The Critical Role of the Network in Supporting Cloud-Based Solutions

Introduction: The Role of the Network

Enterprises of all sizes are increasingly embracing the Cloud-based service model because it provides them with self-service, on-demand access to a much richer range of services and applications at a lower cost than was traditionally available. While there are some short-term benefits for Communications Service Providers (CSPs) to provide Infrastructure-as-a-Service (IaaS) solutions, over the longer term the market for providing a combination of Software-as-a-Service (SaaS) and related solutions, such as high performance computing, presents a much larger opportunity for CSPs. For example, IDC has stated that SaaS solutions alone will generate over $40B in revenue by 2014. By comparison, the current overall market for data center hardware and software is approximately $40B. IaaS solutions currently account for only a very small percentage of this market and that is not expected to change for the foreseeable future. Throughout this white paper, the combination of the SaaS and related solutions that are accessed over a CSP's network will be referred to as network centric solutions.

> "Providing Cloud-based services backed by an SLA is a tremendous opportunity for CSPs"

The movement on the part of enterprises to adopt a Cloud-based service model combined with the growing interest on the part of IT organizations to provide an internal SLA for the services they provide creates tremendous opportunities for CSPs. The primary opportunity is for CSPs to offer a wide range of network centric solutions that are supported by an SLA. CSPs are in a unique position to offer these solutions because, unlike the Internet, the Next Generation Networks (NGNs) that CSPs have deployed are capable of providing contracted levels of availability, delay, jitter and packet loss.

A number of CSPs either already provide, or have announced their intention to provide these types of solutions. This includes:

- Verizon announced its intention to provide unified communications as a Cloud-based offering.
- Orange Business Services announced its intention to offer multiple Cloud-based solutions including security services (e.g., anti-virus and URL filtering solutions) as well as unified communications services.
- Sprint currently offers a Cloud-based Web protection service to provide Web filtering, antivirus and malware scanning.
- Swisscom announced its intention to provide unified communications as a Cloud-based offering as well as its intention to offer a Cloud-based solution for backup and disaster recovery.
- BT announced its intention to provide NetSuite's product offerings as a Cloud-based solution. This includes NetSuite, NetSuite CRM+, NetSuite CRM and all other add-on modules including NetSuite OneWorld.
- Tata currently offers a Cloud-based CRM solution based on a relationship with SugarCRM.

The remainder of this white paper focuses on how a CSP can leverage the investment it has made in deploying a NGN to capitalize on the growing market for network centric solutions.

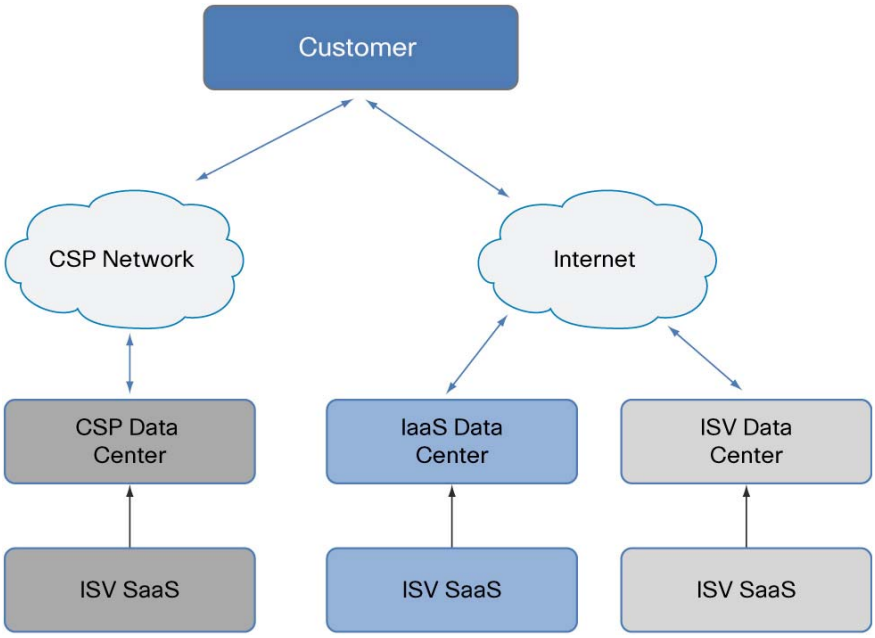
Leveraging the NGN

As recently as two years ago few IT organizations offered an SLA to the company's business and functional managers; a.k.a., an internal SLA. As pointed out in a recent report[1], that situation has changed and currently over two thirds of IT organizations provide an internal SLA. The growing importance that enterprise IT organizations place on providing internal SLAs creates a tremendous opportunity for CSPs.

