# Two competing approaches to hybrid cloud

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# TABLE OF CONTENTS



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# EXECUTIVE SUMMARY

Private and public clouds are becoming pervasive, which means they're a key strategic consideration for IT organizations and decision makers. Public clouds capture the interest of corporations with their rich infrastructure and platform functionality, extensive accessibility, and attractive price points. Private clouds, in turn, bring many of these benefits behind the firewall. Cloud service providers (CSPs) add to the equation by offering hosted, off-premises private clouds. Businesses now see clouds as vehicles for the flexible, highly secure, and managed deployment of application and data workloads onto geographically distributed, software-defined datacenters.

Companies are loaded with large volumes of information from many sources, including public clouds, market data, social networks, and mobile and Internet of Things (IoT) devices. They need to store, process, and analyze this information in order to aid growth and maintain daily functionality. In addition, companies need to integrate their private and public clouds with their legacy IT deployments and figure out ways to smoothly manage workload deployment and execution across their infrastructures. Combined together, these needs have created significant interest in the hybrid clouds that arise from such integration.

Hybrid clouds can bring significant benefits to every element of your organization. With a hybrid cloud infrastructure, your company's management can see a unified view of your cloud infrastructure and collection of workloads—no matter how heavily distributed they are. A hybrid cloud platform also helps IT organizations move towards becoming cloud service brokerages that optimally manage the use of compute, storage, and network resources, whether on-premises or in private, hosted, or public clouds.

A big concern for cloud adoption is end-to-end security, from mobile and IoT devices, through the network, to datacenter devices where data is stored and processed. With this concern comes the requirement that a cloud deployment provide controlled, auditable mechanisms for determining who can access data, when, and for what purposes. Two other key concerns are the ease with which hardware and network components interoperate and the scalability and seamlessness of the whole infrastructure from an IT management perspective. Different cloud vendors have different approaches to addressing these concerns.

Building on our previous exploration of enterprise cloud offerings,[1] we compared two approaches to the hybrid cloud: the Cisco cloud portfolio and the HP

[1] For an introduction to the topic and a comparative discussion of software-based cloud offerings, see our white paper commissioned by Cisco "The enterprise cloud market: a competitive overview" and its associated infographic at facts.pt/1EYvvLz and facts.pt/1SZhd8i respectively.

Helion cloud portfolio. Both cloud portfolios have strong technology offerings that span compute, storage, and network technologies in addition to hardware- and software-based cloud technologies with open software platforms.

Cisco's approach to the cloud is application-centric. Its cloud architecture is built on top of an application platform layer that integrates PaaS, service integration, and configuration management. This layer, in turn, is built on top of a hybrid cloud infrastructure layer that provides a highly automated, secure, policy-based environment.[2] Cisco's Application Centric Infrastructure (ACI) provides an intelligent connectivity backbone across all architectural layers, implementing Cisco's version of software-defined networking.

Cisco's cloud portfolio backbone is an intelligent network fabric built on Cisco ACI technology. Cisco places a strong emphasis on end-to-end cloud security, from devices at the edge to backend compute and data storage facilities. Its approach to security builds on ACI intelligent fabric and switches, which ensure data security for both data-in-motion and data-at-rest, allowing role and capability-based access control at the network layer level. Cisco also provides intrusion detection and packet filtering, as well as intrusion prevention, providing intelligent security automation. Its cloud portfolio is vendor agnostic, supporting a number of cloud platform and infrastructure technology alternatives and offering flexibility for customers.

The HP Helion cloud portfolio includes private cloud, managed private cloud, managed virtual private cloud, and public cloud. The HP approach to hybrid cloud builds on a core infrastructure-centric approach with a solid application development orientation. It is a leader in the support and development of OpenStack cloud technologies. Initial HP cloud offerings had significant vendor lock-in, but HP has recently announced a more flexible infrastructure.[3]

HP emphasizes security, but takes a data-centric security approach. HP Security Voltage for Cloud is a data-centric security software framework that protects enterprise data at the data level, from data movement to the use of data within a cloud deployment.[4] Data is encrypted at capture and protected while in motion or at rest. The HP data-centric encryption approach allows data to be protected as it enters or leaves

[2] See products.mcisco.com/c/dam/en/us/services/collateral/se/acc-white-paper.pdf for more details on Cisco's Application Centric Cloud vision, technologies, and services.

[3] www8.hp.com/us/en/cloud/cloudsystem.html

[4] https://www.voltage.com/solutions/threats/insecure-cloud-data/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

different IT environments, without needing to encrypt or decrypt it in the process. HP Security Voltage can be used in SaaS, IaaS, or PaaS situations, and it spans end-to-end data-centric security between private, public, or hosted clouds in hybrid cloud settings.

Figure 1 provides a general overview of the key competitive profile features for both cloud portfolios, based on publicly available material.

