Software defined networking in the new business frontier

The key to meeting next-generation agility, innovation and application demands in the era of hybrid cloud and IT as a service

IBM

Contents

Introduction

Today's enterprise networks fuel the way people live, work and play, yet their ability to push out the rising volume of data and applications in real time and meet expectations for ubiquitous, secure access is increasingly in jeopardy. The pervasiveness of cloud computing along with the escalating demand for mobility and social collaboration continue to place an enormous strain on enterprise networks. Too often, innovative development can be stalled for weeks or months waiting for provisioning of expensive and inflexible network services. The cumulative effect can be devastating for the business.

Traditional network architectures that are too old, rigid and expensive to scale are out of alignment with today's hybrid cloud (a combination of traditional, public and private cloud infrastructure) and IT as a service (ITaaS) deployments. Whether organizations are actively pursuing growth opportunities through IT innovation or reductions in IT cost and complexity, they need a network that is automated, intelligent and optimized for seamless operation within an increasingly virtualized and hybrid IT environment.

Highly interactive cloud-based applications and volatile traffic patterns demand a network infrastructure that is more agile, more adaptable, and more in sync with the business it supports. The need for instantaneous, elastic connectivity across the enterprise is no longer just an option; it is the table stakes for a successful business.

Software defined networking (SDN) is answering the need for agility, scalability and visibility by transforming hardware-intensive legacy networks into fully programmable, virtualized software-driven networks that streamline operations and the delivery of new services. SDN creates a centrally managed network that can dynamically sense and respond to changing workload requirements, allowing organizations to take full advantage of the flexibility, speed and reduced costs of a hybrid cloud environment. SDN's ability to automate and orchestrate network services dramatically reduces complexity, enabling network resources to be deployed with the same speed as server and storage. This promotes more innovative development and speeds time to market for new applications and services, allowing the business to capture new opportunities and grow revenue.

This paper explores the cloud-era technologies and the emergence of ITaaS that are driving the move to SDN in hybrid cloud data center networks, the implications for the enterprise, and the exceptional business benefits when SDN is deployed holistically as part of a software defined environment (SDE). The paper presents IBM's point of view and outlines the way forward for SDN transformation.

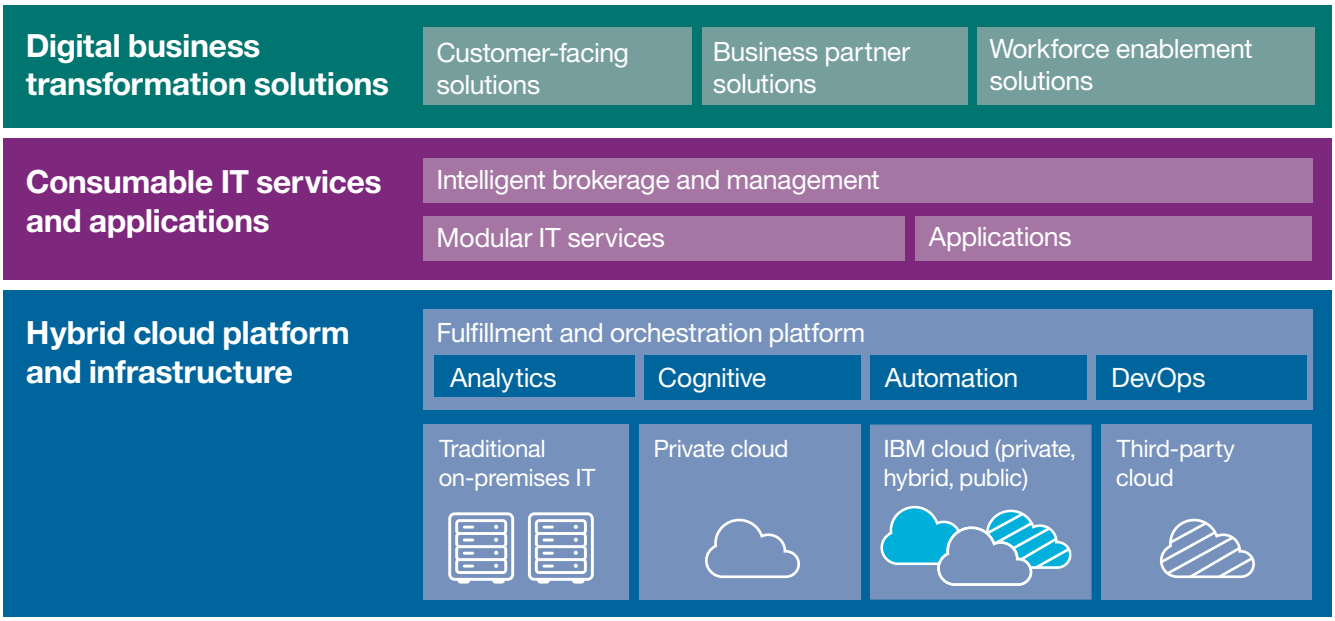
Business trends driving the need for network change

For decades, organizations have relied on the underlying network to link systems and facilitate the transfer of information. The network's role as an agent for IT is without question, with virtually every job, transaction and operation depending on it. But today it is the network's role as an agent for business innovation and agility that is far more compelling.