> "By owning the data center and the NGN, CSPs can uniquely offer an end-to-end SLA with stringent performance objectives."

Figure 1 provides insight into that opportunity. As shown in Figure 1, one approach to providing Cloud-based solutions is based on the solution being delivered to the customer directly from an independent software vendor's (ISV's) data center via the Internet. This is the distribution model currently used for Salesforce.com's CRM application. Another approach is for an ISV to leverage an IaaS provider such as Amazon to host their application on the Internet. Lawson Software's Enterprise Management Systems (ERP application) and Adobe's LiveCycle Enterprise Suite are two examples of applications hosted by Amazon EC2. Both of these approaches rely on the Internet and it is not possible to provide end-to-end quality of service (QoS) over the Internet. As a result, neither approach lends itself to providing an SLA that includes a meaningful commitment to critical network performance metrics such as delay, jitter and packet loss. As such, these Over the Top (OTT) approaches to providing Cloud-based solutions will not be acceptable for the growing number of applications for which enterprise IT organizations need to provide an SLA.

Figure 1: Distribution Models for Cloud-Based Solutions



[1] http://www.webtorials.com/content/2010/11/2010-cloud.html

An approach to providing Cloud-based solutions that does lend itself to offering SLAs is based on the CSP providing these solutions to customers from the CSP's data center and over the CSP's network. CSPs are in a unique position to offer these SLAs in large part because of the investments they have made in NGN technologies, including Ethernet MAN/WAN transport, MPLS, and Layer 2 and Layer 3 MPLS VPNs. Because of these investments, the CSP's network can provide the functionality described below.

CoS/QoS

From the perspective of a user accessing a Cloud-based solution, one of the biggest advantages of an NGN is the ability of services such as MPLS to support a wide variety of classes of service (CoS) that are designed to meet the QoS requirements of different types of applications. For example, mission critical business applications are typically assigned to what is often referred to as a DSCP Assured Forwarding Class. This has an associated network level SLA that is specified in terms of contracted ranges of availability, latency, packet loss and in some cases jitter.

Traffic Engineering

MPLS traffic engineering (TE) can be leveraged to optimize the flow of traffic through a CSP's NGN while simultaneously reducing the cost of operations through the more efficient use of bandwidth resources. TE uses explicit routing that controls the flow of different classes of traffic based on a combination of administrative policies and bandwidth constraints. This capability helps CSPs distribute the traffic evenly over the network and also helps them to eliminate situations in which parts of the network are congested, while other parts of the network are under-utilized.

Resiliency and Restoration

An MPLS-based NGN offers resiliency and availability advantages versus what is available from the Internet. For example, in the Internet a link or node failure can result in extended re-convergence times of several seconds. This type of an outage would interrupt access to Cloud-based solutions and cause frustration on the part of the user. In an NGN, MPLS Fast Reroute provides protection and restoration in the event of a link or node failure. With Fast Reroute, traffic is rerouted from the primary path to a pre-set backup path in less than 50 milliseconds, a recovery time that is transparent to the users of virtually all application.

Privacy and Security

The MPLS VPN model enforces traffic separation by assigning unique VPN route forwarding (VRFs) tables to each customer's VPN. As a result, users in a specific VPN cannot see the traffic that is outside of their VPN. Another advantage of an MPLS-based VPN it that is provides enhanced security by restricting a VPN's VRF tables to only those Provider Edge (PE) routers that provide customer attachment for that VPN. In addition, a customer can easily be assigned a separate VPN for each network centric solution to which they subscribe.

