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VIEWPOINT

SOFTWARE-DEFINED EVERYTHING FOR AGILITY

Businesses experience significant uncertainty due to supply chain disruptions, critical materials shortages, and corporate restructuring. If not aggressively managed, cost and schedule can spin out of their control. Software-defined everything is an approach to efficiently manage these changes with confidence and agility.

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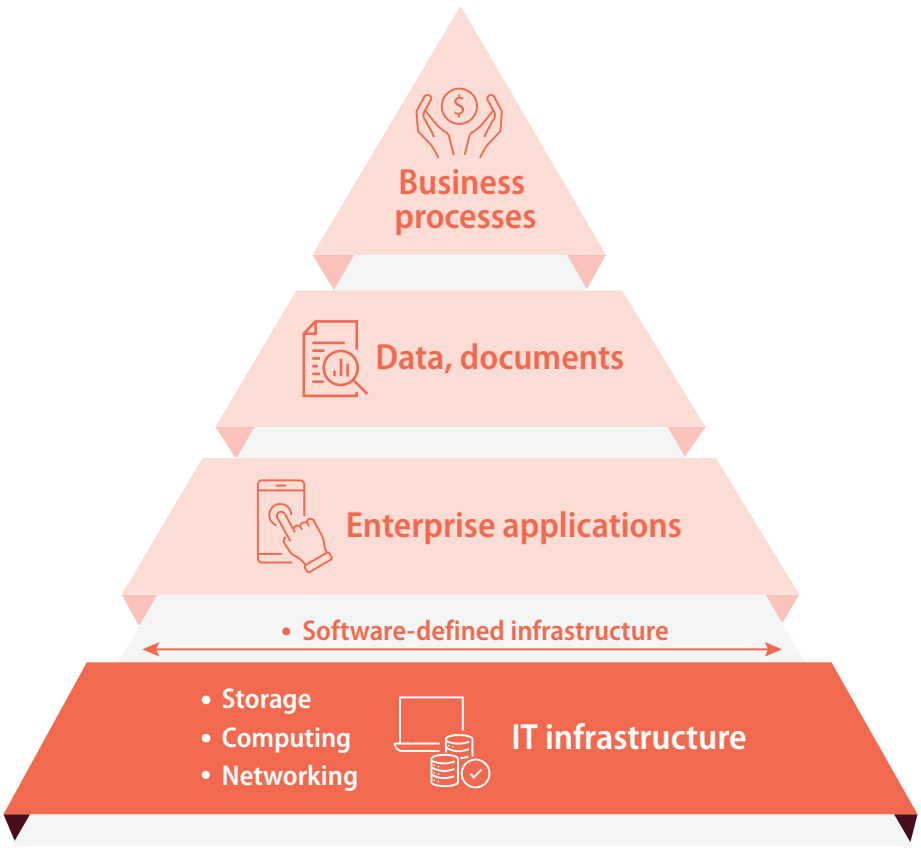
"Software is eating the world" is the oft-quoted yet prophetic 2011 pearl of wisdom from famed tech entrepreneur and author Marc Andreessen.[1] That assessment has only grown in relevance over time. Every simple electronic device contains software and an integrated microcontroller. Although software adds complexity to products, it also creates flexible solutions for a world increasingly defined by volatility, uncertainty, complexity, and ambiguity.

> SDx promotes agility, flexibility, and energy conservation while creating new business models for digital transformation

Software-defined everything (SDx) is an approach where software is a lever to define and control the working of a hardware. SDx adds a layer of software that controls the underlying hardware. Here, any physical item or function can be performed as or automated by software.[2] It is a level of abstraction, making it easy to manage, maintain, and upgrade the hardware. The global SDx market is forecasted to reach USD 160.8 billion by 2024 from USD 51.7 billion in 2019, at a compound annual growth rate of 25%, led by rising demand for virtualization and cloud in data centers.[3]

SDx enables agility, offers flexibility, saves energy, and creates new business models to manage digital transformation. During supply chain uncertainty, software that controls products offers flexibility to manufacture them with available parts, as in the well-known case of Tesla. SDx has become sophisticated, offering higher value and solving bigger problems. Devices with embedded software become software-defined products. In automobiles, Volkswagen expects up to 33% of its revenue from software by 2030. SDx also increases operating model flexibility, helping leaders manage corporate mergers, acquisitions, and spin-offs. It is a cost-effective approach to ease the complexities of IT infrastructure, networks, and storage (see Figure 1).

