Director service, your risk profile is somewhat alleviated; however, security is still your responsibility and the customer's

ownership. With NSX-T Network Security integrated into VMware Cloud Director (& service) you can up-level your security to recognize threats and then action policies to mitigate them as much as possible. VMware Cloud Director supports Edge firewall services, vAPP firewalls, and Dynamic group membership micro-segmentation firewalling and NAT to allow or deny north-south and east-west traffic.

In addition, with VMware Cloud Director Availability you can restore from older snapshots or failover, if necessary, to recover from security-related breaches. The risk may also be obvious in cost. For example, in some areas of the world, cheaper labor means the cost of outsourcing is not effective and doesn't make financial sense.

Many customers need high availability configurations and need to use Microsoft Clustering Services to reduce the risk of downtime. VMware Cloud Director supports independent disks via the UI & API - an independent disk can be attached to multiple VMs at the same time, allowing Cloud Services Provider to offer self-create cluster solutions such as Microsoft Cluster, Veritas Cluster, etc. on their VDC service. These independent disks have other benefits when used in the Container Service Extension. They can be used to provide persistent volume resources in Kubernetes (storage resources in a cluster that operate like a cluster resource and pods can request specific levels of resource from the node).

Risk is also something that can be invisible to infrastructure. Most customers are heavily outsourced to the cloud (73% of customers make the cloud their first choice*), whether that be various off-premises clouds, Cloud Services Provider - SaaS, IaaS or dedicated private clouds, and these environments are now considered critical in the modernizing/transforming journey to cloud. However, in the customers' desire to run rather than walk, most are encountering cloud skills gaps (90% report skill shortage*). Cloud Services Provider are critical to these customer journeys and are equally susceptible to this skill gap, albeit sometimes less so. Risk is mitigated in having a platform that covers multi and hybrid cloud solutions, covering core pillars like security. The multi-site associations VMware Cloud Director can manage means your customers can access their Virtual Data Center resources in any cloud managed by the provider. This means potentially on-premises, in your data center(s), and in VMware Cloud Director service instances in VMware Cloud on AWS or other support public Cloud Services Provider.

VMware Cloud Director spans multi-cloud and with containers (95% of new applications use containers*), multi-level infrastructure with security and isolation built-in. Cloud Services Provider can hence focus on delivery and working with the customer on their cloud transformation.

* 451 - Cloud Transformation & Managed Services; Melanie Posey and Owen Rogers

But, why now?

The business world is investing more than ever in digital services to support the now distributed workforce, supply chain and new go-to-market services. We have seen over the last years the results of ‘all into public cloud customer strategies’ and now is not the time to be pushing harder on these efforts into alternative hypervisor-based clouds. Now is the time to move to cloud, but cloud based on the current and predominant hypervisor, vSphere. Investing now to help flatten the economic decline is as important for the Cloud Services Provider suppliers as it is for the consuming businesses, if not more so as the demand surges on Cloud Services Provider, automation is a necessity, not optional.

Utilizing VMware Cloud Director, Cloud Services Provider can deliver economies of scale to their tenants, multi-tenancy, single point of control and access to services, whilst uplifting their security from edge to distributed for all assets. According to 451 Research “cost reductions are likely to be tied to a particular technology change – say the introduction of a new processor with better price/performance, or a new class of storage” (The Old Managed Service and The Sea: Cloud Economics Trends, Owen Rogers). VMware Cloud Director allows this differentiation using differing resource pools and Flex Policies (see below), differentiated t-shirt or VM slicing for resources and applications, or settings against a tenant Virtual Data Center, and in addition, VMware Cloud Director brings in Storage IOPS controls and tiering to tenants. This capability to centralize and deliver highly automated and differentiated services will provide optimization to customers as they are onboarding critical workloads and services into providers. Even if security and requirements dictate a hosted customer private cloud in the Cloud Services Provider data center, this can still be accessed and managed via VMware Cloud Director.

