



Hewlett Packard
Enterprise

HPE Synergy:

The first platform architected for composability to
bridge Traditional and Cloud Native apps

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Introduction

The evolution of IT organizations from a supporter of the business to a partner with the business continues to accelerate. HPE calls this new style of business the Idea Economy. As trends expand beyond traditional IT, it becomes important to enable an Idea Economy where the business rapidly generates value through new ideas. As the role of IT changes, the operations and economic model of IT must change to accommodate it. At the same time, as IT accelerates to match the speed of the business, it is still the trusted caretaker of some of the most precious digital assets and must provide a stable and secure environment for their storage and access.

This paper introduces HPE Synergy, the first platform purpose-built from the ground up for Composable Infrastructure to bridge traditional and idea economy IT.

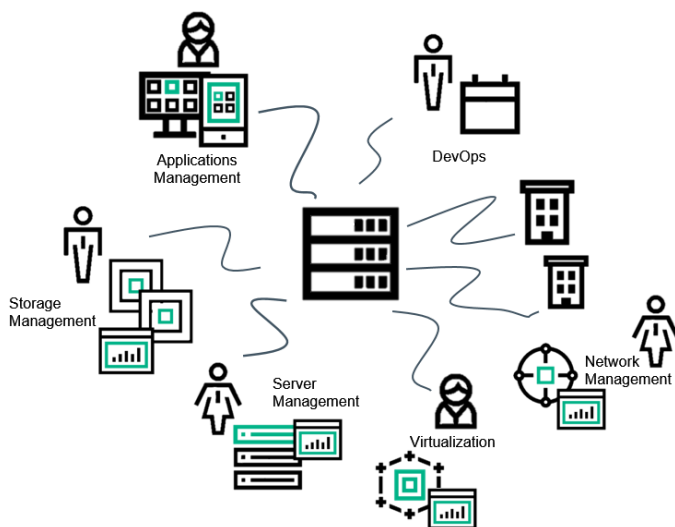
In today's idea economy, every enterprise is at risk of disruption by a new business model. Time-to-market is critical for delivering value faster and better than the competition. Your IT infrastructure must not only keep the business running with traditional applications, it needs to be the engine of value creation through a new breed of apps and services that drive revenue.

To succeed in the Idea Economy, businesses need to:

- Deliver new services faster—be a service provider
- Spend more time developing and improving applications
- Spend less time managing and maintaining infrastructure
- Implement a flexible infrastructure that allows a “build-once, run-many” ops model

Historically, delivering services at scale took hundreds of people, substantial cost, and time. Not so today. Ideas are so easy to take to market that the pace of change is accelerating, and the number of applications in the industry is exploding to a trillion and beyond. Most of these apps are a new breed that includes mobile apps, cloud native or webscale apps, and apps to power the internet of things.

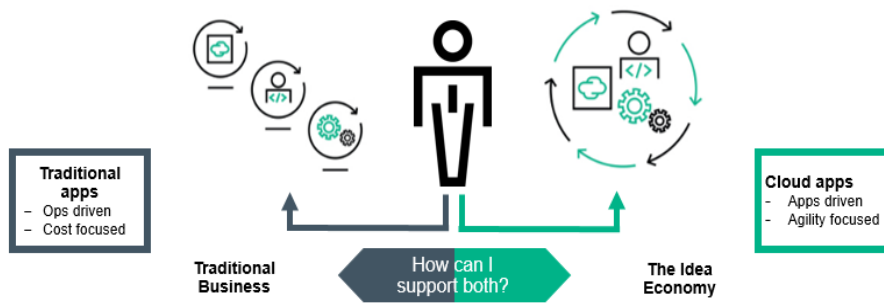
Unfortunately, most enterprises are still set up with traditional IT models that are rigid and complex, involving substantial resources and millions in capital to deliver new services. The complexity of these data centers is inhibiting innovation and driving up costs, particularly as demands on IT increases. To roll out a new application, a complex configuration has to be setup, tested and deployed which could take weeks to months. Similarly, to implement a change, you have to work with a number of different team members, different hardware configurations, and disparate management tools—all prone to adding time, delays and errors.



This complexity leads to a delay in time to market. According to IDC, it takes an average of 160 days to deploy new application infrastructure including server, storage, and fabric capabilities¹. On top of existing infrastructure, it still takes any number of days to deploy a new service.

In the now emerging idea economy, new cloud-native apps are what drive revenue—the applications **are** the business. Characterized by dynamic resources needs, short development periods, and quick turnaround times, this new style of business challenges IT to keep the business running with the traditional applications while standing up these new applications that are going to drive new business and revenue opportunities.

¹ International Data Corporation (IDC) white paper: <http://bit.ly/1ckGLqh>



In the Idea Economy, infrastructure must be the engine of value creation, not the bottleneck to success. What has worked in the past is not going to work in the future since IT must now support two different applications:

- Traditional applications designed to support and automate existing business processes such as collaboration, data processing and analytics, supply chain, and web infrastructure.
- A new breed of applications and services that drive revenue and new customer experiences by leveraging Mobility, Big Data, and Cloud Native technologies.

Traditional environments pressure IT to reduce operating costs while at the same time adjust to the new application environment to increase operational velocity. Such “bimodal” operation is unsustainable for a traditional IT infrastructure because of its inability to adapt instantly. To meet the needs of both facets of business, some companies are installing an additional, separate IT infrastructure. However, this strategy incurs the cost and complexity of managing two infrastructures—both of which are static and prone to over-provisioning.

A new architecture is needed—one that facilitates business’ innovation and value creation for the new breed of applications while more efficiently running traditional workloads.

A new category of infrastructure

Over the years, IT Infrastructure has evolved through traditional, converged and hyper-converged architectures (Figure 1). Traditional architectures use siloed approaches to address increased workloads and data, often at the expense of over-provisioning resources and complicating management. Converged architectures target only a small number of workloads and do not fully achieve velocity or flexibility goals. Hyper-converged architectures address velocity but limit flexibility and do not address key resources such as fabric.

