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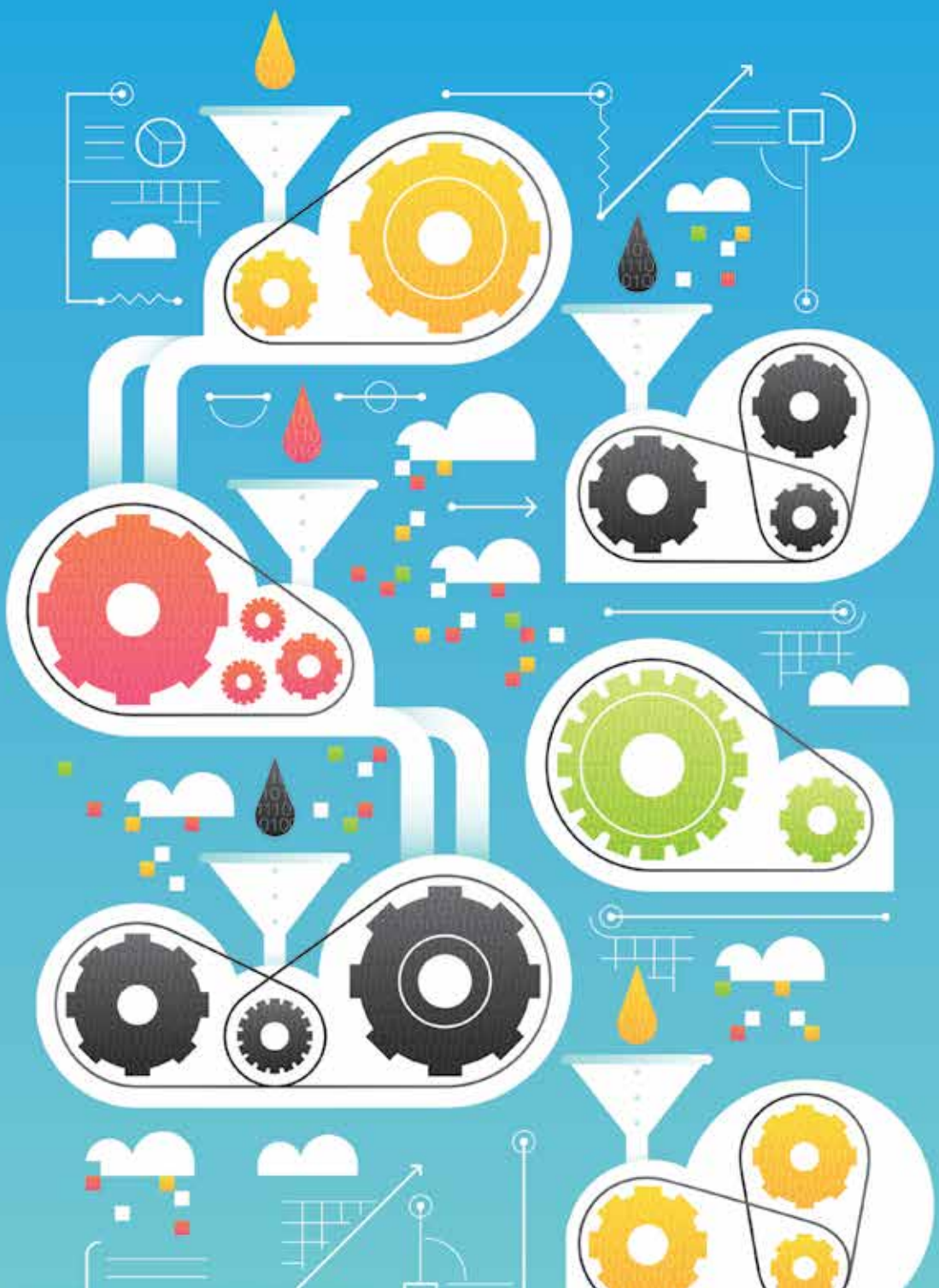
Chapter extract

Software-defined everything

Breaking virtualisation's final frontier



Software-defined everything

Breaking virtualisation's final frontier

Amid the fervour surrounding digital, analytics and cloud, it is easy to overlook advances currently being made in infrastructure and operations. The entire operating environment – server, storage and network – can now be virtualised and automated. The data centre of the future represents the potential for not only lowering costs, but also dramatically improving speeds and reducing the complexity of provisioning, deploying and maintaining technology footprints. Software-defined everything can elevate infrastructure investments, from costly plumbing to competitive differentiators.