Virtual LAN (VLAN) Extension

Various network centric solutions rely on the migration of virtual machines (VMs) between the customer's data centers and the CSP's data centers. In addition, in order to enhance the reliability and scalability of the service, VMs may also need to be migrated between the CSP's data centers. VM migration generally requires that the source and destination physical servers be members of the same VLAN. To accomplish this, the Ethernet-based data center LAN at each location must be extended over the WAN to the other data center. The NGN backbone can support VLAN extensions using a VPLS/VPWS VPN that tunnels Ethernet traffic through the IP/MPLS network.

Network and Application Optimization

A subsequent section of this white paper identifies a set of network centric solutions that are appropriate for CSPs to offer. However, supporting these solutions over the wide area network (WAN) creates a number of performance challenges that CSPs are in a unique position to resolve. For example, disaster recovery and business continuity solutions require quickly transmitting huge volumes of information. Solutions like these would benefit from optimization techniques such as caching, compression and de-duplication. Many of the modules that comprise an enterprise application such as enterprise resource planning are transactional in nature. Application modules such as these send only small amounts of traffic over the WAN. The performance of these modules would benefit from QoS functionality that prevents other applications from negatively impacting them. In addition, as described in the report entitled Virtualization: Benefits, Challenges and Solutions, supporting some forms of desktop virtualization (e.g., client side) requires the use of chatty protocols such as Common Internet File System (CIFS). A chatty protocol can require hundreds of round trips to complete a single transaction. Over a WAN that has tens of milliseconds of round trip delay, the delay that is associated with performing that many round trips typically results in unacceptable application performance. The performance of services such as these would benefit from optimization techniques such as request prediction and spoofing. A complete listing of network and application optimization techniques and the network centric solutions for which they are appropriate is contained in The 2010 Application Delivery Handbook.

CSPs are in an ideal position to provide network and application optimization functionality to mitigate these performance challenges, either as an integral part of a service offering such as MPLS or by deploying WAN optimization controllers (WOCs). For the last several years, many CSPs have deployed WOCs as part of a managed service. While that is still a possibility, as will be discussed in the next section, CSPs can also provide WOC functionality as part of a Cloud-based service.

In addition to the technical advantages provided by a CSP's NGN, the CSP's existing business relationship with enterprise customers constitutes a significant business advantage. Part of this advantage is the fact that because CSPs have done business with enterprises for decades, a significant level of trust has developed between CSPs and their customers. This level of trust is enhanced by the fact that by providing the appropriate functionality, the supporting network and an end-to-end SLA, the CSP presents a single point of accountability to enterprise IT organizations.

The relationships that CSPs have developed with enterprise customers facilitate the sales process and create opportunities for selling bundles of telecom and/or cloud computing services. CSPs that offer network centric solutions also create a foundation that they can leverage to offer additional high value-added services, such as professional services for enterprises that are building private cloud solutions; pursuing hybrid cloud strategies; or developing and/or customizing home grown applications to run in a CSP's data center.

An additional asset of the CSP is its existing system for billing customers. Sophisticated CSP billing systems can include a range of capabilities that are required for monetizing network centric solutions. This includes rating, revenue sharing, usage reporting, service bundling, as well as payments and collection.

CSP's Addressable Market

A recent market research report[2] indicated that SaaS revenues hit US$9 billion in 2009 and are growing at a rate of over 17% per year. According to that report, the Enterprise Resource Planning (ERP) and Content, Communications and Collaboration (CCC) segments together contributed 58% to the SaaS market in 2009. That report also stated that in 2009 that the:

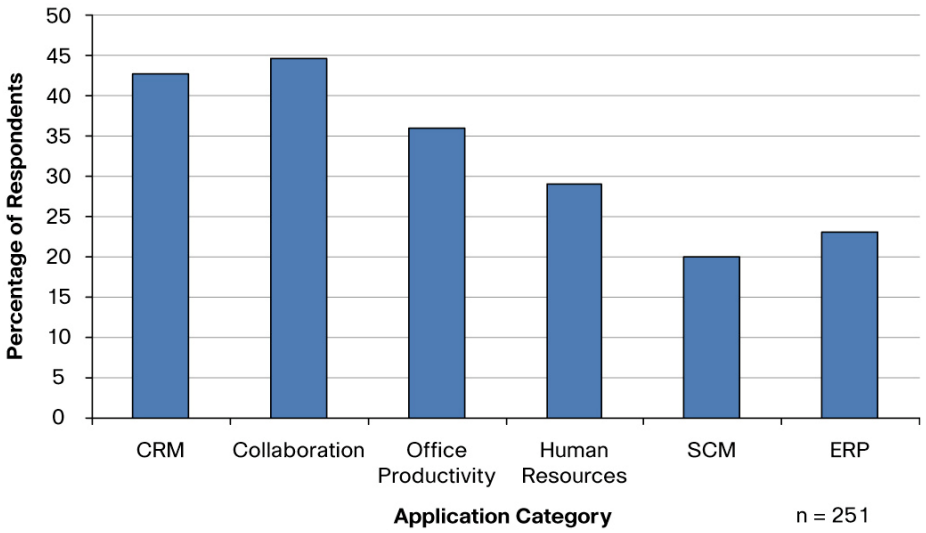
[2] http://www.saasnewswire.com/?p=676

- Customer Relationship Management (CRM) market crossed US$ 2 Billion.
- Supply Chain Management (SCM) market crossed US$ 850 Million.
- Office Suites market is relatively small today, but that market is expected to increase at a CAGR value of 55% for the period spanning 2010 – 2013.

> "The revenue from SaaS is large and growing. There are thousands of providers, but few have the level of brand recognition that CSPs do."

Figure 2 shows the percentage of respondents to an Ashton, Metzler & Associates (AM&A) cloud computing survey[3] that either currently subscribe to, or are likely to subscribe within the next year to various categories of SaaS-based applications. Although they were developed independently, these buying patterns and intentions track closely with the market research data presented above.

Figure 2: Popular Categories of SaaS-Based Applications



The functionality provided by each of the six categories of applications listed in Figure 2 can be quite extensive and is sometimes overlapping. ERP, for example, can encompass myriad functionality including product lifecycle management, supply chain management (e.g. Purchasing, Manufacturing and Distribution), warehouse management, customer relationship management (CRM), sales order processing, online sales, financials, human resources, and decision support systems.

For each category of application shown in Figure 2, there are tens, and sometimes hundreds, of SaaS-based solutions currently available[4]. Table 1 contains a listing of some representative SaaS providers for each category.

[3] http://www.webtorials.com/content/2009/12/cloud-computing-a-reality-check-guide-to-risk-mitigation.html
[4] http://www.saas-showplace.com/saasproviderdirectory/saasapplicationcategory.html

Table 1: Representative SaaS Providers

CRM	Collaboration	Office Productivity	Human Resources	SCM	ERP
Salesforce.com	WebEx	Google Docs	Subscribe-HR	ICON-SCM	SAP
NetSuite	Zoho	Microsoft's Office Web Apps	ThinMind	E2open	Workday
Update	clarizen	feng office	Greytip Online	Northrop Grumman	Lawson Software

While there are currently thousands of providers of SaaS-based solutions, few have the level of brand recognition that CSPs have.

Network Centric Solutions

The following is a description of some of the many network centric solutions that are enhanced by being provided over an NGN.

> "CSPs are highly creditable in offering many Cloud-based services, such as collaboration-as-a-service and network and application optimization."

Collaboration-as-a-Service (CaaS)

One class of application that is particularly appropriate for CSPs to offer as a Cloud-based solution is collaboration. This is appropriate in part because CSPs have a lot of creditability in providing this type of solution and in part because many of the components of a collaboration solution are delay sensitive and hence perform notably better over an NGN than they do over the Internet.

There are many components to collaboration. While some organizations will choose to use a CaaS solution to fulfill all of their collaboration requirements, other organizations will want to fulfill some of the requirements themselves and use a CaaS provider for the remainder of the requirements. As such, a critical component of a CaaS solution is that it can be deployed in such a way that it compliments the other collaboration solutions that potential customers already have, or intend to deploy. Another critical component of a CaaS solution is that it can support a broad range of user devices including desktops, laptops and smart phones. One of the reasons that Cisco is a leader in the Unified Communications and Collaboration (UC&C) market is because their portfolio of products[5] offers a very wide range of functionality. This includes conferencing, contact center, IP telephony, messaging and a suite of applications that enable mobile unified communications.