New technologies organizations are required to support—cloud, mobility, the Internet of Things (IoT) and big data analytics—are reshaping how business gets done while creating new opportunities for innovation and growth. Likewise, hybrid cloud, hailed as a gateway to infrastructure agility, cannot succeed without a capable network to support it.

The emergence of hybrid cloud environments mandates an enterprise ITaaS model, which allows organizations to consume IT resources as a suite of services with usage-based pricing. This model lets organizations connect:

- Business solutions designed to deliver differentiated experiences and unlock new business models to the
- Ecosystem of services and applications that can be mixed and matched to form the best solution for their needs to the
- Platform and infrastructure backing those services, ensuring seamless implementation and simplified management



ITaaS. *The emergence of hybrid cloud environments mandates an enterprise ITaaS model, which allows organizations to consume IT resources as a suite of services with usage-based pricing.*

To meet these new IT and business objectives, organizations need a network that is integrated, agile and secure, able to accommodate rapidly changing workload demands flexibly and dynamically. Such a network can be a growth engine for the business by:

- Increasing agility so new applications and innovations can be designed and deployed at the speed of today's business
- Enabling the seamless migration and modernization of applications in a hybrid cloud environment
- Improving visibility and governance across hybrid cloud networks
- Boosting the security posture of the network, data and applications
- Replacing complexity and risk with operational efficiency

The problem is that most corporate networks simply weren't designed for this new business environment. Most networks are highly inefficient, poorly utilized and comprised of expensive, specialized appliances sized for peak capacity. They require a great deal of manual administration, with controls typically embedded in each hardware device. Because each device is configured separately, the process of modifying or expanding the network for new capabilities, workloads or users is time consuming, personnel-intensive and costly.

The ripple effect of these inefficiencies on the rest of the IT infrastructure can stifle new development. The flow of innovative ideas and the deployment of new applications and services are slowed when the network lacks agility. Whereas virtualized compute and storage resources can be spun up almost instantaneously in support of new applications and changing business conditions, network resources (including switches, firewalls and load balancers) can take weeks or months to procure and provision, costing the organization time, money, and in many cases opportunity. The delays often lead business users to go around IT to provision their own development infrastructures in the cloud. While this practice, known as shadow IT, addresses the needs of individual business units, it poses considerable risks for the enterprise, complicating operations, security and compliance.

Security is also hampered by manual network administration. When deployed applications and services require firewall rules or access controls to be changed, reconfiguring each network device can be an arduous and complicated task, putting the business at risk.

Software defined networking answers the need for a more dynamic, flexible network infrastructure.

The network is a critical linchpin for business agility and growth. While most organizations cannot afford to wipe the slate clean and build a new network from scratch, new architectures and approaches are needed to support the rapidly evolving environment in which the enterprise must operate. Software defined networking (SDN) allows easy building of virtual networks over physical network infrastructure, providing investment protection and smooth migration.

SDN can reenergize the networking space because it fulfills the promise of an agile and more scalable networking environment. It removes the network as a bottleneck to innovation and new service deployment— including deployment of a hybrid cloud environment. It makes the network completely programmable and able to operate with the same fluidity as software defined servers and storage. With SDN, switches, routers, and even whole architectures are capable of dynamically adapting to changing workload conditions in real time.

The value of software defined networking in a software defined environment

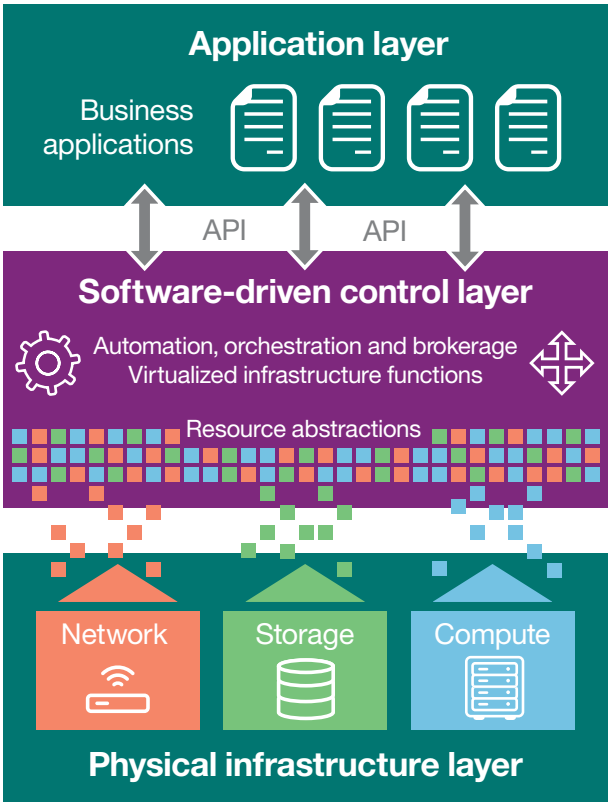
SDN is a technology and a philosophy that is changing the way networks are designed, managed and operated. But its capabilities and benefits increase substantially when it is integrated holistically with software defined compute and storage resources in a software defined environment (SDE).

Software defined environments represent the next generation of infrastructure automation and agility. With SDE, the IT infrastructure is completely programmable and application-aware. Every process is driven by software, eliminating the need for manual administration. The infrastructure operates in a more adaptive manner, dynamically and intelligently responding to application requirements and adjusting to change as it happens. SDE breaks down the server, storage and network silos that typically slow responsiveness. It works across domains to marry the best resources to each application workload, based on a variety of factors, including the characteristics of the application, resource availability and service-level policies.

