NTT DATA
Trusted Global Innovator

WHITEPAPER / Multi-Cloud Services

Software Defined Data Center (SDDC)

Future Platform for Private and Public Cloud Services

Table of Contents

1. Introduction 3

2. Modern IT Challenges 5

3. SDDC & HybridCloud Solution Approach 9

4. NTT DATA POV SDDC / HybridCloud 14

5. NTT DATA Offering 15

6. Benefits & Conclusion 19

Follow us:
NTT DATA Multi-Cloud Services

Connect with our expert:
M.Veseljak@nttdata.com

1. Introduction

Most companies have to deploy new capabilities and business initiatives to get ready for the new digital markets. But in many cases, technology is the limiting step adding unexpected challenges from concept to planning and implementation. LOB and the end-user have drastically changed their expectations towards time-to-market and implementation cycles for innovative business models, customer experience and billing of services, based on public cloud and mobile services experiences. CIO and IT organizations have to change their pace to be accepted and meet the LOB expectations. CIOs have to adapt their organization and operational models to not lose control of IT spending and control risks associated with LOB leaders experimenting with innovative technologies, on their owned budget, navigating into the mobile cloud era. Just announcing a cloud first strategy in some instances implies huge risks and outweighs the benefits by uncontrolled use of technology and IT spends, including LOB experimentation into diverse directions. Corporate IT strategy has to find ways, which include some LOB "managed experimentation", but at the same time keeps overall control of technology, security and overall implementation, operations of IT supporting new business initiatives.

Central IT suddenly must manage projects outside of IT, while still providing guidance and acting as a service broker, keeping oversight even on services not provided by IT. Such services must become integral part of CIOs service offerings, including the required transition —¬ from the experimental stage into day-2 operations. CIOs have a major task of transforming the IT organization role — from a cost center to a strategic partner. A flexible and adoptable architecture from Edge to Cloud will enable the required IT transition: SDDC (Software-Defined Data Center).

This major transformation requires building credibility and comes with some essential prerequisites.

Firstly the CIO must turn his IT organization into a business enabler by delivering efficient, fast adopting yet secure, flexible IT services — in terms of commercial and technology offerings. The second prerequisite is to change IT into a service broker – offering on-premise private cloud services at the edge and core along with a controlled, well managed public cloud service. Only IT organizations which manage to establish a unified operations and management framework in a holistic approach will be successful. We call such an approach Hybrid Cloud.

The enabling technology for Hybrid Cloud is the SDDC architecture defining the required platform common for the IT private and public cloud offering. SDDC architecture allows a logical vs hard-coded infrastructure service definition, utilizing the well-established server virtualization computer science principles. Those principles are abstraction, isolation and pooling of all infrastructure and platform services. The final layer is defined by an automated cloud management platform — SDDC management, controlling both on-prem and public cloud resources, offering Self Services to the LOB and their business transformation projects, including a transparent service catalog and billing engine (public cloud alike).

What are the fundamentals of a Software-Defined Architecture enabling the impact requested from the CIO and his IT organization that finally deliver?

Abstracted logical infrastructure services, leveraged by a software-defined architecture, as opposed to being integrated with the underlying hardware. Companies such as Hyperscalers, internet and social network providers use this approach to drive their efficiency, aggressive cost savings and manageability of their specific workloads — utilizing commodity hardware components, combined with proprietary technologies such as custom applications, platforms and containers. As a result the final services, e.g. AWS, Azure, Meta, is provided to the customers. But the applicable SDDC architecture for enterprises across all industries must meet some key requirements, beyond proprietary:

"CIOs have a major task of transforming the IT organization role — from a cost center to a strategic partner. A flexible and adoptable architecture from Edge to Cloud will enable the required IT transition: SDDC (Software-Defined Data Center)."

1. In addition to cloud-native applications, traditional applications have to run within the SDDC architecture, without being rearchitected

2. SDDC architecture has to support the whole enterprise IT needs — from the edge (production, local data rooms, etc.), on-prem data centers and public cloud based services

3. The IT organization has to be enabled to build upon their existing skills to run the SDDC architecture virtualized environment, while allowing LOBs and software developers to consume IT services via Self-Service access (using either a portal or APIs)

4. Finally all consumed infrastructure services must meet the appropriate security requirements while providing elastic scaling and burst capabilities

Our approach to SDDC meets each of these requirements, and it powers the data centers of many enterprises worldwide. The result is an SDDC platform that enterprises can adopt to run any application on top of any x86, storage and IP network hardware while integrating public-cloud services.

This white paper explores our NTT DATA SDDC end-to-end solutions and how it accelerates and enables Digital Transformation, Digital Business, IT Modernization for our global customers across all industries and regardless of their current situation or starting point.

2. Modern IT Challenges

Characterized by cloud computing, mobility, and Big Data IT organizations are pressed to deliver many new services consumable as SelfService and via APIs to enable adoption of new digital business opportunities.

The gap between the changing business priorities and what their IT organization can deliver continues to grow. If IT and CIO don't find ways to accelerate service creation and delivery, their ability to serve the business could get even more challenging as shadow IT, experimentation and agility of LOBs spiral IT processes and budgets out of control.

Emerging computing models are changing the way different infrastructures, software, and business services are sourced and consumed. Even hardware vendors are developing new consumptions models, e.g. HPE GreenLake or Dell APEX. IT and facilities professionals are bringing innovation to their data centers, but their efforts are being constrained due to disparate architectures, different management approaches and security models, inconsistent tools, and tight budgets. Businesses demand organizations to modernize the delivery of their legacy IT services. Modernization of the data center requires careful planning and execution to meet the complexities of transformation. To assist with this journey, a new standard for the modern data center is emerging—SDDC, or software-defined data center.

Here are the key business outcomes you can expect from SDDC:

1. **Speed** Rapid service creation and service deployment
2. **Alignment** Close gaps in user expectations and business alignment
3. **Cost** Optimized technology, processes, and workforce
4. **Agility** Measurably improved business outcomes to weather impending business and technology storms

At NTT, SDDC is more than just the virtualization and automation of the data center through software. SDDC requires workload or application-driven orchestration and the control of all aspects of the data center — from infrastructure to operations and management, through open and hardware-independent management and virtualization software. To achieve the benefits of SDDC, organizations have to virtualize servers, storage, and networks. The journey begins by understanding the new business needs, which drive transformation of applications and IT infrastructure as well as underlying technologies, all of which are converging. Technology is transforming the way we live and work, moving from traditional to digital business models.

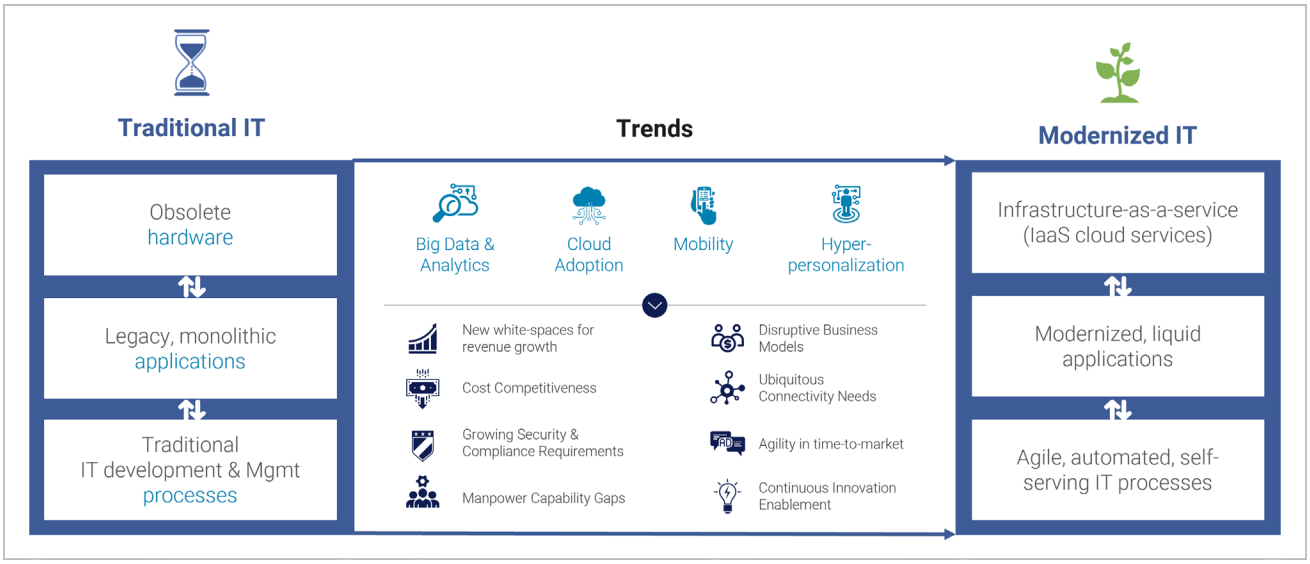


Figure 01
Enterprises are Modernizing Traditional IT to Keep-up with IT Imperatives

New digital era, driven by IOT, called the next industrial revolution.