Many of the CSPs that either already offer a Cloud-based unified communications solution, or which have announced their intention to offer such a solution, base their solution on Cisco's Hosted Collaboration Solution[6] This includes Verizon, Orange Business Services and Swisscom.

[5] http://www.cisco.com/en/US/products/sw/voicesw/products_category_buyers_guide.html
[6] http://www.cisco.com/en/US/netsol/ns1086/index.html

Network and Application Optimization

It was previously mentioned that supporting network centric solutions creates a number of performance challenges that CSPs are in a unique position to resolve. These performance challenges, however, apply not just to network centric solutions but also to a broad range of traffic that transits a WAN. For example, the performance of any form of file transfer benefits from optimization techniques such as caching, compression and de-duplication while the performance of delay sensitive applications such as voice and video benefits from QoS. The ongoing consolidation of servers out of branch offices and into centralized data centers results in chatty protocols such as CISF running over the WAN. As previously mentioned, the performance of chatty protocols is improved by optimization techniques such as request prediction and spoofing. Optimization techniques such as forward error correction improve the performance of virtually any application or service that is delivered to the burgeoning number of mobile workers. The use of optimization techniques to improve virtual desktop services is discussed below.

The traditional way that IT organizations implemented network and application optimization was to either implement WOCs themselves or to use a managed service. In the recent past, service providers such as Akamai began to offer Cloud-based optimization functionality. More recently, companies such as Virtela and Aryaka have announced Cloud-based optimization services.

Virtual Desktop Service

As explained in the previously referenced report entitled *Virtualization: Benefits, Challenges and Solutions*[7], the two fundamental forms of desktop virtualization are client side (a.k.a., streamed desktops) and server side; a.k.a., hosted desktops. Client-side desktop virtualization is based on a model in which applications are streamed on-demand from central servers to client devices. With server-side virtualization, the client device plays the familiar role of a terminal accessing an application or desktop hosted on a central presentation server.

The ICA and RDP protocols that are associated with many hosted desktop virtualization solutions rely heavily on sending small request-reply packets. Optimization techniques such as byte level compression, caching, protocol optimization, and QoS can improve the performance of hosted desktops solutions. In contrast to the small request-reply packets that are associated with hosted desktop virtualization, the code for streamed applications is typically transferred via a distributed file system protocol, such as CIFS. The performance of streamed applications can be improved by optimizing protocols as CIFS, MAPI, HTTP and TCP.

Providing virtual desktop support is of interest to a large number of service providers and many service providers are currently in the process of developing a service offering. One service offering that was announced early in 2010[8] is that Virtual Bridges is hosting its Verde desktop virtualization suite in a Rackspace cloud computing environment. The reason that so many service providers are developing desktop virtualization solutions is the fact that as was recently reported[9], in 2009 the revenue from providing these solutions was US$1.5 billion and is expected to grow to US$65.7 billion by 2013.

Supporting desktop virtualization is more complex than merely supporting standard office productivity applications. Realizing that, the Cisco Virtualization Experience Infrastructure (VXI) is designed to support rich services such as video, voice and collaboration. One of the ways that Cisco effectively provides that support is through partnerships with companies such as Citrix[10] and VMware[11].

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[7] http://www.webtorials.com/content/2010/06/virtualization.html
[8] http://www.eweek.com/c/a/Virtualization/Virtual-Bridges-Rackspace-Partner-on-Hosted-Desktop-Virtualization-622800/
[9] http://www.eweek.com/c/a/Virtualization/Virtual-Bridges-Rackspace-Partner-on-Hosted-Desktop-Virtualization-622800/
[10] http://www.citrix.com/English/ne/news/news.asp?newsID=2303689
[11] http://newsroom.cisco.com/dlls/2010/prod_111610.html

Disaster Recovery (DR)/Business Continuity (BC) Service

Enterprises of all sizes are very interested in disaster recover and business continuity and, as a recent article in CIO Magazine pointed out[12], using a cloud computing model to obtain these services can result in significant savings. In part due to their reputation for high availability, CSPs are in an excellent position to leverage their data centers and NGNs to provide a disaster recovery/business continuity service. An example of a CSP (Swisscom) that is already offering a DR/BC service was mentioned in the introduction. Terremark also currently provides a DR/BC service and SunGard has announced its intention to offer such a service.