VIRTUALISATION has been an important background trend, enabling many emerging technologies over the past decade. In fact, we highlighted it in our very first *Technology Trends* report six years ago.[1] While the overall category is mature, many adoptions focused primarily on the compute layer. Servers have been abstracted from dedicated physical environments to virtual machines, allowing automated provisioning, load balancing and management processes. Hypervisors – the software, firmware or hardware that control virtual resources – have advanced to a point where they can individually manage a wide range of virtual components and coordinate among themselves to create breakthroughs in performance and scalability.

Meanwhile, other critical data centre components have not advanced. Network and storage assets have remained relatively static, becoming bottlenecks limiting the potential of infrastructure automation and dynamic scale.

Enter software-defined everything. Technology advances now allow virtualisation of the entire technology stack – computer, network, storage and security layers. The potential? Beyond cost savings and improved productivity, software-defined everything can create a foundation for building agility into the way companies deliver IT services.

Network building blocks

Software-defined networking (SDN) is one of the most important building blocks of software-defined everything. Like the move from physical to virtual machines for compute, SDN adds a level of abstraction to the hardware-defined interconnections of routers, switches, firewalls and security gear. Though communication gear still exists to drive the physical movement of bits, software drives the data plane (the path along which bits move) and, more importantly, the control plane, which routes traffic and manages the required network configuration to optimise the path. The physical connectivity layer becomes programmable, allowing network managers – or, if

appropriate, even applications – to provision, deploy, and tune network resources dynamically, based on system needs.

SDN also helps manage changing connectivity needs for an increasingly complex collection of applications and end-user devices. Traditional network design is optimised for fixed patterns, often in a hierarchical scheme that assumes predictable volume between well-defined end points operating on finite bandwidth. That was acceptable in the early days of distributed computing and the Web. Today, however, many organisations must support real-time integration across multiple servers, services, clouds and data stores, enable mobile devices initiating requests from anywhere in the world, and process huge and expanding volumes of internal and external data, which can cause traffic spikes. SDN helps manage that complexity by using micro-segmenting, workload monitoring, programmable forwarding and automated switch configuration for dynamic optimisation and scaling.

Software-defined everything

The network is not the only thing being reimagined. Software-defined storage (SDS) represents logical storage arrays that can be dynamically defined, provisioned, managed, optimised and shared. Coupled with compute and network virtualisation, entire operating environments can be abstracted and automated. The software-defined data centre (SDDC) is also becoming a reality. A Forrester report estimates that "static virtual servers, private clouds and hosted private clouds will together support 58 per cent of all workloads in 2017, more than double the number installed directly on physical servers."[2] This is where companies should focus their software-defined everything efforts.

Yet, as you determine scope, it is important to recognise that SDDC cannot and should not be extended to all IT assets. Applications may have deep dependencies on legacy hardware. Likewise, platforms may have hooks into third-party services that will complicate migrations, or complexities across the stack may turn remediation efforts into value eroders. Be deliberate about what is and is not in scope. Try to link underlying infrastructure activities to a broader strategy on application and delivery model modernisation.

Show me the value

A recent Computer Economics study found that data centre operations and infrastructure consume 18 per cent of IT spending, on average.[3] Lowering total cost of ownership by reducing hardware and redeploying supporting labour is the primary goal for many SDDC efforts. Savings come from the retirement of gear (servers, racks, disk and tape, routers and switches), the shrinking of data centre footprints (lowering power consumption, cooling, and potentially, facility costs), and the subsequent lowering of ongoing recurring maintenance costs.