The next big change is driven by data and resulting digital business, changing the business landscape and reinventing our future and growth of economies.

Customer IT departments are under enormous pressure, since IT is no longer accepted for keeping the lights-on and being treated as a cost center, instead IT is seen and treated as a business partner responsible for significant contribution in digital transformation – supporting faster innovation cycles and significant foundation for the growing digital business.

New modernized applications have to be developed and deployed to the market, to innovate with technology creating significant competition advantages, being executed faster with more choices for the business owners. In most cases further requirements for stricter compliance, improved security, controlled costs and increased efficiency, lowering risk require solutions to improve DR and BC.

Traditional IT infrastructure was custom designed to fit the specific needs of the business using any solution from any vendor. This flexibility comes with drawbacks, including the extensive time needed to research and get the initial or expanded infrastructure

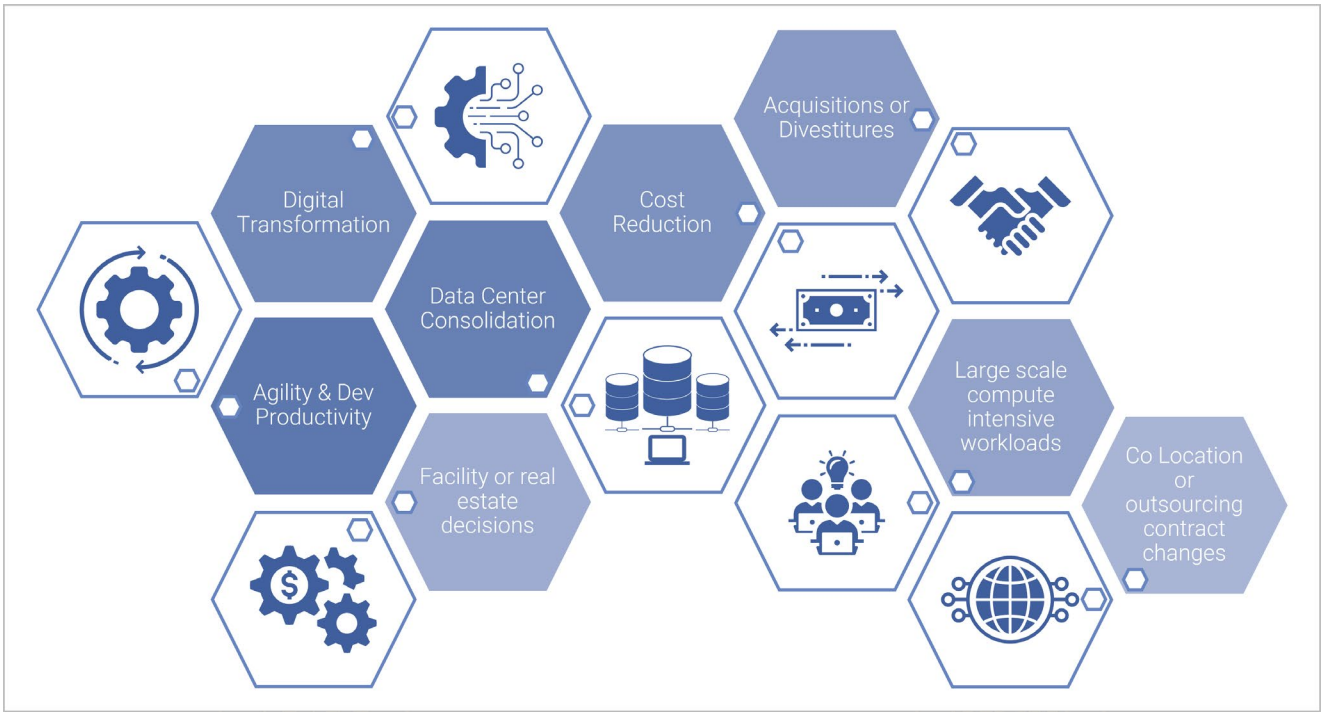


Figure 02
Common Migration Drivers

Digital transformation has become the IT innovation driver across all industries. As more of our daily lives and business opportunities shift into the digital world, there is a corresponding need to prioritize IT activities within an organization. The huge shift has been very disruptive for organizations as existing systems, and operational models failed to adapt quickly enough to meet business needs. This has led to cloud and shadow IT becoming a lightning rod of innovation that happened outside the watchful eye of central IT management. With the success of this model now organizations looking for ways to implement that innovation, supporting their overall sustainability goals.

ordered, installed, and ready to deploy applications. Infrastructure from multiple hardware and software vendors leads to separately managed operational silos, relying heavily on multiple IT staff with different areas of expertise. Without centralized management, achieving security and compliance is challenging. When there is a problem, support issues may get stuck in circular finger pointing where vendors blame one another. Even with careful planning, upgrades may run into complications and operational risk may arise from interactions between products from different vendors. Moreover, each product in this type of legacy stack is likely to be grossly overprovisioned, using its own resources (CPU, memory and storage) to address the

intermittent peak workloads of resident applications. The value of a single shared resource pool, offered by server virtualization, is still generally limited to the server layer. All other components, such as networks and storage, are islands of overprovisioned resources that are often not shared and underutilized. The low utilization of the overall stack results in the ripple effects of high acquisition of space and power costs. Excess resources are wasted in traditional legacy environments.

The physical infrastructure consists of complex hardware silos that are difficult to manage or automate. Regular maintenance tasks and hardware outages require expensive downtime. Mitigating the problem using dedicated standby hardware is expensive. The hardware-centric architecture creates additional operational inefficiencies e.g. the limited CPU capacity in running applications, a single operating system image per machine and inflexible infrastructure that is difficult to troubleshoot.

These problems can be mitigated by trading off a highly flexible choice of vendors and applications for building the infrastructure with a more standardized infrastructure that is easier to support and maintain. Traditional IT can use product compatibility lists to help alleviate multi-vendor support issues by reducing the scope of solutions that can be considered for use to products included in the compatibility list. However, without easy automation solutions and with limited IT staff, achieving compliance remains challenging.

Both converged and hyperconverged infrastructures help IT organizations standardize the choice of multi-vendor products, thereby reducing the time, cost and risk of deployment, configuration and management of separate hardware and software components. Converged infrastructure is largely integrated systems, where an entire solution is built and sold as a single pre-validated and qualified unit. CI systems take the responsibility of system integration and validation of infrastructure components off the hands of customers and assure lifecycle management. Customers can spin up virtual machines, containers and even bare metal servers without having to worry about selecting, integrating or upgrading the infrastructure. A custom management interface and a combination of professional services for setup and upgrades shortens the time to get the solution running.