One way that CSPs can provide this service is by installing cloud storage gateway software at the customer premises. This gateway software makes CSP provided storage services appear as local storage devices. Cloud storage gateways can be implemented as network appliances or as servers that translate standard cloud storage web service APIs, such as SOAP or REST, to either block-based data storage protocols, such as iSCSI or Fibre Channel, or to file-based network storage protocols such as NFS or CIFS. Some cloud storage gateways also include additional storage software features such as backup and recovery, encryption and data compression/de-duplication.

Virtual Data Center (VDC) Extension

The CSP's data center can serve as an extension of an enterprise's data center in order to provide overflow capacity during periods of peak usage. For example, many companies in retail do significantly more business in December than they do any other month of the year. With the traditional approach to IT, these companies must build an infrastructure that can support this peak usage. Since most of this capacity sits idle eleven months of the year, this is exceptionally inefficient. With VDC extension, a company can size its infrastructure for the average demand and leverage the resources of a service provider during periods of peak usage.

In order to provide VDC extension, it must be possible to easily migrate VMs bi-directionally between the CSP's data centers and the enterprise's data centers. As a minimum this means that the CSP's infrastructure must support the same hypervisors and hypervisor management tools that are used in the enterprise. For example, VMware has a certification program for service providers who deliver vCloud Datacenter Services based on vSphere, vCenter, the vCloud Director cloud control system, and the vCloud Request Manager self-service portal.

Service providers that currently offer a VDC extension service include Terremark and Saavis. SingTel has announced their intention to offer such a service.

High Performance Computing (HPC)

The traditional approach to HPC is to leverage large homogeneous clusters of commodity compute nodes that use parallel processing techniques to perform compute-intensive analysis of very large sets of data. HPC applications are utilized in a number of industries, including manufacturing, pharmaceutical, financial services and government. Although the competitive advantages that can be gained with HPC are well recognized, today only the largest enterprises can afford to build clusters comprised of hundreds or even thousands of servers. HPC as a Cloud-based service will generate significant revenues in part because it places the benefits of HPC within the reach of a huge number of small to medium sized enterprises that cannot afford to build the large computing clusters themselves. Another reason that HPC as a Cloud-based service will generate significant revenues is that some large companies will find this service to be cost effective in those situations in which their need to support HPC is sporadic.

Alatum, which was founded in part by Singtel, is an example of a service provider that currently offers a Cloud-based HPC solution.

[12] http://www.cio.com/article/596972/Disaster_Recovery_in_the_Cloud_Yields_ROI

Application Hosting and/or SaaS Solutions

A CSP may provide an application hosting service whereby an enterprise can host one or more of its applications in the CSP's data center. Alternatively, the CSP can partner with ISVs to host one or more applications, or application suites, provided by the ISVs. NaviSite is an example of a company that offers IaaS-based services, application hosting services and SaaS-based services. The SaaS-based service that NaviSite currently offers is the Oracle E-Business suite.

As part of choosing which applications to offer as a SaaS solution, CSPs should work with the ISV to certify that the ISV's applications are fully compatible with the CSP's data center infrastructure. The importance of this certification is highlighted by the relationship between Oracle and Amazon. Oracle is working with Amazon to deploy cloud solutions that run on Amazon's EC2 platform. Oracle, however, has made the statement[13] that, "Amazon EC2 is a fully virtualized environment and uses a virtualization engine that is not supported by Oracle. Users will therefore be directed to Amazon for any virtualization related issues." In order to be successful, CSPs must avoid this type of finger pointing.