Consequently, none of these architectures has proven adequate. To compete in the Idea Economy a new, single system is needed that has the agility to both power innovation and value creation for the new breed of applications and run traditional workloads more efficiently. HPE is pioneering that innovation with a new architectural approach we call Composable Infrastructure.

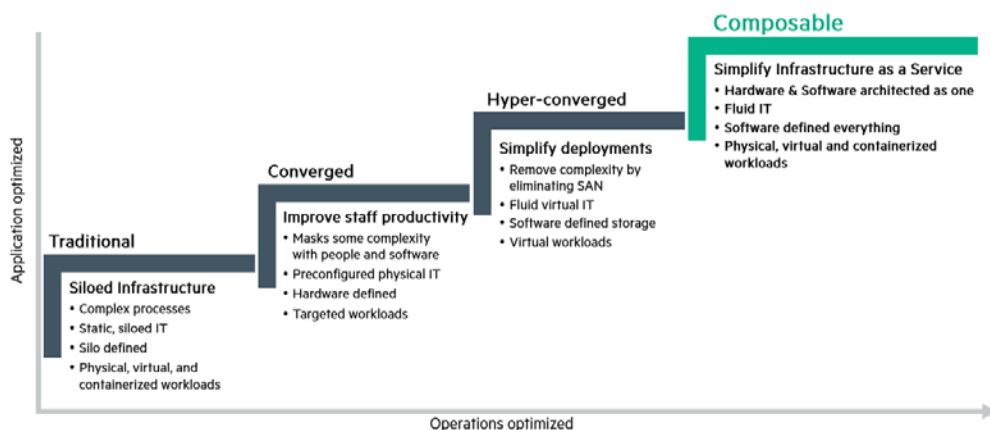


Figure 1. Evolution of IT architecture.

A composable infrastructure empowers you to create and deliver new value instantly and continuously for traditional *and* the Idea Economy by providing an IT that can:

- **Run anything:** Optimize any application, reduce CapEx and free resources with a single infrastructure with fluid pools of physical and virtual compute, storage, and fabric.
- **Move faster:** Accelerate application and service delivery through a single interface that precisely composes logical infrastructures at near-instant speeds.
- **Work efficiently:** Reduce operational effort and cost through internal software defined intelligence with template driven, frictionless operations.
- **Unlock value:** Increase productivity and control across the data center by integrating and automating infrastructure operations and applications through a unified API.

Introducing HPE Synergy: a composable infrastructure platform

HPE Synergy is the first platform architected from the ground up as a composable infrastructure. HPE Synergy is a single infrastructure that reduces operational complexity for traditional workloads and increases operational velocity for the new breed of applications and services. Through a single user interface, HPE Synergy composes compute, storage, and fabric pools into a configuration optimized for any application. As an extensible platform, it easily enables a broad range of applications and operational models such as virtualization, hybrid cloud, and DevOps.

HPE Synergy architectural overview

HPE Synergy integrates the three key elements that define a composable infrastructure: fluid resource pools, software-defined intelligence, and a unified API (Figure 2).

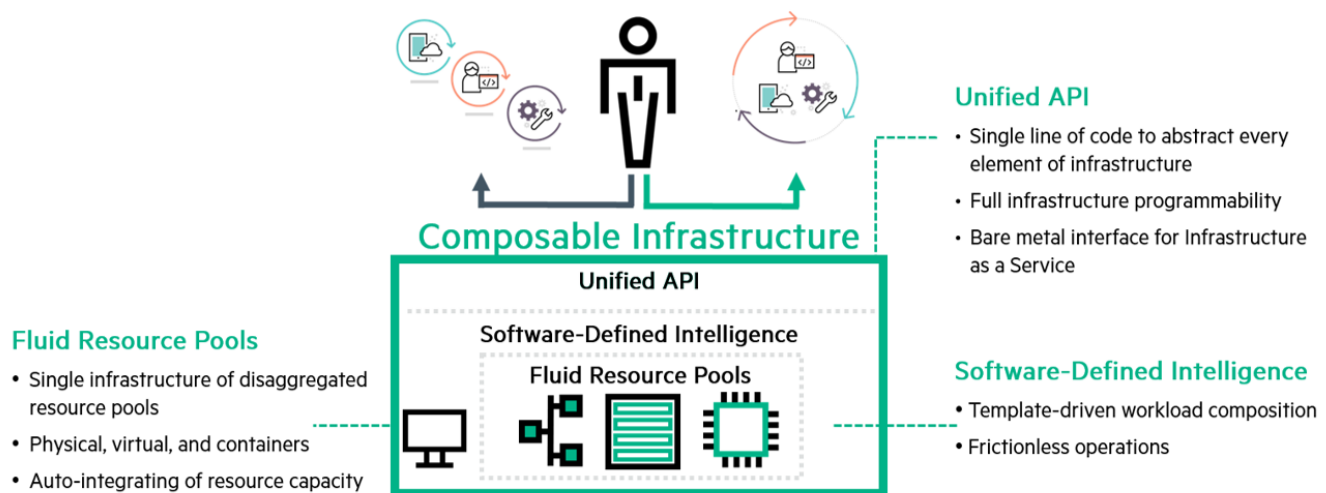


Figure 2. Architectural design principles of a composable infrastructure.

Fluid resource pools

HPE Synergy optimizes resources for application and service levels with fluid pools of compute, storage, and fabric. All resources are now always available and instantly configurable according to the specific needs of each application.

- **Compute:** capacity is configurable for physical, virtual, or container based workloads.
- **Storage:** internal storage is accessible as direct-attached file, object, or remote block. HPE Synergy is extendable with direct attached 3PAR storage as part of the resource pools.
- **Fabric:** bandwidth is dynamically adjustable, scales with expansion, and configurable for multiple protocols.

Additional capacity scales seamlessly into larger flexible pools with an automated process. Operational complexity does not increase with hardware growth, ensuring IT can achieve economies of scale and efficiency. Infrastructure can be effortlessly assembled using building blocks to the size needed for the enterprise, and the composition of resources flexibly adjusted based on the demands of applications.