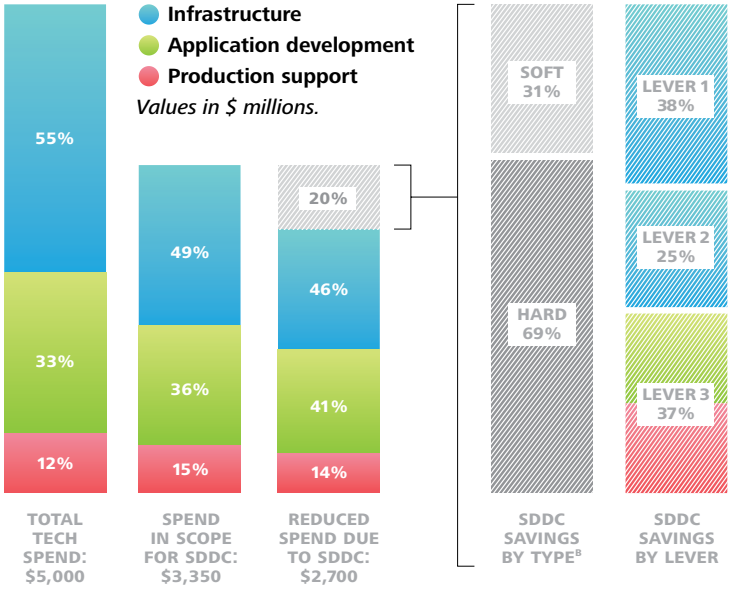
Moving beyond pure operational concerns and cost outlays can deliver additional benefits. The new solution stack should become the strategic backbone for new initiatives around cloud, digital and analytics. Even without systemic changes to the way systems are built and run, projects should see gains through faster environment readiness, the ability to engineer advanced scalability and the elimination of power/connectivity constraints that may have traditionally lowered team ambitions. Leading IT departments are reimagining themselves by adopting agile methodologies to fuel experimentation and prototyping, creating disciplines around architecture

Software-defined savings[a]

A Deloitte analysis of normalised data from software-defined data centre (SDDC) business cases for *Fortune* 50 clients revealed that moving eligible systems to an SDDC can reduce spending on those systems by approximately 20 per cent. These savings can be realised with current technology offerings and may increase over time as new products emerge and tools mature. Not every system is suited for migration; ideal candidates are those without tight integration to legacy infrastructure or bespoke platforms.

Company profile

REVENUE	$25+ billion
TECHNOLOGY SPEND	$5+ billion
EMPLOYEES	150,000+



LEVER 1: OPTIMISE INFRASTRUCTURE

Taking advantage of economies of scale, better aligning demand and supply to reduce underutilised assets, and simplifying the environment by moving to standard platforms.

LEVER 2: ORCHESTRATE INFRASTRUCTURE LABOUR

Automating labour tasks through automation and orchestration to reduce manual work, hand-offs, errors and process bottlenecks.

LEVER 3: AUTOMATE OPERATIONS

Automating development operations, particularly production support-type activities, to increase productivity and reduce support costs.

Source: [a] Deloitte Consulting LLP proprietary research.
[b] Hard savings are those that result in direct bottom-line savings, and soft savings are those that result in improved productivity and efficiency and the redirection or redeployment of labour and resources.

and design, and embracing DevOps.[4] These efforts, when paired with platform-as-a-service solutions, provide a strong foundation for reusing shared services and resources. They can also help make the overall operating environment more responsive and dynamic, which is critical as organisations launch digital and other innovative plays and pursue opportunities related to the API economy, dimensional marketing, ambient computing and the other trends featured in this report.

From IT to profit

Business executives should not dismiss software-defined everything as a tactical technical concern. Infrastructure is the supply chain and logistics network of IT. It can be a costly, complex, bottleneck – or, if done well, a strategic weapon. SDDC offers ways to remove recurring costs. Organisations should consider modernising their data centres and operating footprints, if for no other reason than to optimise their

total cost of ownership. They should also pursue opportunities to build a foundation for tomorrow's business by reimagining how technology is developed and maintained and by providing the tools for disruptive digital, cloud, analytics and other offerings. It's not just about the cloud; it's about removing constraints and becoming a platform for growth. Initially, first movers will likely benefit from greater efficiencies. Yet, soon thereafter, they should be able to use their virtualised, elastic tools to reshape the ways their companies work (within IT and, more importantly, in the field), engage customers and perhaps even design core products and offerings.

My take

Greg Lavender, Managing director, Cloud Architecture and Infrastructure Engineering, Office of the CTO, Citi

At Citi, the IT services we provide to our customers are built on top of thousands of physical and virtual systems deployed globally. Citi infrastructure supports a highly regulated, highly secure, highly demanding transactional workload. Because of these demands, performance, scale and reliability – delivered as efficiently as possible – are essential to our global business operations. The business organisations also task IT with supporting innovation by providing the IT vision, engineering and operations for new services, solutions and offerings. Our investments in software-defined data centres are helping on both fronts.

With 21 global data centres and system architectures ranging from scale-up mainframes and storage frames to scale-out commodity servers and storage, dealing effectively with large-scale IT complexity is mission-critical to our business partners. We became early adopters of server virtualisation by introducing automation to provisioning several years ago, and we manage thousands of virtual machines across our data centres. The next step was to virtualise the network, which we accomplished by moving to a new two-tier spine-and-leaf IP network fabric similar to what public cloud providers have deployed. That new physical network architecture has enabled our software-defined virtual networking overlays and our next generation software-defined commodity storage fabrics. We still maintain a large traditional fibre channel storage environment, but many new services are being deployed on the new architecture, such as big data, NoSQL and NewSQl data services, grid computing, virtual desktop infrastructure and our private cloud services.