Another criteria that a CSP can use when choosing which applications to offer as a SaaS solution is the degree to which the ISV has adapted the application to operate in a multi-tenant subscription model. For example, an application that has been fully optimized for SaaS would use a single version of the application code as the basis of all tenant instances. Another way an ISV can optimize an application for SaaS is to build performance counters directly into the application for monitoring metrics such as the CPU utilization and application response time. These metrics are an additional tool that CSPs can use to ensure compliance with the SLAs that it provides.

The Cisco Value Proposition

Part of Cisco's value proposition is that Cisco has developed a Unified Service Delivery (USD) solution[14]. Cisco's USD solution was designed to enable CSPs to enhance, optimize and assure the delivery of network centric solutions across the CSP's entire portfolio of services. One of the key challenges that Cisco's USD solution was designed to resolve is that in the traditional data center design, functionality such as servers, storage, LAN switches, firewalls and load balancers are typically dedicated to a single service or application. This approach to data center design has a number of negative side affects. For example, it results in stranded capacity and hence an increase in the overall cost of the data center. It also increases the time it takes to deploy a new service or application since new infrastructure must be designed, procured, installed and tested before a new service or application can go into production.

> "Cisco provides the guidance and integrated solutions that enable CSPs to efficiently and effectively offer Cloud-based services."

As part of a USD solution, the CSP's data center consists of a virtualized infrastructure, some of the benefits of which are described below. The USD combines the CSP's data center and NGN, the benefits of which (e.g., QoS, traffic engineering) were previously described, into a single operational entity. By deploying a Cisco USD solution, CSPs overcome the negative side affects that are associated with traditional data centers. These negative side affects are overcome in part by implementing a multi-tenant solution whereby network, storage and compute resources are virtualized across the data center for each tenant. The Cisco Virtualized Multi-Tenant Data Center (VMDC) solution[15] provides design and implementation guidance for how CSPs can deploy efficient multi-tenant solutions. These negative side affects are also overcome because instead of having to deploy incremental

[13] http://www.oracle.com/technology/tech/cloud/faq.html
[14] http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns951/ag_c45-533403.pdf
[15] http://www.cisco.com/en/US/solutions/ns340/ns414/ns742/ns743/ns1050/landing_vmdc.html

infrastructure for each new service or application, a CSP can quickly deploy a new service or application over existing, tested infrastructure. In addition, the cost of the CSP's data center is minimized because the utilization of their data center resources is maximized.

Today no vendor can on its own provide all of the components of a dynamic, virtualized data center. In addition, standards do not exist to allow CSPs to build such a data center in a plug and play fashion using products from different vendors. Realizing this, Cisco, EMC and VMware formed the Virtual Computing Environment (VCE). This coalition has the stated mission of minimizing the risk for any organization that is deploying a highly virtualized, highly dynamic data center.

One of the key concepts that underlie the VCE is the concept of Vblock solutions. Vblock solutions are pre-integrated and tested infrastructure packages that bring together technologies from Cisco, EMC and VMware. A Vblock combines virtualization, networking, storage, security, and management and delivers them as a single entity with a single line of support.

Summary and Call to Action

The movement on the part of enterprises to adopt Cloud-based solutions combined with the growing interest on the part of IT organizations to provide an internal SLA creates tremendous opportunities for CSPs. The primary opportunity is for CSPs to offer a wide range of network centric solutions that are supported by an SLA. CSPs are in a unique position to offer these solutions because, unlike the Internet, the NGN that CSPs have deployed is capable of providing contracted levels of availability, delay, jitter and packet loss. Network centric solutions constitute high value-added offerings that serve to increase the CSP's revenues and improve the CSP's overall profit margin while simultaneously positioning CSPs to provide other value-added offerings; e.g., professional services.

> "In order to successfully deploy Cloud-based services, CSPs need to develop a detailed business plan, a data center architecture and a management strategy."