Figure 1. The hierarchy of enterprise IT footprint and software-defined infrastructure



Source: Infosys

Software-defined infrastructure as a foundation

Strong IT infrastructure is the foundation for overall business success. It comprises hardware, software, networking, and associated systems such as power management and cooling. One such infrastructure is a data center with critical components beyond computing, with minimal usage of power.

A large multinational manufacturing client faced challenges to manage its disparate data center footprint due to multiple acquisitions. The company consolidated and modernized its globally distributed data centers with software-defined infrastructure (SDI). The firm partnered with Infosys to develop a purpose-fit private cloud infrastructure, with software-defined local area network (LAN) and wide area network (WAN). The team implemented greenfield software-defined LAN environment across 250 sites in 12 months. The SDx solution reduced data center footprint by 50%, decreased total network cost by 30%, and accelerated network turnaround time.[4]

SDI is a practical approach to manage corporate spin-offs as well. During restructuring, it is a challenge to separate IT infrastructure,

which includes valuable applications and data among the systems that must be stranded to achieve the synergies defined in the deal structure. IT separation costs may reach 13% of revenue.[5] SDI decouples infrastructure from the software to manage separations successfully while keeping costs under control.

> SDI decouples IT infrastructure from software to successfully manage manage corporate restructuring

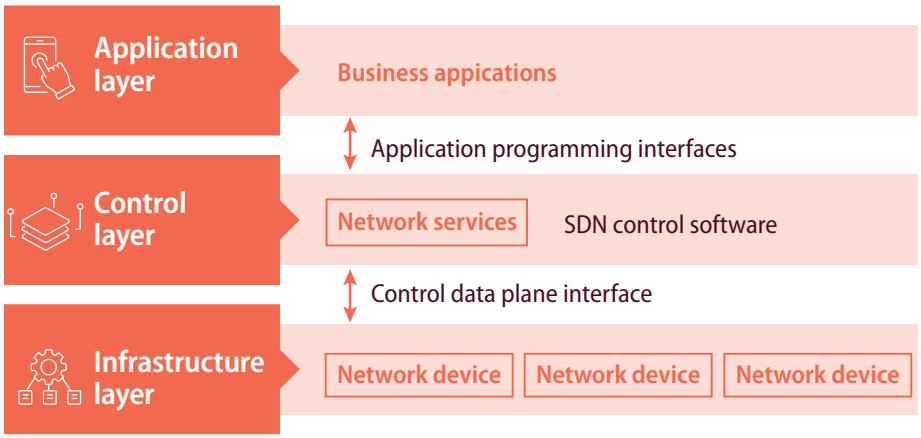
Hewlett-Packard Enterprise (HPE) is a prominent example of a firm where SDI is the core of the corporate strategy.[6] Its fully virtualized computing, networking, and storage resources are logically pooled and managed as software.

Software-defined networks for IT-OT integration

Traditionally, enterprise information technology (IT) and shop floor operational technology (OT) did not communicate seamlessly. One Industry 4.0 tenet is to integrate IT-OT, so the shop floor communicates effectively with the rest of the enterprise. Software-defined networking (SDN) establishes seamless information flow between three layers: infrastructure, control, and application (Figure 2). SDN uses software interfaces to provision, automate, and manage networks without physically handling any router or switch. The shop floor stays aware of external factors, while the sales and marketing teams have visibility on the latest status of a work-in-progress customer order.