By maximizing resource utilization, IT can significantly reduce the chances of overprovisioning and stranded capacity while ensuring right-sized resource allocation for applications, significantly lowering cost. Now IT can manage both infrastructure growth and shrinkage from a single fluid pool of resources not stranded in static silos (Figure 3). Smaller infrastructure reduces CapEx, and better management of provisioning reduces power and cooling consumption, minimizing OpEx. Fluid resource pools are easily expandable by automatically integrating and assembling additional infrastructure readily composed (and re-composable) to meet the changing workload demands of the business.

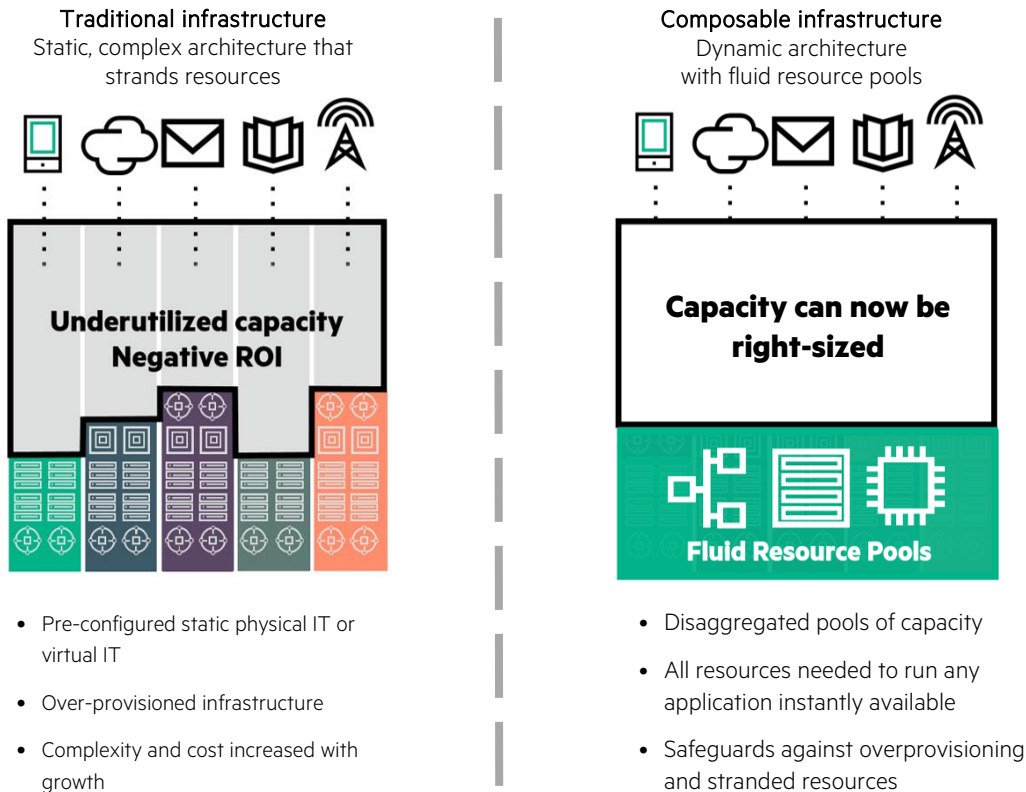


Figure 3. Comparison of resource usage: Traditional versus Composable Infrastructures.

Software-defined intelligence

Historically, infrastructure management involves compute, storage, and fabric silos with their own software management tools. High-level software is often used to aggregate the siloed management tools at a layer that attempts to mask the underlying complexity. Provisioning an application across silos requires a complex process of configuring a variety of different products using a variety of different tools—a process that is very slow, time consuming, and costly to do. It is also error prone because there are so many steps involved. Such a method of provisioning all new infrastructure can take months. Once provisioned, simply getting a new application running can take up to 25 days². Additionally, change operations requires coordination across multiple teams, multiple tools and complex interdependent processes that can often take weeks to complete.

The HPE Synergy platform changes the paradigm of managing IT infrastructure and is unique because it integrates software-defined intelligence into the hardware itself. HPE Synergy enables IT to accelerate application and service delivery through a single interface that precisely

² IDC white paper: <http://bit.ly/1ckGLqh>

composes (and recomposes) logical infrastructures into any combination at near-instant speeds. Compute, storage and fabric pools are provisioned together with their complete state of bios settings, firmware, drivers, protocols, and the operating system image using repeatable templates. This is ideal for traditional IT as well as DevOps approach as it eliminates time-consuming provisioning processes across operational silos that often delay projects for weeks or months.

HPE Synergy reduces operational effort and cost with template driven, frictionless operations. Templates define how the infrastructure needs to function, and the infrastructure's internal software defined intelligence implements the needed changes programmatically.

HPE Synergy abstracts away operational minutia replacing it with high-level, automated operations. Now, change operations such as updating firmware, adding additional storage to a service, or modifying network connectivity implement with a template, significantly reducing manual interaction and human error. This empowers IT to configure the entire infrastructure for development, testing, and production environments using one interface with simplicity, precision, accuracy, and speed.