Hyperconverged infrastructure (HCI) is one of the foundations for SDDC architecture and implementation. Nevertheless IT departments have a number of choices for their specific environment and starting point, like VMware, Openshift on bare metal and others. For the full-stack implementation the growing number of Tools requires careful considerations and decisions. HCI uses software-defined technologies to provide compute, storage, and networking infrastructure services rather than using traditional purpose-built hardware components for each specific domain. HCI software defines the storage that is installed inside individual servers into a single, shared pool of storage and then runs workloads on those same servers. HCI is usually deployed on standard server components; providing a simplified scale-out architecture with intelligence and rich data services moved to the software layer. With a much narrower set of potential hardware and software combinations, HCI vendors more thoroughly test their hardware and software stack, providing easier software and hardware upgrades. Organizations are transforming from traditional do-it-yourself infrastructure to adopting CI and HCI solutions to help them meet their business IT challenges. With CI and HCI infrastructures, multiple pre-engineered and pre-integrated components operate under a single controlled architecture with a single point-of-management and a single source for end-to-end support. HCI provides a localized single resource pool that enables a higher overall resource utilization than can be achieved with legacy infrastructure. Overall TCO (total cost of ownership) for an HCI based architecture is lower with operational savings from simplified management. In the data center, HCI typically has a smaller footprint with less cabling and can be deployed much faster and at lower total cost than traditional infrastructure. The on-prem private cloud implementation can even outperform the public-cloud costs.

“Hyperconverged infrastructure (HCI) is one of the foundations for SDDC architecture and implementation. Nevertheless IT departments have a number of choices for their specific environment and starting point, like VMware, Openshift on bare metal and others. For the full-stack implementation the growing number of Tools requires careful considerations and decisions.”

"Overall TCO (total cost of ownership) for an HCI based architecture is lower with operational savings from simplified management. In the data center, HCI typically has a smaller footprint with less cabling and can be deployed much faster and at lower total cost than traditional infrastructure. The on-prem private cloud implementation can even outperform the public-cloud costs."

Industry infrastructure deployment is transforming as customers begin to shift from a "build" to a "consume" approach. This shift is driven by the need for IT to focus limited economic and human capital resources on driving business innovation. As a result fewer resources are available to focus on infrastructure. While a "build-your own" deployment strategy can achieve a productive IT infrastructure, this strategy can be difficult and lengthy to implement, vulnerable to higher operating costs and susceptible to greater risk related to component integration, configuration, qualification, compliance and management. A "consume" deployment strategy for HCI provides the benefits of previously integrated, configured, qualified and compliant components. Purchasing a HCI system provides a single optimized IT solution that is quick and easy to deploy. A "consume" deployment strategy for HCI provides a simple and effective alternative to "build-your-own", proven by its widespread adoption.

Virtualization transforms physical systems into a virtual environment by creating a logical version of a device or resource - anything from a server to an operating system. Virtualization helps solve problems with utilization and rapid scalability. Without virtualization, traditional server utilization is typically 6% to 12%. Traditional hardware comes in standard sizes making it hard to scale and fully utilize. Virtualization allows organizations to purchase more powerful equipment with better performance and put many optimally-sized virtualized resources on it.

Technologies such as overprovisioning, automatic load balancing, clustering and parallel processing optimize resources and improve uptime. Virtualization technology emulates hardware using software that hides details of the underlying physical hardware. Multiple hardware components and the functionality of that hardware can be efficiently emulated on less expensive, non-specialized hardware. Server virtualization is a mature and proven technology with high adoption rates in data centers of all sizes. Both storage and network virtualization are growing trends.

Storage virtualization groups physical storage from multiple storage devices to appear like a single storage device. Software-defined storage includes storage virtualization and goes further to abstract all storage services from hardware devices using software to create, deploy and manage storage resources and infrastructure. SDS enables expensive proprietary storage solutions to be replaced with software-defined storage that utilizes x86 technology. By utilizing industry-standard x86 technology, SDS helps eliminate the need for SAN and proprietary storage expertise. Organizations can also reduce their storage footprint, thereby lowering hosting and cooling costs. Software-defined networking is a computer networking architecture that separates the data plane from the control plane in routers and switches. While the control plane is implemented in servers using software and is separate from networking hardware, the data plane is implemented in networking hardware. In traditional networking, when a data packet arrives at a switch or router, the firmware tells the hardware where to forward the packet and sends all packets to that destination via the same path. All packets are treated the same. More advanced smart switches equipped with ASIC recognize different types of packets and treat them differently based on the ASIC programming. These switches, however, are expensive. SDN decouples networking control from the hardware's firmware. The network administrator can centrally configure network traffic without changing the settings of individual switches. The administrator can change network rules, prioritization and selectively block packets with greater control. SDN provides better control of network traffic and offer better security options while using less expensive commodity switches as the underlying hardware layer. NTT has developed a complementing product SD-WAN enabling optimal NW bandwidth and package transport capabilities utilizing customers' existing WAN infrastructure, but enhanced by our global backbone network.

3. SDDC & HybridCloud Solution approach

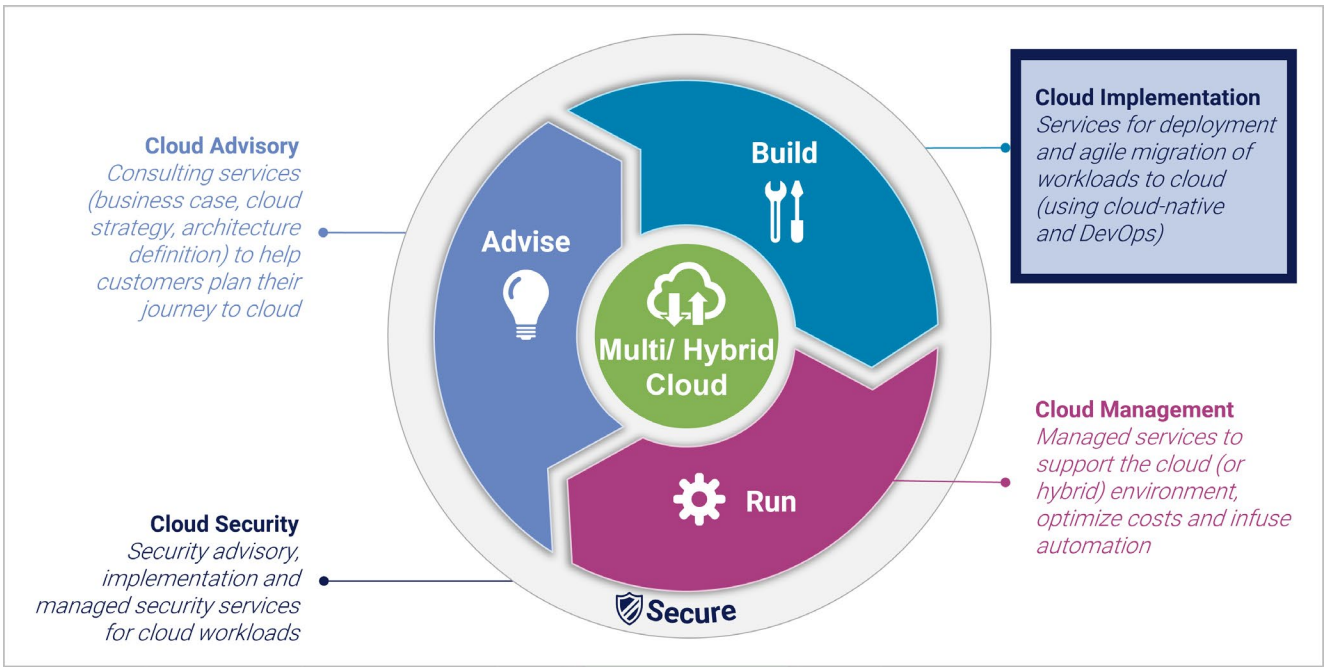


Figure 03
Flexible Cloud Transformation Services

Creating a solid foundation for a hybrid IT delivery model, instead of managing fixed IT assets and delivering IT by traditional means, would require IT to act as a broker of IT services from a range of delivery models — traditional as well as private, public, and managed clouds. This is widely known as a hybrid IT delivery model. Our SDDC offering covers the entire IT infrastructure — server, storage, network, facilities, security, and resources — both physical and virtual, and supports the end-to-end process.