This holistic orchestration of resources is one of the hallmarks of SDE. SDE depends on the integration of compute, storage and networking resources. All three domains can be virtualized and automated with software-driven programmability to enable the kind of orchestrated provisioning, configuration and management required for a truly agile IT environment.

Application workloads aren't tied to specific systems. They run on the most appropriate combination of hardware, whatever and wherever that might be. The benefits of this dynamic, adaptive IT environment include:

- Orchestrated infrastructure provisioning in minutes
- Fast application deployment, enabled by predefined templates
- Continuous infrastructure optimization and reconfiguration to respond to unpredictable cycles of demand using DevOps automation
- Centralized cross-domain management of hybrid IT resources



SDE model. *In a software defined environment, control is abstracted from the hardware. It resides instead in a software-driven control layer that orchestrates resource provisioning and management.*

Today, organizations are recognizing that a move to ITaaS will allow them to consume and acquire IT services as they are needed, thus avoiding the costs involved with having nonessential resources running at all times. With this comes a need to define which and when IT services are required by an application. Through an automated, programmable process, the software defined construct can provision network services along with server and storage as needed, moving from individual static control to software-based control that is agile and API-driven. Network function virtualization allows traditional appliance-based functions to be converted into software-based functions that can run in a virtual machine environment, making provisioning and configuring almost instantaneous and enabling the "as a service" model.

The network no longer has to stand in the way of a simpler, more adaptive, responsive infrastructure. SDN enables the realization of a fully orchestrated and managed IT environment.

SDN fundamentals

In a traditional network infrastructure, each switch decides where traffic should be sent, and it forwards the traffic based on those decisions. With SDN, these two functions have been decoupled from one other. The switch still forwards the traffic, but determining what is sent and to whom is shifted to a centralized control point, a programmable interface that automates network management and control, commonly referred to as the SDN controller.

The SDN controller is aware of what all the nodes on the network are doing. It logically centralizes network intelligence, integrating the information and controls for all of the network switches into a common fabric. Instead of manually setting individual switch controls, network administrators can configure settings network-wide using a centralized console.

When network changes need to be rolled out, they don't have to be implemented in piecemeal fashion on individual devices. They can be deployed cohesively, with the software deploying changes uniformly to all of the devices that need them. Moreover, changes can be deployed to multivendor switching equipment using a single interface.

In addition, network administrators have the flexibility to redirect network traffic as conditions change. The controller not only simplifies their job by reducing complexity, it enables the network to better support the needs—and speed—of the business, however unpredictable they may be.

Network virtualization

Network virtualization is integral to SDN. SDN virtualizes and abstracts network services (constructs, segmentation and security) from the physical network infrastructure and defines them in software, making the network programmable.

The benefits of network virtualization are by now well-known; they include flexibility, operational cost savings, agility and scalability. Network virtualization also allows isolation between virtual instances, whether for compliance, containment, or just to keep development, test and production environments from interacting. It is crucial to containing security risks and maintaining data privacy in multitenant environments.

There are two approaches for virtualizing the network. The fabric-oriented approach focuses on operating the network hardware (fabric) with greater programmability and efficiency. It is usually done as part of major refresh, and it involves modifying or purchasing new physical switches. The more popular and cost-effective approach is to create virtual overlay networks (software abstractions) on top of the existing physical network. Overlay virtualization can be deployed incrementally as needed without any changes to the physical network.

The resulting virtual networks and the applications that run on them are logically isolated so they can be individually programmed and managed. Virtual networks speed time to market for new applications because they allow the creation of identical virtual development, testing and production environments, which streamlines promotion from one environment to the next.

Network functions like load balancing, firewalls and intrusion detection systems can also be virtualized. Instead of running these functions on dedicated network appliances, network function virtualization (NFV) deploys these capabilities as software on virtual machines. This reduces equipment costs because it allows network functions to run on standard commodity hardware. Once virtualized, these functions are more accessible to the applications that need them.

Fabric-oriented, overlay and network function virtualization approaches are complementary and can be used individually or together. SDN as an architectural approach optimizes what these virtualization techniques can accomplish. It provides the dynamic intelligence and orchestration that continuously optimizes the utilization and delivery of virtualized network resources and the flow of data across the network infrastructure.

Vital benefits for business

IDC's *SDN Survey* found that the top benefit drivers for SDN consideration and deployment were security, agility to support virtualization and cloud and operational efficiency.[1] SDN's ability to scale and reconfigure the network for new capabilities, applications and users makes it well suited to address these and other important business objectives.

Agility. SDN's ability to spin up network services much faster than traditional networks turns what is currently a weeks-long provisioning process to minutes. In particular, SDN makes it easier to connect to and leverage cloud resources for developing and testing new applications (Use case 1). Innovative new applications, services and business models can be brought to market at an extremely accelerated rate, enabling organizations to capture opportunities and enhance revenue ahead of competitors (Use case 2). By providing an agile, open and security-rich DevOps environment, SDN encourages the broadest base of users and developers to collaborate, build and market applications. Moreover, existing applications that may have been developed at substantial cost are easier to monetize with a more capable network, while rapid provisioning of services enables organizations to deploy applications faster.