Currently, we are engaged in three key objectives to create a secure global private cloud. The first objective focuses on achieving "cloud scale" services. As we move beyond IT as separate compute, network and storage silos to a scale-out cloud service model, we are building capabilities for end-to-end systems scaled horizontally – and elastically within our data centres – and potentially in the not-too-distant future, hybrid cloud services. The second objective is about achieving cloud speed of delivery by accelerating environment provisioning, speeding up the deployment of updates and new capabilities and delivering productivity gains to applications teams through streamlined, highly automated release and lifecycle management processes.

The results so far are measurable in terms of both client satisfaction and simplifying maintenance and operations scope. The final objective is to achieve ongoing cloud economics with respect to the cost of IT services to our businesses. More aggressive standardisation, re-architecting and re-platforming to lower-cost infrastructure and services is helping reduce technical debt, and will also help lower IT labor costs. At the same time, the consumption of IT services is increasing year over year, so keeping costs under control by adopting more agile services allows our businesses to grow while keeping IT costs manageable. Our new CitiCloud platform-as-a-service capabilities – which feature new technologies such as NoSQL/NewSQL and big data solutions along with other rapid delivery technology stacks – help accelerate delivery and time to market advantages. Packaging higher-level components and providing them to application teams accelerates the adoption of new technologies as well. Moreover, because the new technology components have strict compliance, security, and DevOps standards to meet, offering more tech stacks as part of platform-as-a-service provides stronger reliability and security guarantees.

By introducing commodity infrastructure underneath our software-defined architectures, we have been able to incrementally reduce unit costs without compromising reliability, availability and scale. Resiliency standards continue to be met through tighter controls and automation, and our responsiveness – measured by how quickly we realise new opportunities and deliver new capabilities to the business – is increasing.

Focusing IT on these three objectives – cloud scale, cloud speed and cloud economics – has enabled Citi to meet our biggest challenge thus far: fostering organisational behaviour and cultural changes that go along with advances in technology. We are confident that our software-defined data centre infrastructure investments will continue to be a key market differentiator – for IT, our businesses, our employees, our institutional business clients and our consumer banking customers.

Cyber implications

RISK should be a foundational consideration as servers, storage, networks and data centres are replatformed. The new infrastructure stack is becoming software-defined, deeply integrated across components and potentially provisioned through the cloud. Traditional security controls, preventive measures and compliance initiatives have been challenged from the outset because the technology stack they sit on top of was inherently designed as an open, insecure platform. To have an effective software-defined technology stack, key concepts around things like access, logging and monitoring, encryption and asset management need to be reassessed, and, if necessary, enhanced if they are to be relevant. There are new layers of complexity, new degrees of volatility and a growing dependence on assets that may not be fully within your control. The risk profile expands as critical infrastructure and sensitive information is distributed to new and different players. Though software-defined infrastructure introduces risks, it also creates opportunity to address some of the more mundane but significant challenges in day-to-day security operations.

Security components that integrate into the software-defined stack may be different from what you own today – especially considering federated ownership, access and oversight of pieces of the highly integrated stack. Existing tools may need to be updated or new tools procured that are built specifically for highly virtual or cloud-based assets. Governance and policy controls will likely need to be modernised. Trust zones should be considered: envelopes that can manage groups of virtual components for policy definition and updates across virtual blocks, virtual machines and hypervisors. Changes outside of controls can be automatically denied and the extended stack can be continuously monitored for incident detection and policy enforcement.

Just as importantly, revamped cyber security components should be designed to be consistent with the broader adoption of real-time DevOps. Moves to software-defined infrastructure are often not just about cost reduction and efficiency gains; they can set the stage for more streamlined, responsive IT capabilities and help address some of today's more mundane but persistent challenges in security operations. Governance, policy engines, and control points should be designed accordingly – preferably baked into new delivery models at the point of inception. Security and controls considerations can be built into automated approaches to building management, configuration management, asset awareness, deployment and system automation – allowing risk management to become muscle memory. Requirements and testing automation can also include security and privacy coverage, creating a core discipline aligned with cyber security strategies.