Control of the data center becomes entirely automated by software with applications making the requests for IT infrastructure resources. To deliver SDDC, workloads and applications are abstracted from the infrastructure then provisioned through either a physical or virtualized infrastructure —whichever is appropriate to a given workload and meets the financial and availability targets set by the business.

SDDC reflects the next generation of converged infrastructure from a control and management standpoint. Implemented based on an holistic approach and adopted customizable services, SDDC enables IT to optimize the rapid creation and delivery of business services, through policy-based automation, from the infrastructure up to the application using a unified view of physical and virtual resources. To facilitate the move to SDDC, we provide the foundation, framework, and a rich portfolio of intelligent software-defined products and software solutions that have been engineered specifically for the transformation of IT, to deliver for the future to the new business demands.

To help customers personalize and begin their journeys at the point and pace most acceptable to them, we offer a comprehensive portfolio of professional services. We understand that organizations will evolve their data centers at different speeds. Abstracting more of their workloads (from the underlying infrastructure) or automating more of their existing processes will only get them so far. Without rethinking the overall data center strategy, architecture, governance, and operations, most organizations will hit a speed bump or two as they strive to become more agile, efficient, and service-oriented. This is exactly where our experts can help. We remove the major barriers to your strategic moves to a software-defined data center, so you can realize such enhancements as economies of scale, enhanced IT resiliency, and vastly improved services levels. For example, without rethinking how siloed organizations share their operational data, you can't obtain a unified view of physical and virtual resources. If your facility management system fails to communicate with your IT management systems, you cannot optimize the capacity planning for efficiency. Similarly, without an automated, proactive, solution-based model, your data

Agility

- Build on your innovation foundation

Operational Efficiency

- Focus on your core business by utilizing freed up resources and cost savings

Reduced Risk

- More resilient IT model enables a secure and proven approach to migration

Figure 04
Migration Business Outcomes

center cannot achieve desired resiliency standards. Journey to the New Style of IT Knowing where you are in terms of capability and maturity—and where you want to go—is critical for success, and you'll need to define a journey or roadmap. During the journey, the IT value delivered to the business in terms of speed, cost, and simplicity increases. At each stage, resources become more interrelated and integrated—they start to converge. Many organizations are at an early stage in this journey. IT sprawl needs to be consolidated and standardized. Resources will be converged until they constitute a hybrid model, where each resource is totally integrated with the other in real time, and there is complete alignment between the business and IT.

This can only be achieved by understanding where you are now and where you want to go, and by avoiding the gaps and traps found in between each of the stages of the journey. As you move through the journey, the level of data center convergence will increase and become more agile as software-defined functions and technologies mature and expand. It is important to build the right IT infrastructure foundation at each stage. By increasing the openness and flexibility of your infrastructure, you can embrace the benefits of a software-defined world. To help you through this process, we provide blueprints, models, and best practices to help you do it right from the start and minimize continuous restructuring costs.

Building blocks of our SDDC and HybridCloud approach

The path to a software-defined data center requires interrelated activities that support the increasing

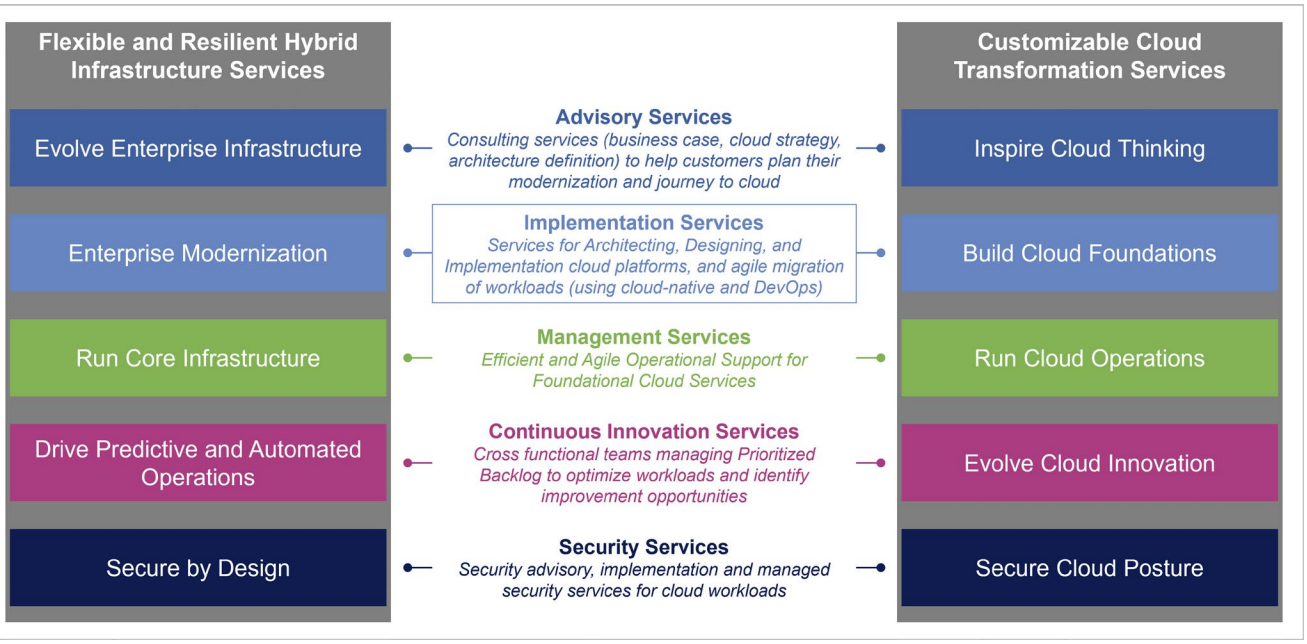


Figure 05
Enabling a Bimodal Cloud and Hybrid Infrastructure Services

level of convergence and resulting level of alignment between IT and the business. We defined an approach to simplify this process. Each block represents a specific set of interrelated activities that will allow you to move toward SDDC in the sequence and at a pace that take full advantage of your resources and budget. Our approach to SDDC and Hybrid Infrastructure Services:

Advisory Services

Our consulting services support customers from the beginning with their cloud journey, advising on implementation of a flexible and resilient Hybrid Infrastructure, based on the SDDC architecture, which provides immediate, quantifiable benefits. By utilizing customized building block NTT delivers substantial business and technical benefits immediately without the risk of a "big bang" approach. With that moving towards the SDDC as a safe investment for the future. The following describes each of our building blocks:

Implementation Services

Architecting, Designing and Implementation of a customized cloud platform enables the simplification and standardization of the applications on modern operating systems and platforms. Agile migration of workloads involves moving applications (and potentially legacy applications) off legacy operating systems and platforms onto modern ones. This migration requires the removal of obsolete hardware and software, which tend to be complex and expensive to maintain, and their removal can significantly reduce operating expenses. It is often difficult to upgrade, consolidate, and converge legacy platforms that are not yet ready for cloud or the delivery of IT as a service. Older servers and devices may be slow, costly to maintain, complex to manage, and may be distributed throughout many different data centers and IT sites. They may also be unable to support the dynamic allocation of computing resources through virtualization, which is critical for a successful transition to cloud computing. In addition, the applications will have the necessary APIs added to enable the application to interact with the SDDC control layer.

Defining the "Landing Zone"

The activities within this building block define when and how IT resources are abstracted from the underlying technology to satisfy application service requests. IT resources (servers, network and storage) are abstracted from their physical implementation in order to improve flexibility, asset utilization, and response time. The definition of the landing zone involves virtualizing not only servers but also storage and networking assets. With the applications available on modern operating systems and platforms, customers IT and business get choices to decide where they are to be hosted in the future.

Some application services might be suitable targets for hosting on cloud environments, some will be suitable for consolidation, others for virtualization, and some applications might be best hosted on emerging technologies, such as GPU supported HPC architectures.