Essential choices for tenants; “Best Execution Venue (BEV) strategies center on the notion that every class of IT-related business need has an environment where it will best balance performance and cost, and the IT organization should be able to select that environment as part of the general practice of IT.”

Source: The old managed service and the sea: cloud economics trends in 2020, Owen Rogers

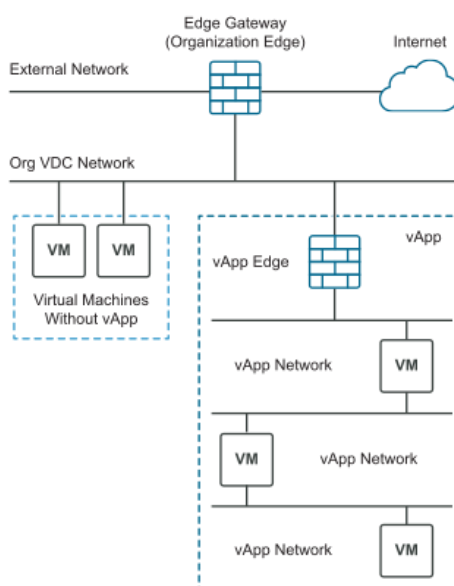
Essentially VMware Cloud Director helps deliver customer BEV choice through consumption models, offering optimized controls at each component; compute, storage, network, and security, but goes a step further. Consumption modeling and placement control help solve BEV challenges and are explained below, but what about consideration of resources needed for applications beyond the basic infrastructures (‘the what’) such as applications. VMware Cloud Director’s hybrid control across multiple clouds means tenants can also control ‘the

where' applications need to reside to optimally use other cloud resources. Cloud Services Provider can design pods specific to application or resource requirements and offer these as targets for their tenants, allowing for complete diversity and control. VMware Cloud Director service on VMware Cloud on AWS is a great example of BEV choice, providing essential AWS adjacency for services to a VMware Infrastructure and application service. Most Cloud Services Provider have redundant and distributed data center architectures which service many customers. From an aggregated viewpoint, having a single point of entry and a single point of administration is required to alleviate the operational cost and increase the speed of delivery. It's not so simple to simply 'stretch' management across more than 2 locations, With the VMware Cloud Director service SaaS solution, providers can also now have an additional vCenter and SDDC in VMware Cloud on AWS / Google Cloud VMware Engine data centers, allowing for stretch management.

How does VMware Cloud Director address customer consumption?

vApp for packaging application infrastructure:

Cloud Director can service customer requirements for infrastructure based on Virtual Machines, K8s containers and introduces the concept of a vApp. A vApp is a preconfigured virtual machine that packages applications and parameters that define operational details. A vApp packages applications with their required operating systems, allowing disparate virtual machines to work together in a stack as an application, including storage, networking, and security provided by edge services with NSX-T.



This is a great facility for whole application deployments, test, development, and production architectures to be built and consumed quickly and effectively.

VMware Cloud Director supports different models of consumption of your physical data center resources to be divided up and provided to customers utilizing the following mechanisms.

Pay-As-You-Go cloud:

Pay-as-you-go is an on-demand service to tenants with no up-front resource allocation to their Org VDC and uses a VM resource allocation. This provides a true public cloud experience to your customers and is great for transient workloads such as development and QA environments. In this service, you can over-provision physical resources with a percentage of non-guaranteed capacity reflected in your SLAs.

As this is set at a VM level, CPU quota, CPU guarantee and speed, as well as memory quota and guarantee, are applied on a per VM basis and not at resource pool level. To avoid oversubscribing your entire pool, you can set a maximum per VM or number of Pay-as-you-go VMs in the Org VDC.

Allocation pool of resources:

This is typically the most used model among Cloud Services Provider as it allows allocated resources but also guarantees some percentage of resources for unexpected peaks in requirement. An allocation pool is where only a percentage of allocated resources are allocated as a committed reservation to the Org VDC. This is ideal for stable production workloads that need guaranteed resources and provides percentage burst capacity into non-guaranteed resource pools. This makes a predictable cost model for customers and lowers risk of a VM not being able to start due to resource constraints, hence suitable for guarantees and SLA.