Similarly, standard policies, security elements and control points can be embedded into new environment templates as they are defined. Leading organisations co-opt infrastructure modernisation with a push for highly standardised physical and logical configurations. Standards that are clearly defined, consistently rolled out and tightly enforced can be a boon for cyber security. Vulnerabilities abound in unpatched, non-compliant operating systems, applications, and services. Eliminating variances and proactively securing newly defined templates can reduce potential threats and provide a more accurate view of your risk profile.

Where do you start?

THE potential scope of a software-defined everything initiative can be daunting – every data centre, server, network device and desktop could be affected. What's more, the potential risk is high, given that the entire business depends on the backbone being overhauled. To round matters out, an initiative may deliver real long-term business benefits, yet only have vague immediate impacts on line-of-business bottom lines (depending on IT cost models and charge-back policies). Given the magnitude of such an effort and its associated cost, is it worth campaigning for prioritisation and budget? If so, where would you start? The following are some considerations based on the experiences of early adopters:

- **Creative financing.** When working within traditional budgeting channels, many organisations source efforts around SDDC as net-new, one-off investments. With this approach, allocations do not affect operating unit budgets or individual line-of-business. Increasingly, organisations are looking at more creative ways to financially engineer their SDDC/SDI investments. For example, some vendors are willing to cover the up-front costs, achieving ROI from the savings realised over time. Others pursue more long-term returns by looking for ways to monetise pieces of the platform build-out.

- **Patterns.** Software-defined everything's flexibility makes it possible for each development team to potentially configure its own stack of virtual components tailored to its individual needs and circumstances, which can undermine efficiency gains. For this reason, companies should make standardisation a design mandate from day one and utilise template-based patterns. Setting a cadence of commonality from the beginning will help ease maintenance complexity, allow for better terms in supplier negotiations for underlying components (assuming the templates are geared towards non-differentiated services) and support the creation of standard policies around security, controls and monitoring that can be automatically deployed and enforced.

- **Meeting in the middle.** Drive the build-out of SDDC from the infrastructure organisation, with suitably aggressive goals. In the meantime, engage with application teams to jointly determine how best to architect for new platforms and infrastructure services. New standards, patterns and approaches will be required; by accelerating awareness, new applications can be compliant as soon as the environments are ready.

- **Not as easy as "lift and shift."** Architecture and development matter. Beyond the complexity of standing up and migrating the operating environment, the assets that run across the network, storage and servers will likely require remediation. Direct references to network addresses, data structures or server components should be redirected to the backplane. Virtualisation management tools cannot dynamically scale or failover applications that single thread, block or use primitive resource control constructs. Existing assets should be analysed application by application and workload by workload to determine the technical considerations needed to support migration. The business needs should then be layered on – both the potential benefits from the new environment, and the long-term viability of the solution.

- **Commoditisation and open stacks.** Intelligent controls and management capabilities in the software layer can also enable organisations to transition from large, expensive, feature-rich hardware components to low-end, standardised servers deployed in massively parallel configurations. Independent nodes at risk of failing can be automatically detected, decommissioned and replaced by another instance from the pool of available resources. This ability has led to an explosive growth in the number of relatively new players in the server market – such as Quanta, which sold one out of every seven servers in 2013 – as well as products from traditional large hardware manufacturers tailored to the low-end market. Various standards and implementation patterns have emerged in support of the movement, including the Open Compute Project, OpenStack, Open Rack and Open Flow.

- **Beyond the data centre.** Companies may realise numerous benefits by coupling SDDC initiatives with a broader transformation of the IT department. DevOps is a good place to start: By introducing automation and integration across environment management, and enhancing requirements management, continuous build, configuration and release management approaches, among other tasks, development and operations teams can meet business needs more consistently and drive toward rapid ideation and deployment. Software-defined everything doesn't entirely hinge on a robust DevOps function. But together, they form a powerful bedrock for reimagining the "business of IT."

Bottom line

IN mature IT organisations, moving eligible systems to an SDDC can reduce spending on those systems by approximately 20 per cent, which frees up budget needed to pursue higher-order endeavours.[5] These demonstrated returns can help spur the initial investment required to fulfill virtualisation's potential by jump-starting shifts from physical to logical assets and lowering total cost of ownership. With operational costs diminishing and efficiencies increasing, companies will be able to create more scalable, responsive IT organisations that can launch innovative new endeavours quickly and remove performance barriers from existing business approaches. In doing so, they can fundamentally reshape the underlying backbone of IT and business.

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Endnotes

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Notes

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