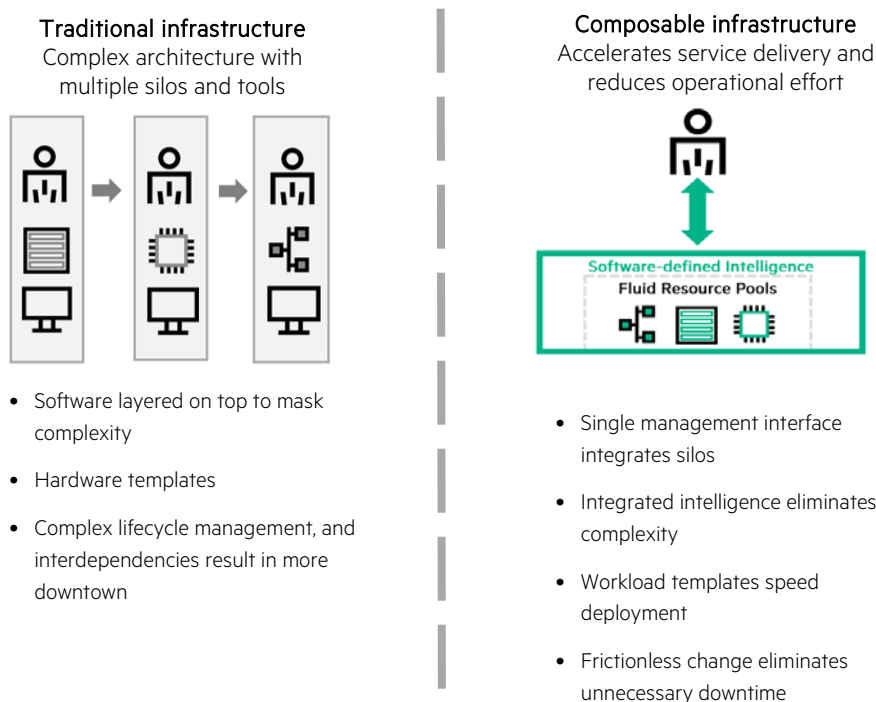


Figure 4. Comparison of software management: Traditional versus Composable Infrastructures.

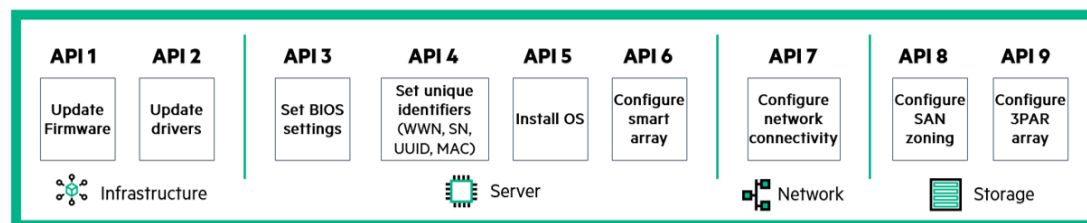
Unified API

Traditional IT management typically involves low-level API abstractions of a number of orchestration applications (Figure 5A). Every device has its own API, and each API has its own data and error code formats. Using multiple interfaces requires knowledge of all APIs and is cumbersome and time consuming. To automate the process across those different interfaces is very complex since those APIs tend to be at a very low (CLI) level, requiring you to configure each component by device bit by bit. Getting a single server up and running can require as many as 500 or more individual calls to low-level tools to get the infrastructure configured properly.

HPE Synergy includes a high level, unified API that brings together all the resources, compute, storage, and fabric under a single interface with a single data format (Figure 5B). Abstracting the API to a high level simplifies programmability.

A: Traditional infrastructure

Different tools and APIs for every task means automation is complex and time consuming



B: Composable infrastructure

Single, unified API for full infrastructure programmability means:

- Increases productivity and control
- Extends power of infrastructure across data center
- Seconds to provision and change
- Leverages ecosystem of preferred data center tools

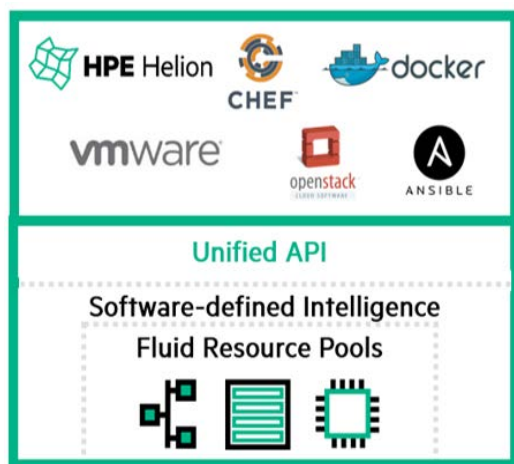


Figure 5. Comparison of programming interface: Traditional versus Composable Infrastructures.

HPE Synergy increases productivity and control across the data center by integrating and automating infrastructure operations and applications through a unified API. The unified API provides a single interface to discover, search, inventory, configure, provision, update, and diagnose the composable infrastructure. When used with programming tools currently available, the unified API makes possible single-line-of-code provisioning of a complete infrastructure for an application, eliminating time-consuming scripting of multiple varied low-level tools and interfaces.

In traditional environments, IT can now automate their IT operational processes and design their workflow around enterprise needs. For the new breed of applications, DevOps can now automate applications through infrastructure deployment, scaling, and updates. The unified API aggregates physical resources in the same way as virtual and public cloud resources, so developers can code without needing a detailed understanding of the underlying physical elements.

This fully programmable interface integrates into dozens of popular management tools such as Microsoft SystemCenter, Red Hat®, and VMware vCenter™ as well as with open source automation and DevOps tools such as Chef, Docker™, and OpenStack.

This degree of tool integration extends the power of Synergy throughout the datacenter:

- Virtualization administrators can automatically provision hypervisor clusters and non-disruptively update infrastructure through the same interface used to manage the virtual machines.
- Facilities operators can visualize power consumption and thermal profile through their Data Center Infrastructure Management (DCIM) interface and make workload placement recommendations.
- IT administrators can easily construct a cloud infrastructure enabling them to be a service provider to the business.
- Application developers leveraging DevOps methodologies can rapidly provision infrastructure and applications together in a single template because infrastructure becomes code through the unified API.

HPE Synergy product overview

The HPE Synergy 12000 Frame (Figure 6) is the foundation of HPE Synergy solution and solves the problem of IT silos at its core. The HPE Synergy 12000 Frame combines all resource pools—compute, storage, and fabric—into a single physical intelligent infrastructure. HPE Synergy Frame's unique design physically embeds HPE Synergy Composer with HPE OneView management software to compose all resources into any configuration.



Figure 6. HPE Synergy 12000 Frame.

The HPE Synergy 12000 is a 10U Frame designed on industry standards and mounts easily into existing racks, plugs into datacenter resources, and is operational in minutes. As the building block for a Synergy infrastructure, the Synergy Frame offers substantial expansion and scalability. Compute, storage and fabric modules are automatically discovered. The system quickly and automatically detects hardware configuration errors and provides guidance on how to correct issues. You can add multiple frames that link together through a simple yet secure management network to establish a frame ring managed as a single logical frame. An infrastructure of multiple frame rings connected by a dedicated management network (Figure 7) can substantially increase resources available to your business as well as IT efficiency—achieving both CapEx and OpEx economies of scale.