These allocations translate into vSphere limits set on the resource pool and are based on CPU and Memory as a first come first serve basis for VMs only as they are powered on. If another organization VDC is using more resources, there is no guarantee that resources will be available to power on VMs. So, underlying availability of resource is must, not only to power on VMs but also guarantee reservation to VMs.

Reservation Pools of resources:

While the Pay-as-you-go and Allocation resource pools are quite complex, the reservation is much simpler. A reservation pool is reserved i.e., it's a 100% committed allocation of resources, even if none are turned on to

use the resources. The Reservation and Limit for CPU and Memory are set to be equal to the allocation value set on the Org.

This model is typically more expensive for the customer and could lead to much underutilized resource, but guarantees capacity, which is ideal for business-critical applications.

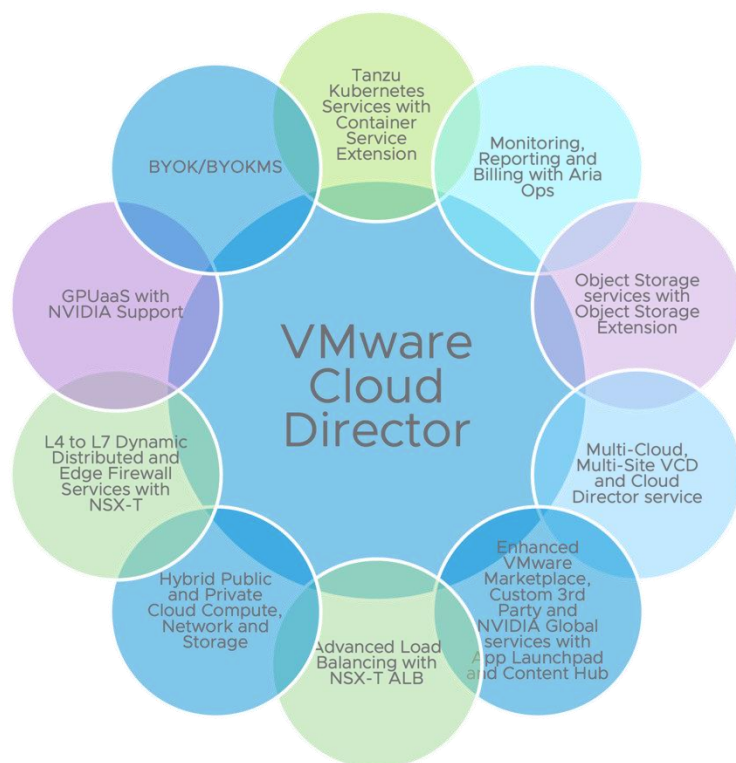
Flex Allocation model:

The amount of CPU and RAM at both the VDC and the individual virtual machine (VM) level can be managed using a combination of a flex allocation VDC and VDC compute policies. Many providers roll this into 't-shirt sizing' of VM services. This provides either an elastic pool or elastic VMs with additional control of storage and network.

Of course, once you have selected resource allocation models, you don't have to do anything more in vCenter, this is automated for you using vSphere reservations and limits.

VMware Cloud Director extensibility

Most platforms require some sort of extensibility to allow you to personalize the service and to integrate it with business systems. Cloud Director provides extensibility in 2 ways: UI extensibility and operation orchestration. UI extensibility uses a supported framework in VMware Cloud Director, delivering a huge amount of value and capability separated to the core product. As the diagram shows there are many services ancillary to core VMware Cloud Director services that can be fully automated and delivered to provide tenants with a seamless experience.



UI extensibility for VMware Cloud Director:

Portfolio extension is a major factor in keeping customers engaged so you can provide the best service you can. Analyst research has shown that Cloud service providers with a richer portfolio of solutions are able to charge more and see less discounting and customer attrition. There are several factors at work here: differentiation and breadth. The more you can differentiate and provide a good breadth of services, not just with managed services but also with self-service portfolios, the less likely a customer will need to go anywhere else.