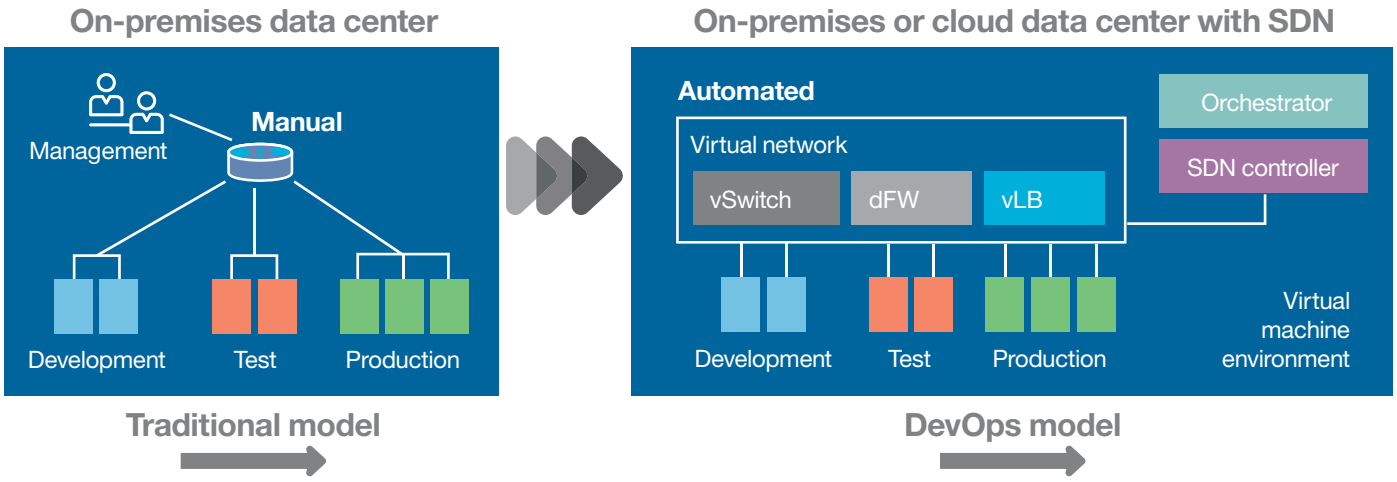
Use case 1: Burst to the cloud for application scalability and new innovation

Traffic volatility is a fact of life for most companies. By shifting applications and services to the cloud, it is possible to cost-effectively acquire the additional server capacity needed. But bursting requires a network that is ready to handle the alternate flow of traffic. SDN is capable of rerouting traffic and quickly auto scaling to meet the fast-changing demands of cloud bursting.

Use case 2: Rapid app innovation for faster speed to market

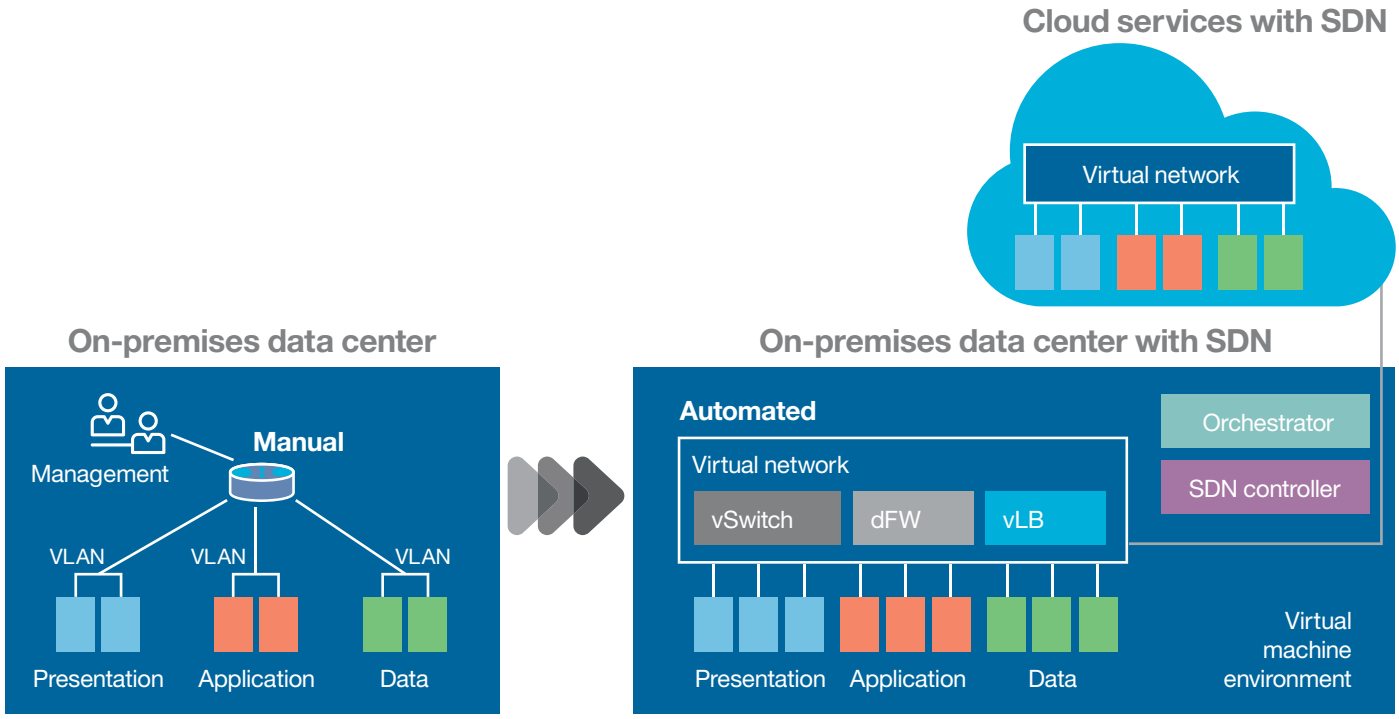
Rapid provisioning and de-provisioning of network resources is key. An agile DevOps environment requires a network that dynamically aligns to the entire development and testing cycle, offering instant deployment and allowing cloud applications to access on-premises data as needed. In a physical network environment, network resources are purchased, installed, configured and manually changed each time there is a new release. This process can take weeks or months, slowing new application development, creating significant resource and cost inefficiencies, and incurring possible errors in the manual set up. SDN can help create and tear up the development environments instantly, spinning up the required network resources in seconds as required by an application across all locations and all instances of the DevOps cycle.