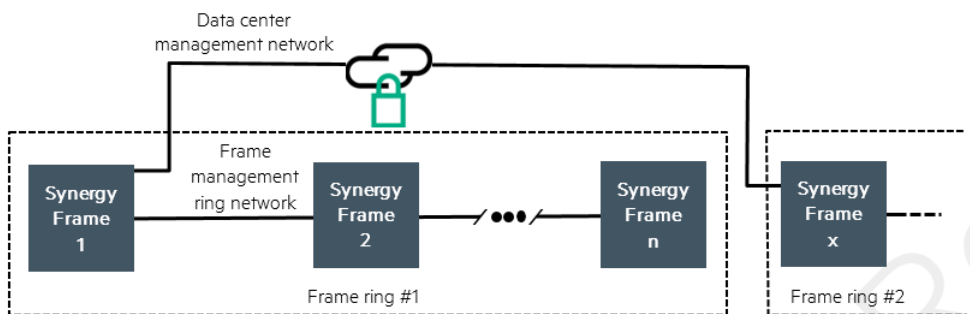


Figure 7. HPE Synergy scalability through frame expansion.

A combination of storage options, 2- and 4-socket compute modules, and a variety of redundant fabric modules allow Synergy to meet a wide range of workload requirements so you can easily deploy the entire infrastructure needed to run an application and store its data. The HPE Synergy Frame is designed to accept multiple future generations of compute, storage, fabric, and management modules while preserving the ability to leverage existing storage and connectivity resources. The frame's direct-connect mid-plane delivers 16.128Tb/s of bandwidth and is future-proofed with a photonic-ready design that will exceed bandwidth requirements for the next decade.

Embedded software-defined intelligence enables self-discovering, auto-integrating, self-securing, self-orchestrating, and self-diagnosing capabilities. Built-in templates allow you to accomplish operations such as setup, provisioning, and updating in a single step. Changes implement quickly and automatically for continuous application availability.

HPE Synergy Composer

HPE Synergy Composer powered by HPE OneView provides a single interface for assembling and re-assembling Synergy's compute, storage, and fabric resources into any configuration. It enables *infrastructure as code*, accelerating transformation to a hybrid infrastructure and provides on-demand delivery and support of applications and services with consistent governance, compliance, and integration.

HPE Synergy Composer deploys, monitors, and updates the infrastructure from one interface and one unified API. It allows IT departments to—in a single step—deploy infrastructure for traditional, virtualized, and cloud environments in just a few minutes. Resources can be updated and redeployed without interrupting service. HPE Synergy Composer is a physical appliance integrated within the HPE Synergy Frame (Figure 8).



Figure 8. HPE Synergy Composer in HPE Synergy 12000 Frame.

HPE Synergy Composer uses server profile templates to automate the process of provisioning and updating compute, storage, and networking resources with built-in software defined intelligence. Server profile templates are a powerful new way to quickly and reliably update and maintain existing infrastructure. Templates simplify one-to-many updates and manage compute module profiles with inheritance functionality. This allows updates to be made only once in the template and then propagated out to all of the profiles created from that template. Elements such as server firmware, BIOS settings, local RAID settings, boot order, network configuration, shared storage configuration, and more are all updated with the template process. This ensures that the infrastructure is deployed and updated consistently, with the right configuration parameters and firmware versions—streamlining the delivery of IT services and the transition to a hybrid cloud. With reduced complexity and faster service delivery times, IT ultimately responds better to changing business needs. This is ideal for DevOps environments because it delivers infrastructure as a service and eliminates time-consuming provisioning processes across operational silos that often delay projects for weeks or months.

Powered by HPE OneView, HPE Synergy Composer provides a unified API for discovering, searching, inventorying, configuring, provisioning, updating, and diagnosing composable resources. Using the unified API eliminates the need for multiple low-level programming interfaces, so administrators and software developers can be more productive. This fully programmatic interface also integrates into popular management tools, such as Microsoft SystemCenter and VMware vCenter. It is also future proofed by integrating into popular open source automation and configuration management tools, such as HPE Helion, Chef, Puppet, Python, Powershell and OpenStack. The unified API's ability to integrate into a variety of environments means composable infrastructure can support IT essential to both traditional applications and those associated with the Idea Economy.

The Unified API powered by HPE OneView enables automation tools to provision on-demand and pragmatically, without requiring detailed knowledge of the underlying physical elements. By connecting automation tools with HPE Composer, bare metal infrastructure can be directed the same way as virtual and public cloud resources.

HPE Synergy Image Streamer

In the hyper-connected Idea Economy, fluid alignment between infrastructure and workloads and the fast deployment of end-to-end resources is paramount. HPE Synergy Image Streamer provisions compute modules with bootable images created from golden images, resulting in infrastructure deployments and updates with unmatched speed and agility. The HPE Synergy Image Streamer is a physical appliance contained within the frame (Figure 9) that serves as a repository for golden images used on physical and virtual infrastructure..



Figure 9. HPE Synergy Image Streamer in HPE Synergy 12000 Frame.

HPE Composer and Image Streamer enable true 'stateless' operation by integrating operating environment images with server templates and profiles for rapid implementation onto available hardware. With access via the Composer's Unified API, HPE Image Streamer enables programmatic control of its functions. Provisioning is controlled from the GUI, or with a single line of code seamlessly integrated into existing scripting processes. This allows partners, developers, and users to integrate, automate, and customize HPE Image Streamer use for scaling across large infrastructure blocks.