The Cloud Director extensibility framework is an open-source capability that provides differentiated solutions such as Disaster Recovery, Migration, Backup and Restore, and Object Storage (not a limited list). Some of these solutions are not from VMware but are using the extensibility framework to push solution capabilities directly into Cloud Director for customers to consume. There are two different levels of extensibility: basic UI extensibility and advanced. Basic will literally pull the application itself, colours, branding and all, into Cloud Director UI. If the application has a proficient API, you can alternatively opt for advanced extensibility, pull in the functions via the API to make it look and feel like a Cloud Director natural extension like in the following examples:

VMware Cloud Director Encryption Management solution (BYOK/BYOKMS):

The introduction of **VMware Cloud Director Encryption Management solution**, featuring Bring Your Own Encryption as a Service (BYOEaaS), presents several advantages for organizations aiming to bolster their data security, compliance, and oversight within a cloud environment. This approach empowers customers to oversee encryption keys while utilizing VMware Cloud Director services. The security framework complies with full Sovereign regulations, enabling Sovereign tenants to employ their encryption keys (BYOK) and/or their key management system (BYOKMS) to create and encrypt virtual machines within VMware Cloud Director.

Providers can host this Sovereign service within their Sovereign Cloud infrastructure but are unable to access the keys. The keys are exclusively held by customers, ensuring providers have no visibility or access. Providers commit to maintaining the confinement of encryption keys within Sovereign boundaries. In essence, the VMware Cloud Director bundled with the Encryption Management solution and Thales CipherTrust Manager forms a comprehensive solution for organizations seeking heightened data security, compliance fulfillment, and control over encryption protocols. This combination allows businesses to embrace cloud services' advantages while upholding data protection and management. For more details see the [Thales CipherTrust Manager and VMware Cloud Director Encryption Management Solution](#) Brief.

Disaster Recovery from VMware Cloud Director Availability:

A great example of UI extensibility is Cloud Director Availability. Using the Cloud Director extensibility framework, VMware has created a Disaster Recovery and Migration solution that is simple and quick to deploy in your Cloud Director and Cloud Director service environment. Within hours, you can configure customers to replicate either protection or migration into their target VDC, whether in your premises or hosted in VMware Cloud on AWS under the Cloud Director service's control (Migration only). Once in their Org VDC, you can sell Cloud to Cloud Disaster Recovery between your data centers.

Dell Data Protection for VMware Cloud Director:

Data Protection is a core requirement for workloads in the cloud, but previously there has been no native solution for Cloud Director clouds. Now Cloud Services Providers can deliver full self-service backups and restores directly to the Cloud Director interface for their tenants.

Dell EMC Data Protection for Cloud Director is a great example of a plug-in providing tenants with a single management endpoint for backup and restore operations in their virtual data centers. Tenants can manage crash-consistent image-level backups of VMs, vAPPs and files, restore to a new VM or in-place, by policy or ad hoc and even file-level restore.

S3 Object Storage via Object Storage Extension:

Proving how versatile the extensibility framework is, the Cloud Director Object Storage Extension (vOSE) provides an S3 interface to Cloud Director. The plugin extension allows Cloud Director and organization cloud administrators to view, configure and perform other management tasks, with VMware Cloud Director, this is now OSE and has had substantial updates in capability. The OSE provides S3 Object Storage capabilities with Cloudian's HyperStore S3 object storage and Dell ECS within Cloud Director and AWS native S3 as well as Ceph. Tenant portals can be offered to provide customers with self-service access to configure and manage their own S3 Object Storage buckets as storage targets. This capability includes the S3 Object Lock security solution that prevents malware from changing any files.