SDN enables organizations to establish a collection of reusable network templates that can be used to deploy virtualized networks with all the requisite capabilities (switches, firewalls, load balancing and more) already automated and orchestrated. When new applications are ready to be deployed into production, the templates enable appropriately outfitted virtualized networks to be provisioned in a matter of minutes.

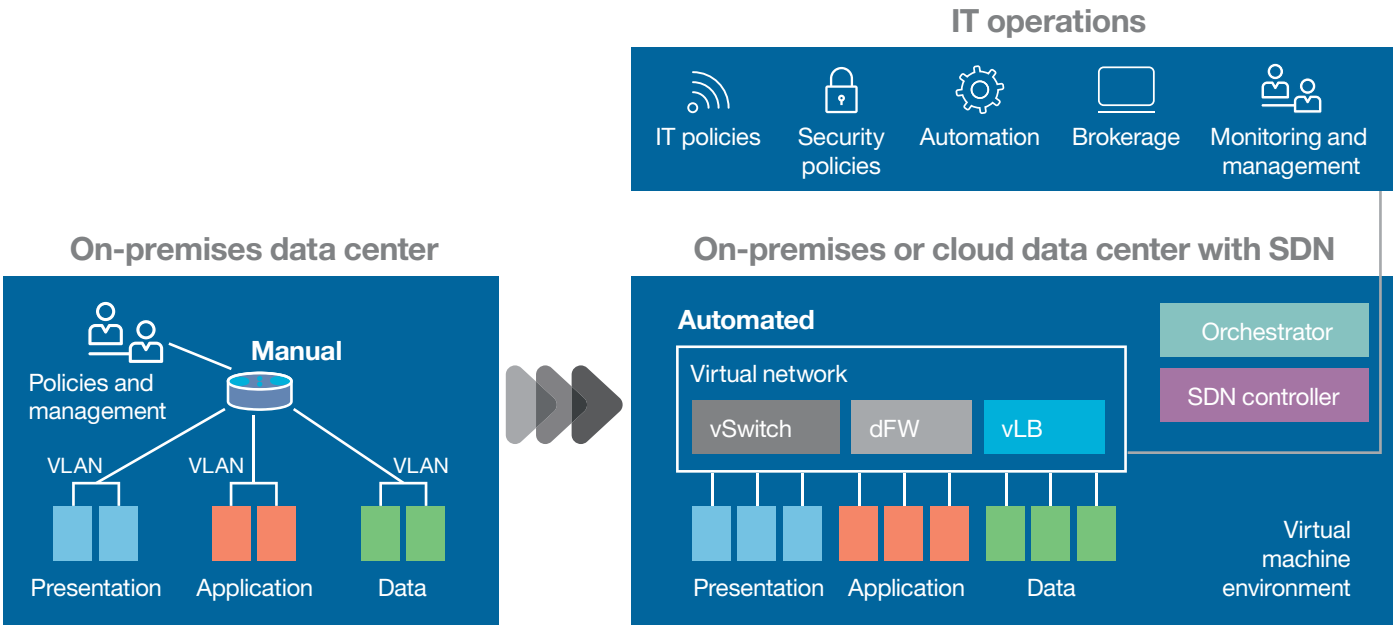


Seamless app migration and modernization. To take full advantage of a hybrid cloud environment, organizations should be able to place and access applications either on the cloud (public or private) or on-premises. While it is important to understand which applications should be on-premises and which should be cloud-based, it is also important to consider the network implications. The network must be architected to allow seamless migration of workloads and smooth running of migrated applications; i.e., applications can interact and access the information they need, whether on-premises or cloud-based.

Each time an organization migrates or modernizes an app in a hybrid cloud environment, a software defined approach across the data center network environment gives the programmability to automatically spin up the network resources in line with the workload needs. SDN can align network functions instantly to match application requirements while deploying workloads and network functions together. The programmability enables rapid provisioning of networks to quickly migrate apps in a hybrid cloud environment.