With Synergy Image Streamer, you can rapidly clone and create unique bootable images for compute modules, enabling quick deployment or update of new compute resources. This is much faster than the traditional, sequential process of building servers (i.e., physical provisioning followed by operating system (OS), hypervisor installation, I/O drivers, application stacks, et cetera). Traditional methods also require copying and/or customizing each image for each compute module. HPE Synergy Image Streamer accelerates these processes by tight integration with HPE Synergy Composer. Together, they consistently deploy bootable images and hardware configuration simultaneously across pools of stateless compute modules. This simple, consistent process streamlines the provisioning process, reduces complexity and provides consistency across the composable infrastructure. Administrators can design bootable images for compute modules, with the OS and application stacks included, for efficient, agile ready-to-run environments. HPE Image Streamer uses similar processes for both initial deployments and updates, thus creating a new paradigm for managing images at the compute modules.

HPE Synergy Image Streamer ensures high availability by providing redundant repositories of bootable images. The separation of management and data networks provides additional security and dedicated bandwidth. In addition, security vulnerabilities typically associated with PXE boot alternatives are eliminated, and no external network connectivity are required for operation.

True stateless operation allows IP addresses to be assigned to operating systems (similar to the way IP addresses are assigned to hardware) and then booted as if in a SAN environment. Unlike booting-from-SAN environments, no additional setup or configuration is required. The Image Streamer set up is much faster and more efficient than a boot-from-SAN environment, and it can deploy new images quicker and at lower cost than traditional on-server boot disks. By integrating with Composer profiles and templates, image and configuration compliance can be enforced by flagging out-of-compliance resources and enabling remediation to bring them back into compliance to assure consistent operations.

To upgrade an image, you just revise the profile or template to associate with a new boot image. When the compute module reboots, the profile automatically updates to connect the module to the new image. Similarly, rollbacks are accomplished by simply changing the profile back to the

original boot image, followed by a reboot. This update process avoids complex and time-consuming patching processes. HPE Synergy Image Streamer automates the seamless configuration, provisioning, and updating of composable infrastructure.

HPE Synergy Composable Storage

Creating a truly agile and efficient IT infrastructure requires the transformation of traditionally rigid physical systems into flexible physical or virtual resource pools. HPE Synergy Composable Storage creates a pool of flexible storage capacity using multiple storage options that you can configure almost instantly to rapidly provision infrastructure for a broad range of applications and workloads.

HPE Synergy Composable Storage offers high-density storage options that span from fully integrated internal storage modules and software-defined storage to directly connected and fully orchestrated flash arrays. No matter the data type, connectivity protocol, or service level requirement, with HPE Synergy Composable Storage, you can respond effortlessly to unpredictable demands. As a key building block for many applications, HPE Synergy Composable Storage is designed to store and share anything—file, block and object data—with enterprise-class reliability. It delivers a new level of simplicity, density, and flexibility by eliminating the complexity and limitations of siloed resources and administration.

HPE Synergy Composable Storage is composed along with compute and fabric resources to meet the demands of a wide range of data workloads, such as OS boot, database, collaboration (email/communication), file, web, and media streaming. It is flexible enough for virtualization, network file sharing, clustering, and object storage. The HPE Synergy Composable Storage Module provides the ideal storage choices for every target workload. Its architecture—from the controller to its non-blocking SAS fabric—offers full utilization of flash storage, whether internal or Fibre Channel-attached. Its high performance capabilities enable I/O-intensive workloads like database, as well as email, file sharing, web scale applications, and media streaming. HPE SmartArray technology is used to accelerate performance, increase RAID protection, and add encryption to improve availability and security.

HPE Synergy D3940
Storage Module



Figure 10. HPE Synergy D3940 Storage Module in HPE Synergy 12000 Frame.

The HPE Synergy D3940 Storage Module (Figure 10) provides in-frame storage with a capacity of 40 drives. Up to five storage modules (200 drives) can be deployed within a Synergy 12000 Frame for up to 768 TB of storage capacity. Drives are allocated to compute resources without any fixed ratios and in any combination. Storage can be configured as direct-attached or remote storage and can be presented as block, file, or object enabling a wide variety of workloads. The HPE Synergy Storage Module offers multi-tiered technology for solid state disk (SSD) and hard disk drive (HDD) storage in both SAS and SATA options to achieve the right cost/performance. Its non-blocking SAS fabric allows full utilization of flash storage and up to 2 million IOPs with internal all-flash capability and up to 3.2 million IOPS with Fibre Channel attached flash storage.

- Additional data services can be delivered via software-defined storage in the form of virtual storage appliances (VSAs) running on these internal storage modules, on external storage, or via HPE Helion OpenStack.
- Fibre Channel-attached storage options such as all-flash arrays that scale up to 12 Petabytes usable per system deliver massive performance, low latency, and extreme scalability with unified provisioning from the HPE Composer powered by HPE OneView.

These flexible storage options achieve the right cost/performance based on a wide variety of workloads. For larger scale enterprise applications looking for Tier-1 service levels, HPE's FlatSAN technology enables direct connection from HPE Synergy to HPE 3PAR StoreServ flash arrays, capable of serving both block and file applications with 6-nines of availability, and up to 60PB and 10M IOPs in a single federated storage pool.

HPE Synergy Composable Storage's superior, enterprise-grade availability allows IT to quickly and confidently implement infrastructure changes with one-tool, one-step template-based operations. Change operations such as updating firmware is automatically implemented while the infrastructure is online, which significantly reduces manual interactions and errors, and ensures real-time compliance.

HPE Synergy Composable Compute

Driving a truly agile and efficient IT infrastructure requires the transformation of traditionally rigid physical systems into flexible physical or virtual resource pools. HPE Synergy Composable Compute creates a pool of flexible compute capacity configurable almost instantly for rapid provisioning of infrastructure for a broad range of applications.

HPE Synergy Compute Modules (Figure 11) are available in both two-socket and four-socket designs with multiple x86 architecture choices that provide the performance, scalability, density optimization, storage simplicity, and configuration flexibility to power a variety of workloads, including business processing, IT infrastructure, web infrastructure, collaborative, and high-performance computing.