Kubernetes Cluster Services and the Container Service Extension:

Within VMware Cloud Director Kubernetes is a first-class citizen, this means Kubernetes infrastructure is as native to VMware Cloud Director as a VM or vAPP. The Container Service Extension (CSE) plugin provides enhanced support in the plugin UI, API and CLI for ecosystem Kubernetes Clusters, such as native Kubernetes and Tanzu Kubernetes Grid Multi-cloud (TKGm). Tanzu Kubernetes Grid vSphere (TKGs) is supported natively and isolated with NSX-T for multi-tenancy. As more cloud workloads continue to 'transform' to cloud-native architectures, more and more customers require Cloud Services Provider to provide a secure environment for their cloud services to run on. Typically, container solutions run in VMs and are hence bound by the same management capabilities at the VM level, which means many operational processes are still very relevant in these environments. Now Tanzu Kubernetes Grid TKGs/TKGm and Tanzu Basic brings container solutions and full-stack to vSphere and VMware Cloud Director, allowing Cloud Services Provider to accelerate their Kubernetes Clustering solutions and controls for their customers moving away from a VM analog to a native container on ESXi strategy for speed and simplicity.

VMware has focused on Cloud Director as the entry point for customers to access cloud-native solutions for their developers. This is complemented with an array of Cloud Native solutions mostly derived from the Container Service Extension (CSE) API work that allows developers to create and operate Kubernetes clusters via their normal Kubectl commands.

This unified user experience is agnostic to the backend; whether CSE performs the K8s cluster L/C work or vSphere Tanzu Basic does instead, the UI experience remains the same.

However, Kubernetes by itself is only one layer in the container service stack. Other capabilities from the container ecosystem are needed as well, such as a code repository, cluster health monitoring and healing, and lifecycle management.

If a developer wants to use their own tools and just wants Kubernetes, then VMware Cloud Director with CSE or Tanzu Basic (TKGs or TKGm) is a great solution to enable Cloud Services Provider to access and deliver upstream Kubernetes cluster provisioning and management either via CSE or natively in VMware Cloud Director with vSphere Tanzu and differentiated with additional applications and tools from Bitnami via the App Launchpad.

To know more about Architecting Kubernetes as a Service Offering with VMware Cloud Director read the detailed [blog](#).

Deliver Bitnami applications to your tenants:

The Bitnami Community Catalog is fully integrated with VMware Cloud Director via the Content Hub or App Launchpad. This makes it easy for Cloud Services Provider customers to find, deploy and manage software – across any physical or virtual environment, in any format (VM, container, and public cloud images), and for any cloud platform. With VMware Cloud Director integration and App Launchpad, Cloud Services Provider will be able to offer Bitnami, custom, and 3rd party application portfolios to developers within the VMware Cloud Director tenant portal. Developers then just point, click, and deploy the necessary framework applications they need operating in their tenant portal, which is easily provisioned by their DevOps teams.

The process of delivering applications to your end customers couldn't be easier. A simple Cloud Services Provider – SaaS contract must be signed, allowing Cloud Services Provider access to the service, where they can subscribe to the Bitnami applications. Once done, these are synchronized to the Cloud Director instance of your choice, where they are available for customers to click to deploy.

Provide your customer applications via Content Hub or App Launchpad:

Need to present your tenants with access to applications rather than relying on their knowledge of the underlying infrastructure? The Content Hub or App Launchpad feature will permit tenants to access a pre-curated catalog of applications, defined by the cloud administrator that they can simply deploy with some integrated workflow and 1-click app deployment. App Launchpad functionality is integrated with VMware Cloud

Director, automates VM or container creation, networking, and firewalling, and assigns a Public IP for the application without the user needing any knowledge of the underlying fabric.

Also, it provides the users the option to rollback or upgrade their applications or containers deployed through the content hub. The system facilitates the flexibility to upgrade or downgrade a container app to an alternative app/chart version. It generates revisions during various stages such as the creation, updating, upgrading, downgrading, or rollback processes of container apps. This includes the capability to specifically rollback a container app to a chosen revision. Asynchronous tasks are delivered as a consequence of CRUD operations conducted within the container app. Additionally, there are deployment status tooltips within the container app that aid in troubleshooting.