Seamless workload migration. *SDN can align network functions instantly to match application requirements while deploying workloads and network functions together.*

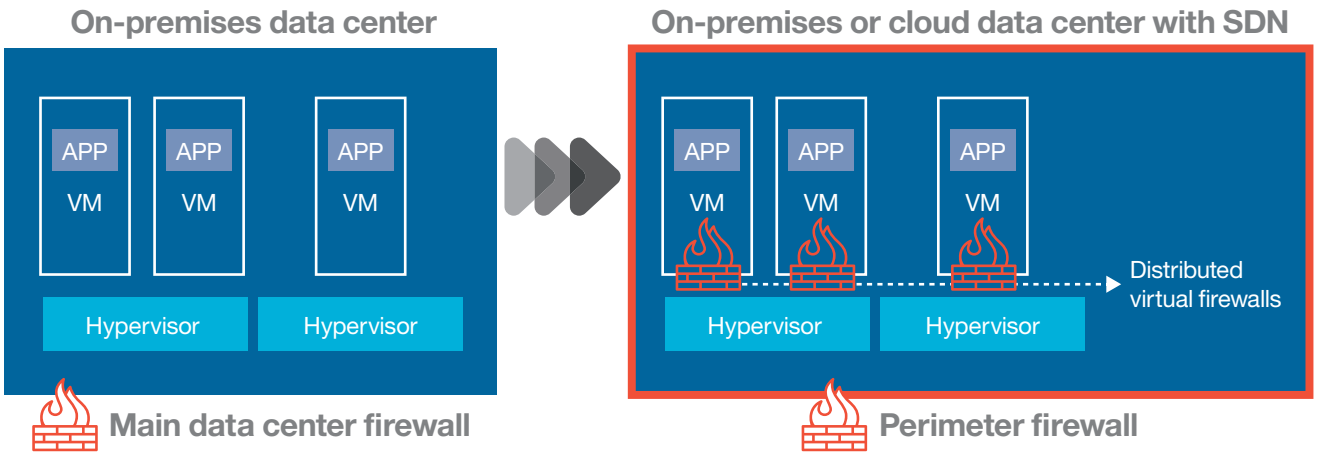


Visibility and management. *SDN provides both by centralizing and automating management and control.*

Visibility and governance. Manual network administration and governance inhibit business agility. It is critical for organizations to establish full visibility and dynamic governance across cloud and on-premises platforms and the underlying networks that connect them. The network management system should be able to proactively monitor and manage on-premises and cloud networks with a feedback mechanism that generates constant improvement. With agile DevOps and movement of workloads in a hybrid cloud environment, governance policies required by applications should be applied and changed quickly.

Gaining visibility into networks and applying policies is easier with SDN. It is also easy to apply and change policies on virtual machines making the governance model more agile and secure.

Operational efficiency. As the scale and complexity of the network increases, so does the need for visibility and management. SDN provides both by centralizing and automating management and control. This not only simplifies troubleshooting and traffic re-routing, it enables entire service chains (that is, all of the network services required for a given application flow) to be provisioned and reconfigured from a single control point. Long-standing network limitations to IT efficiency and overall productivity can be overcome.



SDN security. *SDN allows finer-grained security controls to be wrapped around trust zones, applications and individual virtual machines.*

Improved security. SDN-enabled automation and forwarding decisions improve the security posture of the network by allowing for more granular, zero-trust network security. While legacy networks enable perimeter security around the data center, SDN allows finer-grained security controls to be wrapped around trust zones, applications and individual virtual machines. Each asset and user can have its own security profile based on macro-level policies that define the appropriate level of protection. Such micro-segmentation allows for the more effective application of security measures like firewalls because the underlying rules—which can number into the tens of thousands for a single organization—are easier to manage. Modifications are made centrally and then pushed out so that any asset or user with that profile gets updated automatically. Policies are enforced as applications and services are deployed, and policies are removed as those same services are decommissioned. SDN frees organizations from having to manually find and modify every instance of a firewall rule.

Furthermore, SDN makes it possible to establish a distributed firewall system, which can mitigate vulnerabilities in the event the perimeter firewall is breached or an application exploited (see Use case 3).

Use case 3: Protect internal data center traffic with a distributed firewall

SDN enables more targeted protection while simplifying firewall administration. Instead of relying on a conventional perimeter firewall to protect the entire data center, organizations can create a distributed firewall system, adding virtual firewalls to protect each virtual machine. This additional layer of firewall security mitigates a breach in one virtual machine from leapfrogging to another. In addition, SDN automation and centralized control enable administrators to quickly view, modify and curb network activity to limit the chances of a breach in the first place.

Moving from capex to opex. SDN offers the potential to significantly lower current operating expense (opex). An IDC survey found that 50 percent of enterprise respondents reported opex savings of 10 to 20 percent from implementing SDN, while approximately 31 percent of respondents reported opex savings of 21 to 30 percent. Enterprises can expect to reap capital expense (capex) savings too, with IDC reporting that about 43 percent of respondents indicated capex savings of 10 to 20 percent.[2]

Automation and centralized control reduce the time spent provisioning and managing the network. By expanding processing capacity, network virtualization lessens the need for additional capital expense while enabling considerable savings in power, cooling, cabling and real estate. SDN also lessens the need for purpose-built appliances, enabling the virtualization of network functions like load balancing on lower-cost commodity servers. In addition, running multiple functions on the same server platform reduces the degree of over-capacity needed than when the same infrastructure is deployed using function-specific hardware appliances.