Daimler Truck North America faced challenges with poor visibility and shop floor monitoring due to network and infrastructure limitations.[7]

Figure 2. A typical architecture for software-defined networking[8]



Source: Cisco

This delayed responses to customer orders. SDN implementation helped the firm integrate information and operations technology. The refreshed plant-to-business network provides visibility and reliable, secure connectivity everywhere.

Software-defined storage for elasticity

Software-defined storage uses a software layer abstracted from physical hardware storage devices for provisioning and control. The control software monitors storage capacity usage and increases it when demand rises, creating elastic storage. Cloud architectures are examples of software-defined storage and computing.

In 2018, Toyota Motor Corp. announced its intent to transform from an automobile to a mobility company. Connectivity between vehicles was a major feature of this mobility. Connected car operations will send billions of data points each day. Toyota needed a cloud-based architecture that was cost-efficient, resilient to fluctuations, and scalable to match growth. The company uses a software-defined, serverless compute service that enables users to run their codes without provisioning or managing servers.[9]

Automotive component manufacturer Continental developed its cloud-based platform for collaborative development of vehicle architectures and software.[10] One of their early projects imports camera and radar data from a fleet of vehicles for virtual simulation of automated driving. The cloud-based platform offers the elasticity to scale up computing and storage when required.

Software-defined products for flexibility

Products today are driven by the proliferation of electronics, connectivity, and embedded software. This automotive sector trend transformed modern vehicles into computers on wheels. Tesla popularized the concept of a software-defined vehicle with its Model S, where the onboard software is responsible to operate the vehicle. This approach helped the carmaker manage chip shortages during the pandemic.

Tesla followed a design-for-availability approach. It assembled its cars with the available chip and tweaked the software accordingly to make it work. Homologation is the approval process for specific car configurations with parts to work per specifications. This approval is crucial to test the compatibility of

different chips with car parts and configurations. Manufacturers who carry out homologation proactively benefit during critical parts shortages. A software-defined product approach helps them make the product work with available parts.

Not to lose out in the race, Toyota announced "Arene" as its vehicle operating system, targeting 2025 for rollout. Arene will handle basic vehicle operations to advanced features such as autonomous driving.

Software-defined manufacturing for control

Toyota has expanded SDx into its manufacturing process through digital twins. This helps the company simulate several scenarios that are not possible physically. Critical assets are constantly connected and hence support continuous improvement initiatives.

Industrial equipment supplier Fanuc connects robots and machine tools used on shop floors through a network for better control to proactively avoid malfunction. Operators use edge computing for analysis to aid decision-making at the equipment level. Fanuc developed an application to convert their factory into a software-driven system.[11]

Cloud-based design and manufacturing (CBDM) is networked, distributed product making. CBDM accelerates product realization through a resource and knowledge-sharing platform between service providers and customers.[12] CBDM provides on-demand self-services for engineering resources such as design software, ubiquitous network access, rapid scalability, resource pooling, and virtualization.

Software-defined approach for success

SDx creates benefits beyond individual computing infrastructure, networking, products sold, and manufacturing; the entire enterprise can become software-defined as well. SDx elevates organizations whose value creation strongly depends on software and services.[13]

Software is ubiquitous and the differentiating factor for competitive advantage, while hardware has now standardized and commoditized. However, a software-defined approach needs significant talent, which requires investments to train teams in multidisciplinary areas, ranging from software development capabilities to monitoring IT infrastructure, networks, computing, storage, and products.

From a product perspective, it is a challenge to retrofit existing products and facilities to make them software defined. However, the option should be evaluated starting with early stages of conceptualization and design.

> SDx creates benefits beyond computing infrastructure, networks, products, and manufacturing

SDx abstracts vital hardware and infrastructure and helps organizations manage operations, maintenance, repairs, and upgrades. It optimizes infrastructure with better utilization, consolidation, and automation. Consequently, companies achieve economies of scale, minimize labor costs and power and cooling bills through asset consolidation. They also realize direct cost benefits from agility, flexibility, and elasticity. While SDx does require upfront investments, associated cost savings and related benefits create the level of ROI that converts Industry 4.0 from an enticing vision to a worthwhile economic reality.

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