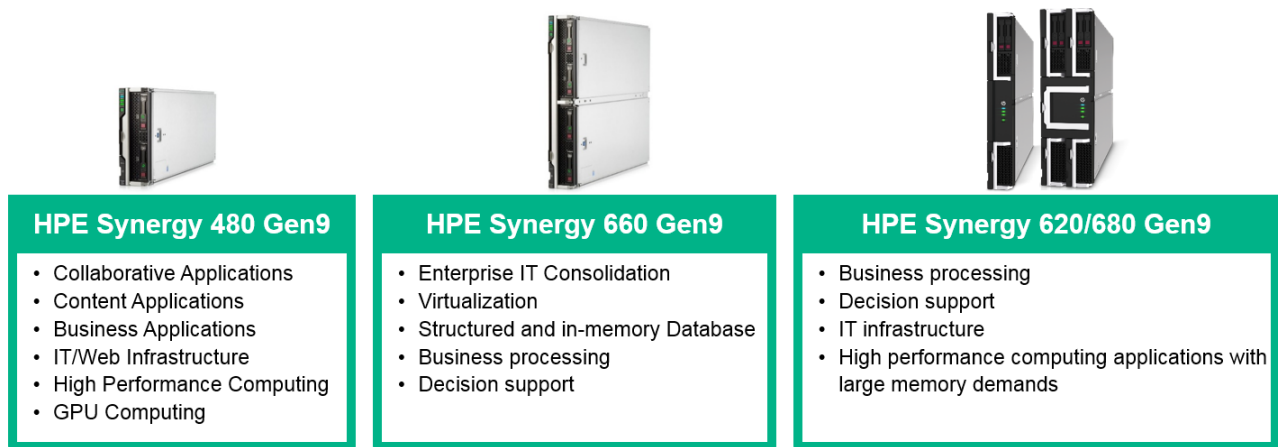


Figure 11. HPE Synergy Compute Modules.

The HPE Synergy 480 Gen9 Compute Module delivers superior capacity, efficiency, and flexibility to power demanding workloads and increase virtual machine density by providing a full range of 2-socket processor choices, right-sized storage options, and a simplified I/O architecture. It is designed to optimize general-purpose enterprise workload performance including business processing, IT infrastructure, web infrastructure, collaborative, and high performance computing in physical and virtualized environments while lowering costs within a Composable Infrastructure. The HPE Synergy 480 Gen9 Compute Module has increased memory capacity (up to 1.5 TB) with twenty-four DIMM slots, and features the Intel® E5-2600 processor family without any DIMM slot restrictions. Greater consolidation and efficiency are achieved through an increase in virtual machine density per compute module.

The HPE Synergy 660 Compute Module handles data-intensive workloads with uncompromised performance and exceptional value. The HPE Synergy 660 Gen9 Compute Module is a full-height, high-performance with high-density Intel E5-4600 processors, 48 DIMM slots providing up to three TB of available memory, flexible I/O fabric connectivity, and right-sized storage options. The HPE Synergy 660 offers a large memory footprint and powerful processors required for more demanding workloads like in-memory and structured databases. Its HPE DDR4 SmartMemory offers up to a 30%¹ performance increase over the previous generation.

The HPE Synergy 620 and HPE Synergy 680 Gen9 Compute Modules are designed to meet the needs of almost any enterprise IT tier and workload. These two-socket and four-socket x86 compute modules with Intel E7 processor are ideal for financial, insurance, healthcare, manufacturing, and retail enterprises that require more memory, mission-critical levels of availability, extended versatility, and real-time performance. The HPE Synergy 620 has 48 total DIMMs (up to three TB), one or two Intel E7 processors, and five mezzanine connectors for a variety of storage and networking options. The HPE Synergy 680 has 96 total DIMMs (up to six TB), four Intel E7 processors, and ten mezzanine connectors. These compute modules include many more RAS features than the Intel E5 family of processors to accommodate higher levels of reliability and availability, and twice the DIMM slots per processor to accommodate large in-memory computing applications.

HPE Synergy Composable Compute's flexible design optimizes internal storage choices to match workload requirements. The compute module has a flexible front bezel design with two or four HPE SmartDrive bays, each of which features up to two drives per bay or four or eight micro form factor drives with built-in RAID with a choice of SAS, SATA, HDD, and flash storage. If internal storage is not required (such as environments

using the HPE Synergy Image Streamer), there is an option to order compute modules with no internal storage hardware for a stateless configuration. For workload acceleration, PCIe NVMe SSDs from HPE combine the high throughput and low latency of a storage workload accelerator with the flexibility and convenience of a standard form factor drive, ideal for web scaling, cloud, OLTP, Big Data, or business intelligence. HPE Synergy also is perfect for software-defined data services and external attached storage options.

The Smart Array controllers integrated with the compute modules deliver superior reliability and increased compute module uptime with additional fault-tolerance (RAID) levels, online spare capability to facilitate automatic rebuilds after a drive failure, and fault prevention with predictive spare activation before a failure occurs.

The compute modules converge traffic over high-speed 10/20 GB connections using HPE Converged Network Adapters. When connected to HPE Virtual Connect SE 40Gb F8 modules, each module provides up to eight adjustable connections (seven data and one storage, or all data) to each 20 GB compute module port.

With its infrastructure management simplicity and agility, HPE Synergy Composable Compute modules become a composable resource that self-discovers, is quickly provisioned, easily managed, and seamlessly redeployed. Freed of stranded compute resources, enterprise data centers can now deliver the right compute capacity for changing workload needs. HPE Synergy Composable Compute's superior, enterprise-grade availability offers quick and confident infrastructure changes. Change operations such as firmware updates can be applied instantly for initial set up or staged so they automatically take effect later. Staged updates copy the new firmware to compute modules where they are stored until a convenient maintenance window, at which time it is applied. The deployment of the firmware completes with one-tool, one-step template-based operations, and changes which can be timed with application needs, significantly reducing manual interactions and errors, and ensuring real-time compliance.

HPE Synergy Composable Fabric

HPE Synergy Composable Fabric delivers high performance and composability for the delivery of applications and services. It simplifies network connectivity using fabric disaggregation in a cost-effective, highly available, and scalable architecture. HPE Synergy Composable Fabric creates a pool of flexible fabric capacity configurable almost instantly to provision infrastructure for a broad range of applications.