In order to capitalize on the tremendous opportunities presented by the industry-wide transition to utilize network centric solutions, CSPs need to develop a detailed roadmap. The three primary strategic components of the roadmap are a business plan, a data center architecture and a management strategy. In particular:

1. CSPs must prepare a detailed, multi-year business plan that outlines their strategy. This plan must include the definition of the services and/or applications they will offer, the target market and how the service or application will evolve over time. The plan must also include the expected penetration rate, pricing, costs (i.e., G&A, marketing, sales, advertising, infrastructure) and expected profits.
2. CSPs need to develop an architecture for their data centers that can support a wide range of existing and future network centric solutions without major modification. The Cisco USD solution provides a reference that CSPs can use to develop this architecture.
3. CSPs must develop a management strategy that details how they will establish and manage SLAs that are both meaningful to customers and yet achievable by the CSPs. The strategy must also outline what the CSP will do to drive operational efficiency and eliminate concerns on the part of potential customers.

For each of the three strategic components, the roadmap should also contain a number of tactical considerations. For example, relative to the business plan:

1. CSPs should evaluate the viability of getting started by offering one or more Cloud-based services or applications that involves a traditional CSP core competency; i.e., collaboration, network and application optimization.

2. CSPs should evaluate if they need to develop relationships with third parties (e.g., system integrators, professional services organizations) in order to provide a complete solution.

3. CSPs must determine which ISV supplied application(s) they will offer as a SaaS-based solution. Some of the principal considerations are the:

    - Suitability of the application to be offered as a SaaS-based solution. This includes the degree to which the application has been optimized for multi-tenancy.

    - Potential market size for the application as a SaaS-based solution. As previously noted, some of the most popular categories of SaaS-based applications, both now and in the near term, are collaboration, CRM, human resources, office productivity, ERP and SCM.

    - Compatibility of the application with the CSP's data center infrastructure.

    - Suitability of the application to be accessed over a WAN. This includes the application turns per task, the bandwidth requirements and the applicability of various WAN optimization techniques.

Other key considerations include the amount of competition for offering that application as a SaaS-based solution as well as the ISV's receptiveness to third party SaaS hosting.

4. CSPs must develop an SLA for each network centric solution that includes availability, response time, provisioning time, etc. In many cases the solution will be multi-faceted and the SLA must reflect that. Using collaboration as an example, the SLA may need to establish different goals for each component of the collaboration service; e.g., IP telephony, conferencing, contact center and messaging.

Relative to the data center architecture:

1. The data center architecture that CSPs develop should be based on a broad implementation of virtualization as described by Cisco's VMDC solution. This includes the virtualization of servers, storage, switches and routers. It also includes the virtualization of appliances such as firewalls, intrusion detection systems (IDS) and intrusion prevention systems (IPS), WAN optimization controllers (WOCs) and application delivery controllers (ADCs). As part of developing a virtualization strategy, the CSP should determine to what degree it can help its existing customers migrate from physical servers to virtual servers and to what degree it can on-board new customers directly onto its virtual infrastructure.

2. In order to facilitate the rapid deployment of new customers and new solutions, the data center design should be based on the replication of standard building blocks consisting of servers, switches, storage and appliances. CSPs should establish the goal of being able to easily add the capacity that is necessary to support thousands of new users.

3. The data center architecture must indicate how each potential network centric solution that is identified in the business plan will be hosted. For example, a CSP might decide to host an ERP application in three data centers - one each in EMEA, the Americas and the Pacific Rim. However, because of their sensitivity to delay, the CSP might also decide to host applications such as collaboration or network and application optimization in tens of data centers around the world.

Relative to the management strategy:

1. CSPs must implement a performance test environment that enables them to quantify the metrics that they can support as part of an SLA. This task is closely linked with the task listed directly above – identifying how and where each network centric solution will be hosted.

2. CSPs must ensure that as many of their data center processes as possible are automated to the degree possible. This includes implementing a workflow engine and a workload scheduling function that can distribute customer workloads both across the servers within a data center as well as across the servers in disparate data centers. This also includes implementing an orchestration system that allows CSPs to automate the arrangement, coordination and management of computer systems, storage, security and networks in order to efficiently deliver their solutions to customers.

3. CSPs must develop the ability for a CSP to assuage the concerns of potential customers. For example, CSPs must be able to demonstrate to potential customers that they have the tools and processes that enable them to meet the commitments specified in the SLA. CSPs must also be able to demonstrate that they can pass the same audit requirements that the customers are required to support.

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