Management Services

The activities within this building block provide for the management of the physical and virtual resources into a single pool capable of being managed from one location with converged tooling. Further, there is a need to integrate infrastructure management with facilities management in order to optimize the supply and demand for IT resources. Data center infrastructure management is a specific industry approach for managing IT and facilities infrastructure assets. Today's DCIM capabilities do not take into consideration the elements of applications — or the more complex details of IT infrastructure—that provide businesses with detailed operational capabilities beyond just infrastructure, as most DCIM products are highly proprietary with little interoperability capabilities. Managing a software-defined infrastructure requires an approach that aligns how people interact with complex and highly dynamic systems. To really increase productivity, the management software for the SDDC must enable infrastructure resources to be defined once and instantiated multiple times, facilitate collaboration across multiple domains of expertise, help IT and facility administrators assess the impact of changes to their environment quickly, and enable greater automation through programmatic access to monitoring and control functions.

Continuous Innovation Services

The activities within this building block are designed to create the SDDC with the exact level of capability and maturity aligned to the ever-evolving needs of your business. Here, continual process improvement is the order of the day. Built into NTT's support model the evolution of IT service capabilities, define required target improvements, this helps IT and business to achieve their defined goals on time and within budget. The evolution and continuous innovation of the SDDC begins with elevating your organization from its siloed state, optimizing it for efficiency, and moving toward a service-enabled organization. These steps will be followed by the achievement of a hybrid

delivery model and the arrival at the point where IT is providing dynamic reconfigurable services. Each step includes the evolution of many aspects of customers IT organization, including people, policies, processes, products, and proof of value compared to predefined target measures.

Security Services

Only an intrinsic, holistic and universal management of the software-defined data center's security, continuity, and management software provides the necessary protection against logical and physical threats. Those are analyzed uniformly to produce a holistic risk profile of the SDDC implementation. Data center operations and orchestration platforms are integrated with security information and event management systems to support unified threat analytics. Compensating measures are automatically applied to address emerging threats. For example, assets registered in within the organization's configuration management database contain configuration items related to security and continuity. When an application making a service request is detected as containing credit card information, only servers, storage, and network segments rated as PCI-compliant are abstracted.

SDDC Automation

An absolute prerequisite for building an effective SDDC and supporting a hybrid or even multi cloud delivery model is a fully integrated Automation layer. For example, the move to cloud through SDDC is a process, not a project. It requires automating infrastructure elements as well as integrated business processes and service delivery, based on a SelfService catalog, enabling the business and DevOps to consume the implemented services. To realize the speed of requested services delivery enabled by a Service portal, organizations need to automate where possible. Automation can be used to streamline and optimize a wide range of tasks — bare-metal provisioning of physical and virtual machines, servers, networks, storage, and databases; compliance reporting; operating system or security patch management; configuration updates; and all additionally required business process related tasks. It can be applied to automate tasks, processes, and service delivery time. Through automation, IT departments can standardize their tools and processes and achieve new levels of consistency and accuracy. Especially, if the underlying architecture also enables API based consumption and aggregation of services towards bigger service blocks.

Designing the Architecture and the Service Catalog

Based on the requirements and specific starting point a customized SDDC Architecture has to be developed. This is the start of the journey to move from the inflexible, asset-based definition of IT to a service-oriented view, where there will be a need to assemble a set of fully articulated IT services. This requires looking outward to internal and external customer needs, instead of internally to IT assets and processes. The first step is to define the specific IT services, with a focus on three key elements — customers (the "who"), suites of services (the "what"), and SLAs (the "how well"). With the portfolio of IT services defined, a consumable service catalog of standard, repeatable IT services aligned to business needs, which delivers real IT value is created. The service catalog clarifies what the individual services are, how to order them, when to expect the transaction to be completed, and what to do if expectations are not met. Typically, a portal is created to allow users to interact with the service catalog.

Unit based consumption and billing

Only if the infrastructure is enabled for chargeback and report-back, allows to allocate the usage of resources to the specific consumers of those resources. With IT departments facing growing pressure to control costs and demonstrate responsible financial management of IT resources, services need to be delivered cost-efficiently. One way to contain costs is to implement an effective chargeback system that enables organizations to identify what IT services are being provided and what they cost, to allocate costs to business units, and to manage cost recovery. Under this model, both the IT service provider and its respective consumers become aware of their IT service requirements and usage and how they directly influence the costs incurred. SDDC provides public cloud alike SelfService, unit based resource consumption.

Consultative Architecture approach

A robust architectural approach and software-defined technologies that include methodologies, project lifecycle and management, and solution architecture. Our solution architecture and consulting methodology ensures that the enterprise architecture governs the development of all solutions based on business, functional, and technical and implementation requirements and decisions.

Our SDDC architecture ensures that your organization takes full advantage of the latest software-defined server, storage, and networking products and technologies from NTT and our partners. For example, our SDN provides an end-to-end solution to automate the network, from data center to campus and branch. Expanding the innovation of SDN, the NTT SDN ecosystem delivers resources to develop and create a marketplace for SDN applications. We also offer storage for the SDDC, with programmatic control of infrastructure via open and standards-based APIs.

The application specific orchestration environment is a defining requirement in our SDDC. In order to build a solid foundation and integrate SDDC within your existing IT environment, it is important to have an overall blueprint. A blueprint protects existing investments and helps make the right decisions that provide the long-term flexibility and agility needed to meet the increasing demands of the New Style of IT. Our SDDC architecture blueprint gets you started and steers you in the right direction toward advancing the maturity of your SDDC environment.

Our architecture is based on the use of open standards to enable compatibility with software-defined technologies. Our architecture blueprint addresses business, functional, technical, and implementation requirements — a layered approach essential to total alignment of the SDDC ecosystem to support your business needs.

Organizational Change Management

The journey towards SDDC, the degree of integration between the IT infrastructure, facilities, delivery model and organization will change, based on changing market demands, defined IT Strategy, e.g. from "Public-cloud first" to "Smart Hybrid Cloud". Focusing on technology alone is not sufficient to achieve the necessary adoptions, as the organizational impact in terms of people, process and governance are critical factors that define the difference between success and failure. This alignment requires a solid understanding of how people, skills, structure, roles, metrics, process and governance all need to change throughout the journey to support the new IT models. Advisory will become crucial to anticipate these changes and ensure correct implementation supported through a holistic organizational change management (OCM) program. Partnership between business and IT will increase along with the implemented changes and achievements. There are various tools and models that can help in understanding where the gaps are and how they should be filled. Especially in times of resource shortages and huge demand for specific skills NTT may provide relief ensuring scalability and re-skilling for the envisioned journey.