Enabling ITaaS

One of the key elements of the ITaaS model is the successful deployment of brokerage services. This can transform how an enterprise plans, buys and manages IT services through a catalog of simplified and standardized service options that enables users to easily compare services, features and prices to select the best fit for their workloads and requirements.

Business leaders, application and infrastructure teams can partner to continuously update the catalog of services, effortlessly adding valuable services such as monitoring and security to new innovations as they move to production. IT services can be provisioned, managed and governed in an automated way across any platform, and both on-premises and cloud services can be viewed and administered from a single screen.

These brokerage services provide the business process front end for an enterprise to plan, buy and manage a large portfolio of IT capabilities, but they require:

- Networks that provide the back-end aggregation of all the network services required
- The ability to provision networks in line with the application requirements
- The ability to select network technologies and service providers to ensure best-fit network services

SDN can provision and manage the network functions required by an application or component that has been selected via brokerage services.

IBM SDN reference architecture

As interest in SDN has mounted, the demand to integrate it into existing network designs has produced a complex array of technologies and deployment options. IBM has worked with many of the SDN solution providers to understand the capabilities and the limitations of these products. We have incorporated much of this knowledge and experience into a reference architecture designed to help organizations navigate the SDN marketplace.

Currently, IBM has defined many use cases (such as micro-segmentation) and more than 100 requirements to help adapt SDN to different client environments. Requirements include the need to align network security policies to the new SDN-driven capabilities, perhaps leveraging metadata from virtual machines in addition to the standard IP address segmentation rules.

IBM assets like the reference architecture help clients determine the best way to use SDN technologies to solve their organization's challenges. They explain how to get SDN technologies up and running quickly and with minimal churn.

The reference architecture provides IBM services professionals with a blueprint for SDN and for assisting clients with SDN strategy and design. It helps simplify solution design, shorten the time to deployment and reduce risk by aligning the solution to business priorities.

Readiness for SDN

For the majority of organizations, the business case for SDN has become clear. In fact, according to IDC, the SDN market is expected to grow at a compound annual growth rate of 53.9 percent from 2014 to 2020 to reach $12.5 billion at the end of the forecast period.[3]

However, as Brad Casemore, director of research for Datacenter Networks at IDC states, "With SDN, as with other software defined technologies, success hinges on how organizations prepare for and adapt to software- and developer-driven practices and processes. In many cases, your organization will have to break down its traditional IT operational silos and restructure toward more of a DevOps model. Although such change can be difficult, it has the potential to deliver substantial business benefits in opex and capex cost savings, time to revenue and overall business agility."[4]

The IT infrastructure is continuously changing, becoming more virtualized, automated, cloud-enabled and hybrid. With so many moving parts, adding any new technology can be difficult. That makes SDN readiness vital, and there are many considerations to take into account. Certainly, the business drivers must be well understood to make sure SDN can satisfactorily address current priorities. Business agility should be front and center among them. The advantages of a self-provisioning, self-adjusting, fully programmable network cannot be overstated.

Organizational readiness is imperative. SDN does not merely improve current networking, it necessitates an entirely new perspective of networking and IT. However, if current network operations are ingrained, networking personnel might not see a reason to change, especially if nothing is fundamentally broken. They may be concerned about the relevance of their skills and resist change. Readiness needs to address these concerns, and it should include training to encourage the mastery of the new technologies, including the programming, scripting and application programming interface (API) skills needed to facilitate the transition to an automated network. Opportunity awaits those that embrace SDN and develop this knowledge. IDC found that 48 percent of enterprises foresee SDN as a means to deploy networking personnel to higher-level tasks, including network analytics, orchestration and virtualization.[5]

SDN adoption will necessitate greater collaboration between the groups that provide network and IT services today. For example, those that support network security must collaborate closely with those that provide network services for servers, middleware and applications. Establishing a tighter linkage between network teams, other IT infrastructure teams and application groups is especially important because it allows network behaviors to be tied to business priorities. It facilitates automation and orchestration within an overall SDE context, and that is the basis for improved agility and efficiency.

An important aspect is selecting the right SDN technology in line with business and application needs. The complexity of SDN technologies can be overwhelming, and an unbiased approach and a point of view on multiple technologies coupled with a deep understanding of business needs can enable integration of the best-fit SDN technology into the IT environment.

Infrastructure readiness is another fundamental prerequisite for SDN. Networking personnel should assess the stability and resilience of the infrastructure and its maturity in terms of automation and virtualization. The full value of SDN is achieved through integration with software defined compute and storage domains. When the entire infrastructure has the intelligence to sense and respond to changing workload requirements and orchestrate resources holistically, the benefits of SDN are the greatest.

IBM's transformation methodology

SDN is now becoming pervasive. According to IDC, while SDN in the data center has received significant focus and visibility, software defined WANs are growing in capability, popularity and adoption.[6] Many network functions are being virtualized and can be deployed in any location—the cloud, on-premises data centers, at the edge of a WAN or as an integral part of the WAN. The enterprise now has the flexibility to select from a variety of options to start their SDN journey depending on their business needs. Multiple options, approaches and suppliers add to the complexity of determining the best place to start the SDN journey. A roadmap that fits enterprise business needs is a thoughtful approach.

SDN is not a technology that has to be implemented all at once. It can be implemented gradually, automating parts of the network as required by the organization. Network overlays are a leading option for incremental deployment because they do not significantly disrupt existing operations.