Whenever a tenant user engages in actions like creating, editing, or initiating rollbacks on a container app, Cloud Director triggers the generation of a new revision. The Content Hub Operator is tasked with resource allocation within the Kubernetes cluster and updating the data stored in the Cloud Director accordingly.

Infrastructure as code with Terraform Provider:

Terraform Provider enables VMware Cloud Director customers to access “Infrastructure as code,” e.g., virtual infrastructure that can be built, modified and retired entirely by executing code and using the configuration file as the input. Providing infrastructure as code using Terraform Provider in VMware Cloud Director enables customers to manage, provision and orchestrate infrastructure resources.

As a Cloud Services Provider, you can create and configure this capability then use it for automating deployment of infrastructure and services to customers or offer it directly to tenants. Cloud Services Provider can configure a range of offerings using a standard configuration management service. Terraform Provider enables customers to provision VMware Cloud Director infrastructure and services or consume more advanced offerings to configure and orchestrate lifecycle management using additional custom plugins.

GPU as a Service (GPUaaS):

VMware Cloud Director is a cloud service delivery platform that enables the deployment and management of virtualized resources, including virtual machines, storage, and networking. With the introduction of GPUaaS, VMware Cloud Director allows service providers to offer GPU-intensive workloads, such as machine learning, artificial intelligence, and graphic-intensive applications, to their customers in a scalable and efficient manner.

GPUaaS in VMware Cloud Director leverages VMware's vSphere platform and NVIDIA's virtual GPU (vGPU) technology. vGPU allows for the virtualization of physical GPUs, enabling multiple VMs to share a single GPU

while providing a dedicated and isolated GPU experience to each VM. By utilizing GPUaaS, service providers can allocate GPU resources to specific VMs based on customer requirements, allowing users to access the power of GPU acceleration without the need for dedicated physical GPUs. This enables greater flexibility, cost-efficiency, and scalability for GPU-intensive workloads in a cloud environment.

Operational Automation Extensibility within Cloud Director:

To save operational costs, Cloud Director automation allows for scaling and repeating processes to avoid errors and deliver repeatable business. Using vRealize Orchestrator (vRO), a core component of Cloud Director, Cloud Services Provider can import existing operational and production scripts, exposing vRO workflows as dynamic tiles in the Cloud Director HTML5 UI per tenant or for all tenants.

vRealize Orchestrator natively integrates into VMware Cloud Director, enabling Cloud Services Provider to automate complex workflows and deploy a variety of services such as ticketing, service queries and more, all while maintaining access control and visibility to the enterprise and Cloud Services Provider. Using this capability, Cloud Services Provider can quickly and easily extend their portfolio to tenants with their own services and specialization.

Delivering monitoring and chargeback to the customer

Monitoring:

The VMware Cloud Director HTML5 UI, in combination with Aria Operations, vRealize Management Pack for VMware Cloud Director, and vRealize Management Pack for NSX, allows tenants to access a performance dashboard, along with reporting and billing capabilities from the drop-down menu within VMware Cloud Director.

Aria Operations Chargeback: Billing (eliminating Chargeback aka tenant app module):

The integrated metering and dashboard functionalities empower Cloud Services Providers to invoice their tenants and individual customers for the services used, while allowing customers to examine their billing details. The direct integration of Aria Operations within VMware Cloud Director offers insights into the costs associated with virtual machines, App Launchpad services, and Kubernetes services. This integration ensures accountability for charges and provides performance dashboards accessible through self-service. This

transparency in costs enables a clear understanding of the actual expenses linked to the virtual infrastructure supporting business services.

Through the Aria Operations plug-in within the tenant portal, tenants gain visibility into both performance metrics and billing/metering chargeback information. This feature is pivotal in comprehending usage patterns and ensuring service quality. Additionally, it offers customizable reporting capabilities, enabling providers to expand their managed services and boost revenue through tailor-made dashboards. The migration of Chargeback data to VMware Aria Operations is necessary for this integration.