4. NTT DATA POV SDDC / HybridCloud

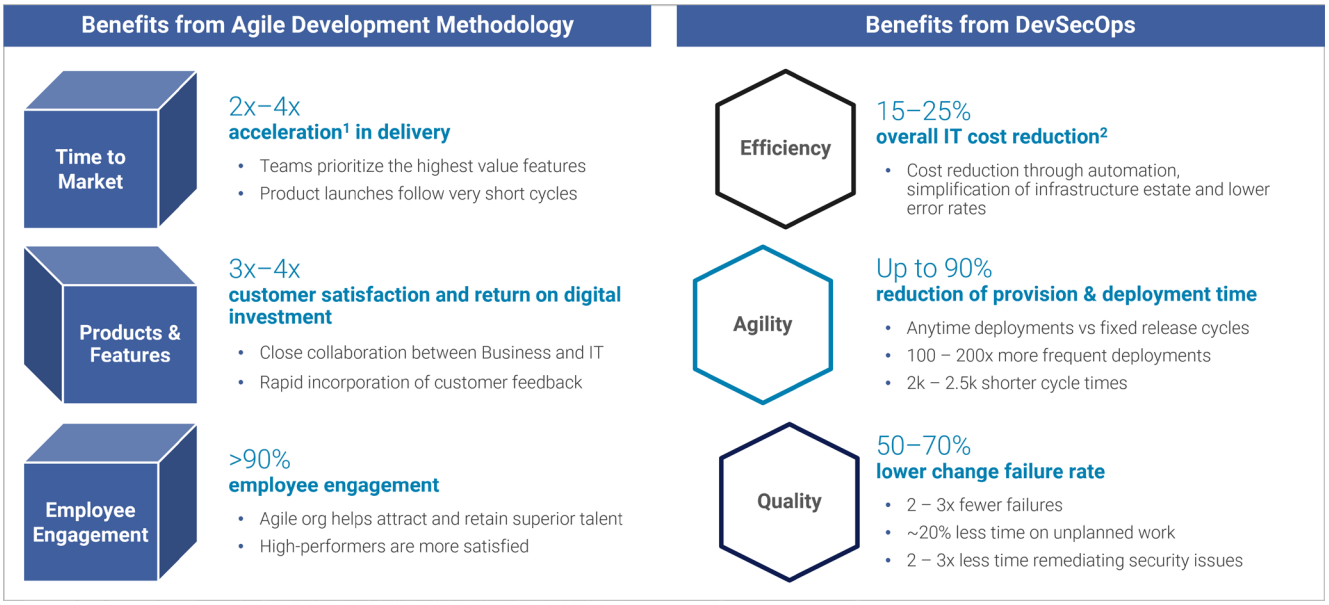


Figure 06
New Ways of Working Improves in Efficiency, Agility and Quality

Certainly SDDC cannot resolve all of the existing issues related to efficiency, agility and quality demands of business and IT within any customer environment, but doing it right it is the enabler for fast and sustainable changes. The demand for processing huge data created to enable digital business, digital transformation of production facilities to the next level, utilization of new technologies like 5G/WiFi6 and accelerated cloudification require a robust, proven and multi-cloud ready architecture. Starting with pre-processing of data at the "edge", where those are generated by IoT devices, cars, medical devices, vehicles, etc., regional consumption and exchange for digital business, central processing in classical data center environments, up to processing in public-clouds – SDDC can be the solution for a seamless integration platform. Customers IT have a number of choices related to their specific situation and starting point, classic VMware centric IT may build on their existing and established platform skills extending their Hypervisor / VDI environment to a Hybrid MultiCloud. Others may decide for a baremetal OpenSource implementation running their workloads as containers. Legacy applications can be containerized enabling shut-down of big hosts and associated license models. With greenfield built SDDC, organizations are enabled to move very fast from CAPEX intense owned IT to OPEX based consumption models, buying in into the freedom of choices, where workloads will run in the future.

SDDC enabled HybridClouds will allow IT and business a seamless, accelerated transformation for their digital business, digital transformation and cloudification with low risk – gain cloud like agility and high-performance!

5. NTT DATA Offering

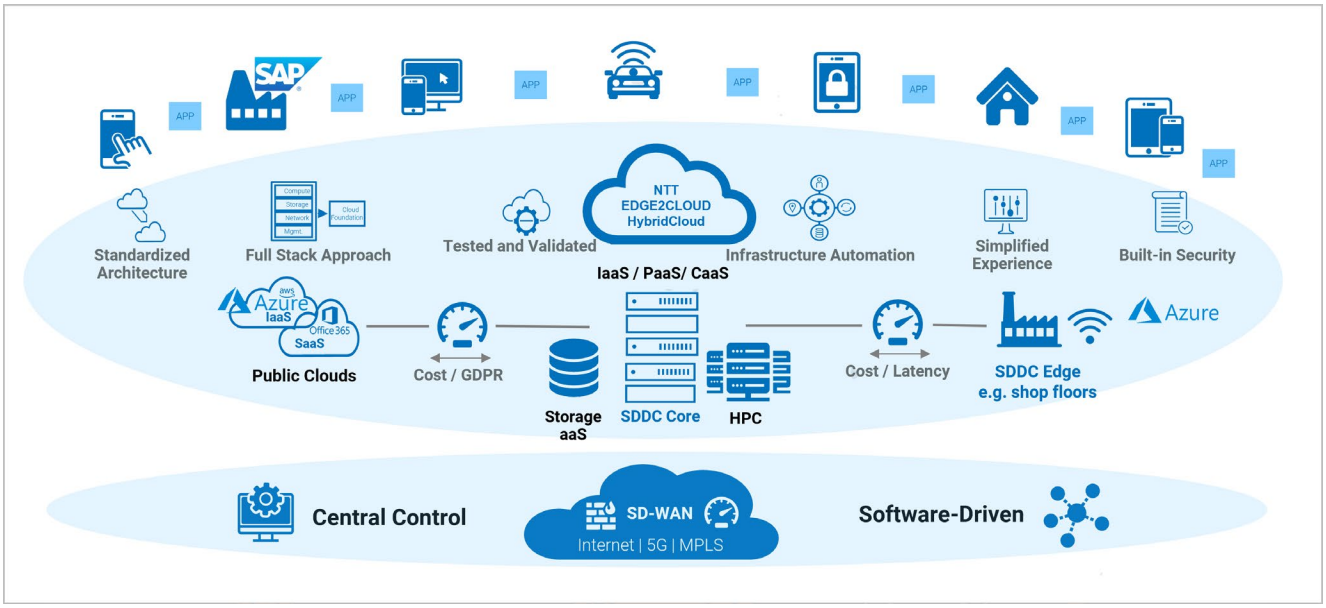


Figure 07
Hybrid Strategy – Challenges of Complexity

SDDC reduces the overall challenges and complexity

As shown in the picture above NTT provides a holistic services portfolio for SDDC implementation.

The fundamentals of the offering are a customized standardized Architecture, with a full stack approach, tested and validated design, including infrastructure Automation delivering a simplified experience with an intrinsic security.

The flexibility and scalability of the SDDC Architecture allows implementation at any customer within any environment, same sizable stack could be utilized as edge (next to production, telecom equipment, shops, city environment, etc.) or at remote / core data centers with public cloud integration, if required.

Customers get the freedom of choice based on specific requirements and parameters, e.g. workloads, technology, cost, latency or regulatory demands. Nevertheless by central control /management and SelfService/API software driven deployment and consumption, operational cost and skill utilization are optimized.

Finally a multi-tenant, unit consumption based model allows capex reduction converted to an up- and down-scalable opex finance model.

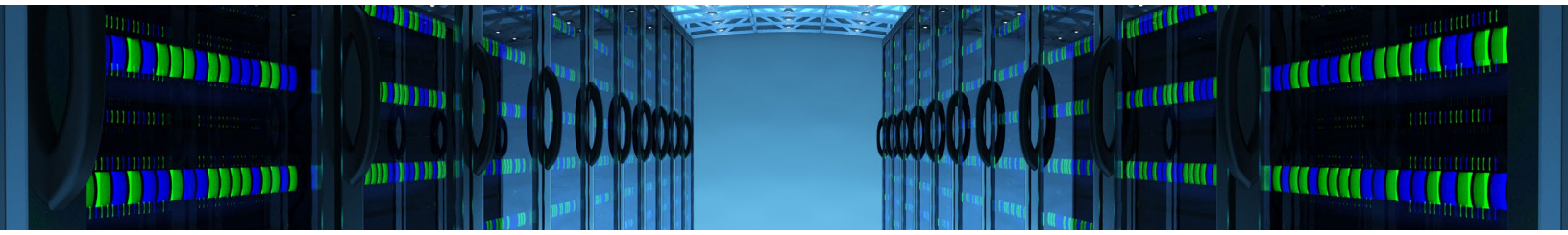
Beyond pure infrastructure NTT provides global optimized SD-WAN (traffic and cost optimized wide-area network connectivity) and required application modernization services.

According to an IDC/ Frost &Sullivan study there are two major factors that drive cloud strategies and adoption:

75% of IT leaders say cloud is the most critical part of their entire digital transformation strategy (Source: Frost & Sullivan)

93% of enterprise customers rely on multiple clouds (Source: IDC)

Here NTT offerings provide the fastest way to a flexible and granular SDDC implementation enabling digital transformation and multiple HybridCloud integration!