IBM's three-step transformation methodology helps clients leverage their existing network in the creation of a software defined network:

- **Strategize and plan.** IBM networking consultants begin by assisting clients in the development of a software defined network strategy. We start with an in-depth assessment of current workloads, management and infrastructure to gauge enterprise readiness. Current maturity levels are examined in processes relevant to SDN and SDE, including virtualization, automation, integration and security. These network design services help identify the issues inhibiting network agility and determine where improvements are required to ready the infrastructure and the organization. Recommendations are often aimed at linking networking operationally, technically and organizationally with other parts of the enterprise, including operations, security and application development and management.

- **Design and deploy.** Consolidation and virtualization eliminate redundancies and improve the scalability of existing network hardware while reducing the need for future capital expenditures. IBM networking experts help clients identify redundancies and decide which devices can be retired. They help clients determine the best virtualization and SDN technology for their needs and help apply those technologies in their network environment.

- **Monitor and manage.** IBM can monitor and manage a client's entire hybrid cloud environment, including servers, storage, networking, middleware, cloud and databases. Software defined networks are a part of this overall environment. Dynamic automation, advanced analytics, proven processes and tools and cognitive capabilities are used for incident prevention and reducing mean time to resolution. IBM offers deep expertise in networking and cross-IT domains to help manage the network with the rest of IT, while centralized IT infrastructure management across multiple network technologies and technology providers helps reduce complexity and drive operational efficiency.

IBM knows networks

IBM knows what it will take to modernize and optimize the network architecture for the new business frontier. In the age of cloud, mobility, the Internet of Things and ITaaS, where hyper scale computing is the norm, agility is essential and software defined technologies and virtualization provide the path for attaining it. IBM has years of experience designing and integrating these capabilities into network infrastructures with the people and expertise needed to transform networks while keeping the rest of IT in mind.

IBM SDN services are not just designed to build a better infrastructure and simplify operations. They are designed to improve our clients' business outcomes by increasing their agility and speeding time to value for new innovation and service delivery. We design our solutions to meet the needs of the organization, allowing clients to leverage their existing infrastructure investment.

Because we do not manufacture SDN technologies, we can offer an unbiased and valuable point of view when it comes to helping clients navigate the maze of SDN technologies and providers. We offer independent, objective advice and solution design, coupled with our relationships with leading technology providers. Our approach is not limited to technology. We look at a client's requirements and help select and integrate the best technology aligned to business needs.

IBM consultants leverage proven methods and reference architecture for SDN strategy and design, then provide clients with the flexibility to choose how and where it will be implemented. We offer a full suite of implementation services or tools for clients who choose to do it themselves.

IBM leads our clients through a transformational roadmap that includes SDN strategy, assessment, architecture, design, deployment and management. We provide the capabilities, experience and expertise to help clients transform their existing network infrastructures and maximize the benefits of a software defined environment.

At our Client Innovation Centers, we can build, integrate and test client SDN solutions before they are actually implemented in a production environment. In these labs, we bring together all of the products from leading network providers to determine the best technologies and deployment options for each client and ensure a more seamless, hardened deployment later.

Fully integrated SDN solutions can be deployed to a client's data center, an external provider site or a cloud, and we have a library of templates to streamline network automation and orchestration. Once SDN is up and running, we can provide monitoring and management services onsite or remotely. We provide services for every stage of the SDN life cycle.

At IBM, we don't believe the network is best served as a siloed operational domain. SDN's greatest potential lies in its convergence with software defined compute and storage, when all enterprise infrastructure resources can be dynamically orchestrated across domains and data centers. IBM delivers technologies and services to enable this kind of holistic orchestration and management by enabling organizations to break out of their silos, embrace the software defined value proposition and benefit more fully from the business agility promise of SDN, SDE and the cloud-era technologies they support.

Conclusion

Now more than ever, the network is the connective tissue for the enterprise, but the needs of the business have surpassed the network's capability to serve it. Rapidly rising demands for cloud-based mobility, social media and big data services require a new approach, one that can sense traffic and reconfigure the network automatically for new workloads and business conditions. SDN is that approach.

The business advantages of a dynamic, programmable and virtualized network environment are significant and include more innovation, faster time to market, and better security. It is imperative when it comes to successful deployment of hybrid cloud and ITaaS. The transition to SDN requires thoughtful strategy and design to prepare the organization and the infrastructure. IBM offers the knowledge, experience and services to help develop the necessary skills and facilitate the transformation.

For more information

To learn how IBM is helping organizations transform the network for greater agility, please contact your IBM representative or IBM Business Partner, and listen to the on-demand webinar available at **ibm.com**/marketplace/cloud/software-defined-networking/resources/us/en-us

IBM Global Services
Route 100
Somers, NY 10589

Produced in the United States of America
November 2016

[1,3] IDC, "Successful SDN Adoption Requires Software-Defined Services: 2015 SDN Survey Services Observations," IDC #US40306515, December 2015.

[2,4,5] IDC, "IDC PlanScape: SDN and IT Organizational Challenges," IDC #US40713915, December 2015.

[6] IDC, "SDN Market to Gain Enterprise Headway, Driven by 3rd Platform and Cloud," IDC #US40628315, November 2015.

ICW03011-USEN-01