HPE Synergy Composable Fabric's enterprise-grade availability allows IT to implement frictionless infrastructure changes with one-tool, one-step template-based operations from the HPE Composer. Change operations such as modifying network connectivity or updating firmware are automatically implemented from the Composer GUI or unified API while the infrastructure is online, which significantly reduces manual interactions and errors, ensures real-time compliance, and minimizes downtime.

HPE Synergy Composable Fabric's disaggregated, rack-scale design uses a master/satellite architecture (Figure 12) to consolidate data center network connections, reduce hardware and management complexity, and scale network bandwidth across multiple frames. The master module contains intelligent networking capabilities that extend connectivity to satellite frames through the HPE Synergy Interconnect Link Modules. This eliminates the need for a top-of-rack switch and substantially reduces cost. The reduction in components also simplifies fabric management at scale while consuming fewer ports at the data center aggregation layer. HPE Synergy Composable Fabric modules provide up to three redundant fabrics per frame, and the flexible QSFP unified ports can be configured for either Ethernet or Fibre Channel.

HPE Synergy Composable Fabric employs a flat, east/west architecture to maximize data throughput and minimize latency with only a single hop within large domains of virtual machines and up to 60 compute modules. In contrast, legacy hierarchical architectures use a north/south design that creates oversubscription bottlenecks and adds latency caused by multiple hops, both of which negatively impact performance.

With HPE Synergy Composable Fabric, infrastructure scaling is fast and simple. Additional frames become an extension of the existing fabric, and the east/west design scales so the performance of the existing workload is not negatively impacted. HPE Synergy Composable Fabric can precisely match workload performance needs using its low-latency, multi-speed architecture. Up to 95% of network sprawl can be eliminated at the compute module edge with one device that converges traffic inside

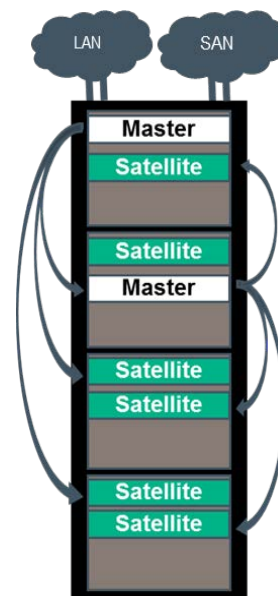


Figure 12. HPE Synergy Compute master/satellite fabric architecture.

frames and directly connects to external LANs and SANs. Using Flex-20 technology, redundant Virtual Connect modules provide adjustable downlink connections to dual-port 10/20Gb Converged Network Adapters on each compute module.

HPE Virtual Connect Modules (Figure 13) are interconnects with wire-once, change-ready templates that allow workloads to be moved without modifying the network. They provide simple, seamless connectivity between virtualized compute modules and data center fabrics. The highly available, disaggregated architecture provides cost-efficient, easy-to-manage, and resilient fabric for traditional and next-generation workloads. The HPE Virtual Connect SE 40 GB F8 Module is ideal for environments requiring native FC, FCoE, and Flat SAN compute and storage connectivity with the Virtual Connect experience. .



Figure 13. HPE Synergy fabric solutions for composable infrastructure.

For traditional switched network environments, HPE Synergy offers a broad portfolio of switches for Ethernet and Fibre Channel networking (Figure 14). The HPE Synergy 40 GB F8 Switch is a Layer 2/3 Fiber Channel switch that gives full manual control to network administrators who want to manage their HPE Synergy interconnects from a Command Line Interface (CLI). This fabric solution allows the network administrator to manage the switch within the frame with the same tools, and features, security. The HPE Synergy 40 GB F8 Switch design uses the same master/satellite architecture as HPE Virtual Connect SE 40 Gb F8 module to consolidate data center network connections, reduce hardware complexity, and scale network bandwidth across multiple frames. The master module contains intelligent networking capabilities that extend connectivity to satellite frames, eliminating the need for a top of rack switch and substantially reduces cost.

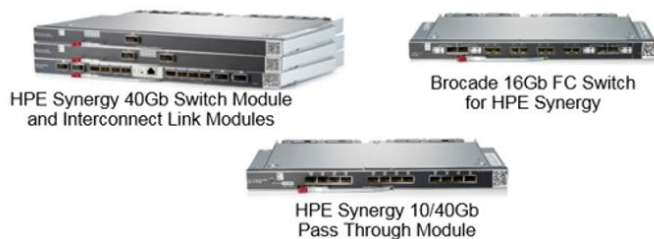


Figure 14. HPE Synergy fabric solutions for traditional network environments.

In addition to the composable fabric, HPE offers other interconnects such as a pass-through module and a SAN switch module. If you need to directly connect compute modules to an existing network, HPE offers a pass-through. The HPE Synergy 10Gb/40Gb pass through module allows for a 1-to-1 connection between a compute module and a top of rack switch. This allows network administrators to manage all switching outside of the frame with the network operating system of choice.

The Brocade 16 GB Fibre Channel SAN Switch Module for HPE Synergy provides high performance, low latency networking with cut-through mode FC SAN capabilities. This switch is ideal for financial services, trading applications, medical imaging, and rendering.

Conclusion

HPE Synergy enables IT to deliver a new experience by maximizing the speed, agility, and efficiency of operations. By precisely adjusting fluid pools of resources, the cost of over provisioning is reduced with a single infrastructure that runs any application. When you accelerate IT, everything goes faster. Operations teams can easily automate and accelerate internal processes. Developers can now take advantage of the open unified API and software defined intelligence to quickly access infrastructure resources to accelerate the application development process. This means ideas can be realized faster, so your business can deliver better experiences for customers, stay ahead of the competition, and grow revenue. With HPE Synergy, your IT can now break free from the ordinary and accelerate the extraordinary to become a value creation partner for your business. Hewlett Packard Enterprise can help you transform to a hybrid infrastructure with HPE Synergy as the foundation. With

transformation expertise, HPE can help you design the right solution, integrate your solution into your existing environment, proactively support your environment ongoing, further automate your infrastructure, and help you flexibly finance your investment.

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