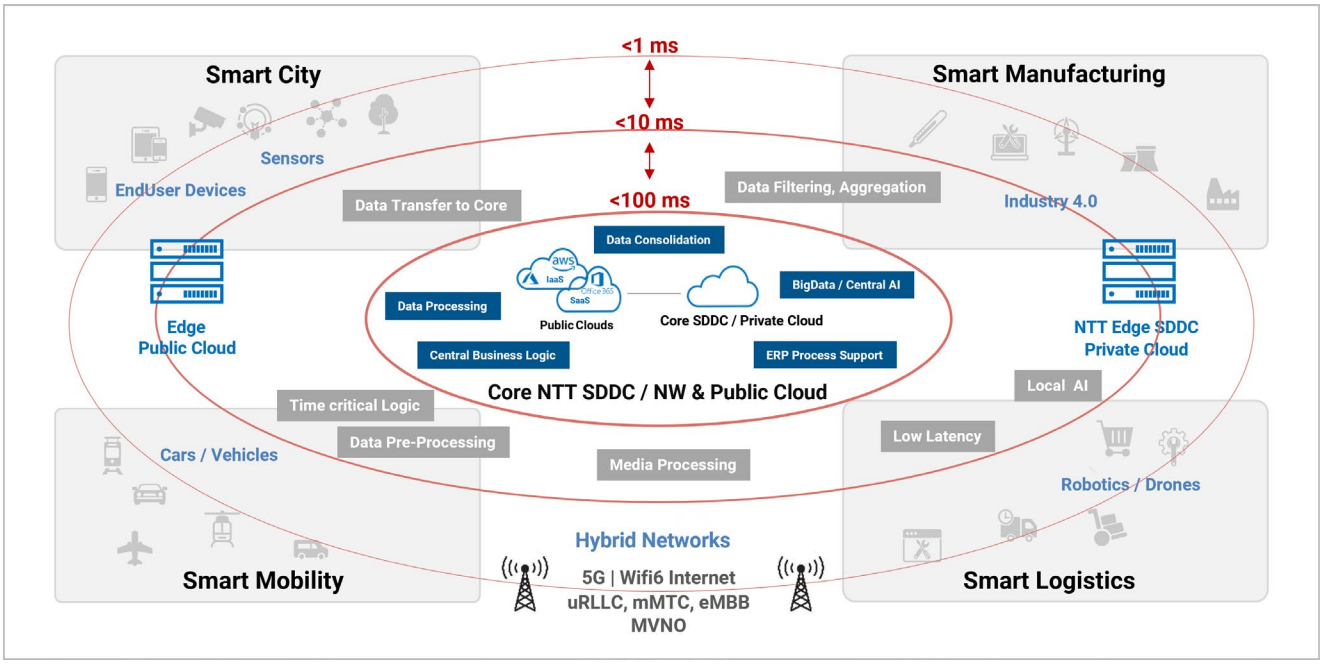


Figure 08
EDGE2Cloud – Sample Use Cases & Latency

SDDC implementations and use cases shown in the graphics above allow to build standardized solutions for the digital business. Based on the standard SDDC Architecture considering e.g. the latency requirements a number of functions may be distributed across SDDC implementations at the edge, where data are collected, while the same architecture may be scaled in the core for handling of consolidated big data.

The major NTT SDDC benefits summarized:

Software-defined data center (SDDC) solution

Combining server, storage and network virtualization together leads to a completely software-defined infrastructure. The Why, What and How of the Software-Defined Data Center (Osterman Research, May 2017) identifies the enhanced business benefits of an SDDC solution:

1. Speed and productivity of IT staff

Because of its software-defined nature, with proper tools, an SDDC is easier to configure, reconfigure and keep secure, resulting in IT operations that are more responsive to change and more efficient. Move over SDDC permits frequent service updates and rapid standup or teardown of test environments.

2. Security

The SDDC software-defined nature enables consistently enforced policies that act on logical, abstracted characteristics of the workload and its data. Traditional data center operations must distribute rules across a range of different hardware devices that will need to be manually updated with inevitable hardware and configuration changes. Relevant policies remain in place and automatically adjust to changes in the underlying physical environment of SDDC workloads.

3. Reliability

Traditional IT operations are inherently error-prone, even when using a centralized management console. SDDC's ability to automate operations reduces repetitive tedium and error, which in turn maximizes security and minimizes unplanned downtime.

4. Utilization of hardware

Virtualization increases the hardware utilization, allowing organizations to make more efficient use of their capital expenditures. For example, it allows several workloads to share software-defined computing, storage and network resources. It unifies networking functions using non-specialized hardware avoiding lock-in to specific networking equipment.

5. Enables interoperable cloud

SDDC helps organizations realize the benefits of hybrid clouds without vendor or technology lock-in. The combination of automation, abstraction, visibility and control fosters consistency that will ease the placing of workloads into public or private clouds to an even greater extent than virtualization alone would permit. The ability of cloud computing to offer solutions that

addresses the major business and IT challenges stated above is driving more organizations to use cloud computing as a key part of their IT infrastructure.

The National Institute of Standards and Technology provides a definition of cloud computing.

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models. The five essential characteristics of cloud computing are:

1. **On-demand self-service**
2. **Broad network access**
3. **Resource pooling**
4. **Rapid elasticity**
5. **Measured service**

A public cloud is formed when a cloud provider makes computing resources publicly available over the internet or other broad network channels. In a public cloud, setup for a consumer is usually quick and easy. Users pay for resources used rather than for direct hardware. Some providers also charge a subscription fee. If more resources are needed, the cloud can instantly provide them. There is no need to install additional hardware or software. One of the concerns and barriers for organizations using the public cloud is data security and governance. Private cloud describes a computing infrastructure privately held by an organization that has capabilities similar to a public cloud but is completely internal and therefore could be considered more secure based on an organization's regulatory and compliance requirements. Virtualization provides many cloud-like resources allocation features. The addition of cloud management tools can be used to build a private cloud. According to the current studies (like Gartner, IDC, Frost&Sullivan) most organizations have a strategy to use multi-cloud platforms across both public and private clouds resulting in a potentially complex multi-cloud strategy, moving from a public-cloud to a smart-cloud strategy.

According to the current studies (like Gartner, IDC, Frost & Sullivan) most organizations have a strategy to use multi-cloud platforms across both public and private clouds resulting in a potentially complex multi-cloud strategy, moving from a public-cloud to a smart-cloud strategy.

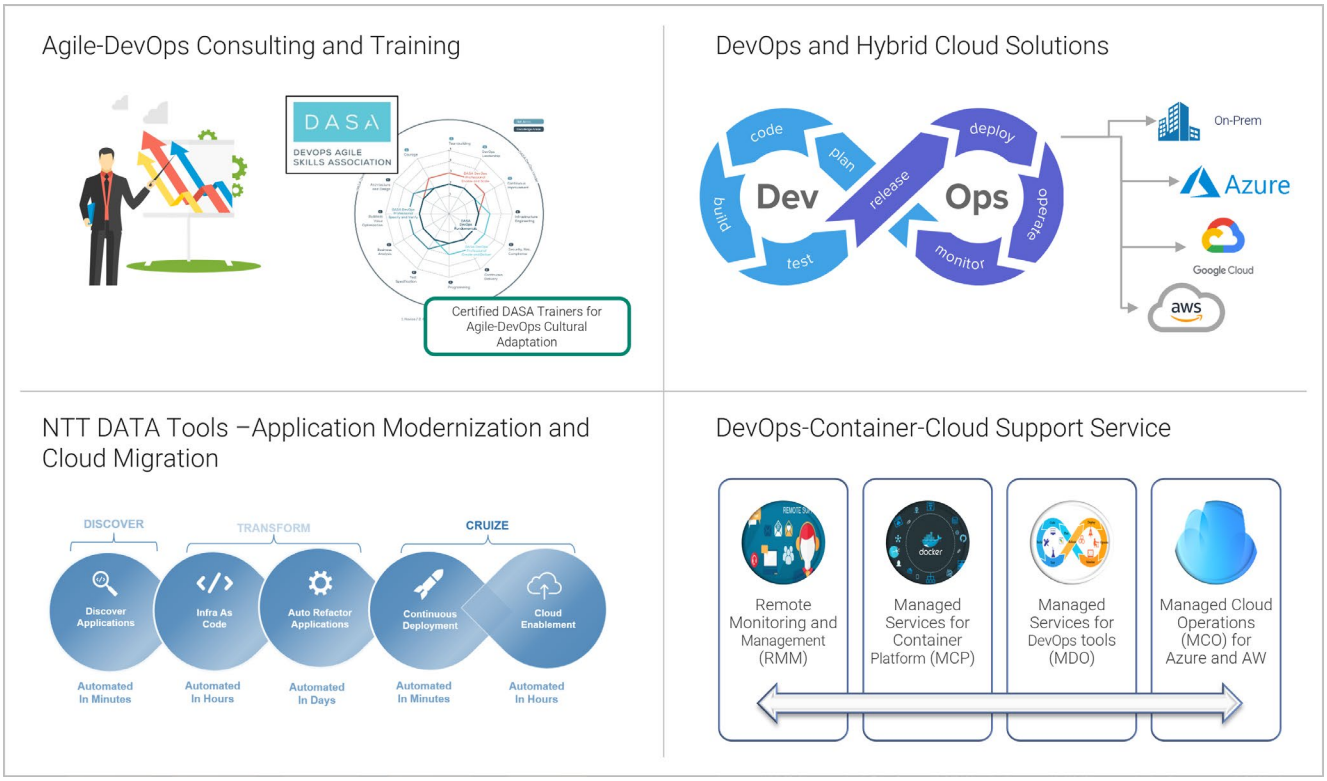


Figure 09

NTT DATA Digital Transformation Offerings in Cloud and DevOps

Please find the complementing NTT offerings for an SDDC implementation support pictured below:

All IT departments must manage their application portfolio. That portfolio is typically split into two categories: existing applications and new applications. For existing applications, customers are wrestling with managing costs and maintaining a reliable, secure environment that will keep an existing portfolio of applications extended through its logical lifespan. They are also thinking about how they can add new capabilities and features to enhance and extend the value of existing applications. At the same time, they are prioritizing new built-in-the-cloud applications focused on differentiating their business from their competition. As they wrestle with this dual portfolio, customers have a number of options on how to support legacy applications. They can choose to maintain applications unchanged, but in an increasingly virtualized and enhanced environment. They can also choose to move applications to the cloud and re-platform, hopefully with as little cost or effort as possible. They can refactor or rebuild applications for the cloud, build brand new apps in the cloud or replace them with a set of SaaS applications. Each of these decisions are based on business priorities and this is driving cloud adoption and strategies.

For many organizations, this increasingly diverse application landscape is resulting in an enormous amount of IT complexity — over 93% of organizations are deploying their workloads across two or more clouds. This multi-cloud approach grows increasingly complex — multiple operational silos resulting from disparate management and operations tools, increasingly complex application and infrastructure lifecycle management — ultimately delivering inconsistent SLAs. Solving this complexity is one of the biggest IT challenges.

Customer workload needs are changing, sometimes wanting to extend things out to a public cloud, and at other times wanting to bring things back on-premises. Almost every study shows that organizations desire to use a variety of cloud platforms across both public and private clouds. When ESG surveyed CIOs, 91% of respondents reported that their company's cloud strategy would include on-premise data centers where many have found some workloads realize 2-4x savings versus public cloud alone. There is a desire to future proof cloud decisions and provide flexibility through a hybrid cloud strategy. However, to do so effectively, customers must simplify the multi-cloud complexity challenge. Customers value a hybrid cloud strategy, which addresses the biggest issue regarding extension across on-premises and off-premises, with 83% of customers stating that they value consistency of infrastructure from data center to cloud.

6. Benefits & Conclusion

The Software-Defined Data Center (SDDC), a proven architectural approach based on virtualization and automation, drives many of today's leading data centers. Our approach enables companies to adopt SDDC technologies at their own pace, without having to rip and replace the existing infrastructure.

Our architecture for the SDDC enables IT to adopt a hybrid cloud strategy and empowers enterprises to achieve outcomes that enhance efficiency and security while achieving faster time to value for new IT projects. It gives individual technology organizations the flexibility to reimagine their role within IT and enables the broader IT organization to become a strategic partner to the business.

Based on complementing services NTT is positioned as a full-stack partner for your digital business, digital transformation and cloudification. As shown the SDDC Architecture is capable to be implemented at any size within any industry enabling Multi-Cloud integration, accelerating the IT modernization, capex to opex conversation, digital business, application modernization and overall digital transformation.

As shown the SDDC Architecture is capable to be implemented at any size within any industry enabling Multi-Cloud integration, accelerating the IT modernization, capex to opex conversation, digital business, application modernization and overall digital transformation.

Abbreviations

API
Application Programming Interface

ASIC
Application-specific integrated circuits

BC
Business Continuity

CI
Converged Infrastructure

CI-CM
Converged Infrastructure Capability Model

CMDB
Configuration management database

CPU
Central processing unit

DCIM
Data Center infrastructure management

DR
Disaster Recovery

E2C
Edge2Cloud

ESG
Environmental, Social and Governance

GPU
Graphics processing unit

HI
Hyperconverged Infrastructure

HPC
High performance computing

IOT
Internet of Things

IP
Internet protocol

LOB
Lines of Business

NIST
National Institute of Standards and Technology

OCM
Organizational Change Management

PCI
Payment Card Industry

POV
Proof of Value

SaaS
Software-as-a-service

SAN
Storage Area Network

SDDC
Software-defined Data Center

SDN
Software-defined Network

SDS
Software-defined Storage

SLA
Service level agreement

TCO
Total cost of ownership

Authors

Marijan Veseljak is a Principal Solution Architect at NTT DATA Services Germany. He has worked in the IT area since 1984 and held various roles in leading IT companies including EDS, Perot Systems, Dell Services.

His previous roles included Software Architect, Network Consultant, Data Center & Infrastructure Consultant, ITSM Service Manager and Infrastructure Client Delivery Manager.

As Principal Solution Architect he mainly focuses on the design and implementation of EUC and Infrastructure Solutions for cross-industry customers. In addition, he's a member of the NTT DATA Global Industry Team focusing on Infrastructure, 5G Solutions and business development for Mobility, Automotive, Healthcare & Life Science and Cross Industries.

Special thanks to:

- **Gustavo Filip** | NTT DATA Japan, Head of Cross Industry Solutions
- **Sai Sakar** | NTT DATA Japan, Head of Global Automotive & Telecom

References — Pictures

Page 1: Imagine Photographer / Royalty Free
Page 5: Modernizing Traditional IT / Royalty Free
Page 6: Common Migration Drivers / Royalty Free
Page 9: Flexible Cloud Transformation Services / Royalty Free
Page 10: Migration Business Outcomes / Royalty Free
Page 10: Bimodal Cloud and Hybrid Infrastructure Services / Royalty Free
Page 14: Benefits from Agile Development Methodology and DevSecOps / Royalty Free
Page 15: Hybrid Strategy – Challenges of Complexity / Royalty Free
Page 16: EDGE2Cloud – Sample Use Cases & Latency / Royalty Free
Page 17: NTT DATA Digital Transformation Offerings in Cloud and DevOps / Royalty Free

About NTT DATA

NTT DATA – a part of NTT Group – is a trusted global innovator of IT and business services headquartered in Tokyo. We help clients transform through consulting, industry solutions, business process services, IT modernization and managed services. NTT DATA enables clients, as well as society, to move confidently into the digital future. We are committed to our clients' long-term success and combine global reach with local client attention to serve them in over 50 countries.

Visit us at nttdata.com

Contact:

Marijan Veseljak, Principal Solution Architect
Global Solution Design Center (GSDC)
NTT DATA Services Germany
M.Veseljak@nttdata.com

NTT DATA
Trusted Global Innovator