## Competitive profile

| Overall hybrid cloud portfolio approach | |
|---|---|
| Cisco | HP Helion |
| Application-centric view of workload deployment, combining policy-based network intelligence and resource management with a network-centric hybrid cloud architecture | Development-centric view of workload management, with a heavy focus on OpenStack technologies and management features |
| Multi-vendor cloud strategy, with minimal vendor lock-in, supporting multiple hypervisors, multiple cloud management platforms, and multiple cloud providers; Supports OpenStack as one of several alternative cloud management platforms customers can choose for their cloud deployments | Single-vendor cloud strategy, supporting multiple hypervisors, but not multiple cloud management platforms or cloud providers; Cloud Service Automation and OpenStack represent HP's cloud management platform; no integrated multi-vendor solution |
| Application Centric Infrastructure (ACI) provides a comprehensive software defined networking solution, spanning cloud layers from the application layer down to the hardware layer | HP provides software defined networking management and implementation tools; also uses tools contained in HP Helion OpenStack |
| Open cloud model; allows customers to use preexisting hardware, compatible with many hypervisors and many cloud management platforms. | Open cloud model, allows customers to use preexisting hardware, compatible with three hypervisors |
| Policy-based, end-to-end, robust data and network security for hybrid clouds, powered by Cisco ACI and other technologies | Achieves hybrid cloud security through data encryption, sharing policies, and threat detection |
| Unified management of hybrid cloud solutions and application provisioning with complete workload mobility across multivendor clouds and seamless networking solutions, even to third-party public clouds | Unified management of OpenStack-based clouds and compatibility with third party clouds like Amazon Web Services |
| Cisco Intercloud Providers and Cisco Powered Service Providers have hundreds of members and datacenters; many availability zones and regions for flexible compliance with data sovereignty laws and regulations; and catalogs for ISVs to validate and sell their solutions | HP Helion has two public cloud regions in the US; HP Helion partner programs allow service providers, resellers, and independent software vendors to sell and validate services for HP Helion |

**Figure 1: An overview of key differences between Cisco and HP Helion cloud offerings.**

# APPROACHES TO HYBRID CLOUD

Increased market competition and competitive pressures are making it essential for businesses to seek improved agility, or an increased capacity to quickly provide business solutions to new and changing problems. To do this in a technology-dependent world, businesses need IT agility—the ability to produce comprehensive, timely, adaptable IT solutions to business problems.

Hybrid clouds address many of the issues surrounding the flexibility of IT capacity management and resource assignment by providing flexible access to public clouds and off-premises private clouds and by offering tools for managing distributed workloads. To gain IT agility in a hybrid cloud context, it must be easy to create, modify, or update applications and data stores that implement business solutions. In addition, deploying such applications and workloads must be simple. There are many factors that can aid or hurt IT agility. We aim to view each key factor as it applies to Cisco and HP.

## The Cisco approach

Cisco takes both a *network-centric* and *application-centric* approach to creating a hybrid cloud solution. The Cisco cloud portfolio focuses on fabric components that connect different clouds and workloads across clouds. It achieves network centricity by providing an intelligent network fabric, implemented on top of Cisco switches, that allows flexible resource provisioning. Cisco offerings are heavily policy-based; Cloud managers can define policies as constraints on the operation of a cloud deployment, which the cloud infrastructure then enforces. Cisco intends for this approach to make it easier to automate network, resource, and cloud management.

Cisco uses the intelligence embedded in its network switches and fabric to implement end-to-end security regardless of the devices connecting to the network. By offering this, Cisco aims to ensure that data flows are secure throughout all network paths in a deployment. These data paths can be further secured when they extend to external public or private clouds through the use of network virtualization. Cisco claims to provide end-to-end security for hybrid clouds and supports its security focus with many of its current technologies.

Cisco implements application centricity with its Cisco Application Centric Infrastructure (ACI). Cisco ACI is a policy-based, software-defined networking solution for simplifying and automating the management of workloads, networks, storage, servers, security, and other parts of the infrastructure. ACI provides services to all layers of the Cisco cloud stack (see Figure 2). By decoupling application needs from network resources, it makes the application the focus of the infrastructure.

The ACI ecosystem is built on a fabric component (either a Cisco Nexus 9000 series switch or a Cisco Application Virtual Switch) and the Cisco Application Policy

Infrastructure Controller (APIC). Workloads and services that use ACI are built on open APIs. Cisco curates the Cisco Developer Network for ACI, which provides documentation and other resources developers require for developing services that use the ACI fabric.[5] Along with other Cisco security solutions, Cisco uses ACI to provide network and application-level security.[6]

Cisco, widely known for networking and switching components, manufactures many cloud-ready hardware solutions. The Cisco Unified Computing System (UCS) portfolio includes cloud-ready hardware for servers, fabric, storage, and other rack-able components.[7] Software components, such as Cisco UCS Director and Cisco UCS Manager, manage UCS hardware and the Cisco UCS management software suite includes cloud-oriented tools. Though it offers many of its own cloud management packages, Cisco is vendor-agnostic regarding cloud software.

Cisco Nexus switches also include cloud-ready features. For example, Nexus 9000 series switches can operate in the standard NX-OS network operating system mode or in ACI mode for full ACI compatibility,[8] allowing applications to request infrastructure components regardless of their location. As part of the Cisco networking portfolio, Cisco provides software-defined networking functionality through ACI.[9]

Finally, Cisco offers significant professional and consulting services, and Cisco hybrid cloud users have access to a growing global partner network that can provide hybrid cloud hosting and other services. The Cisco Intercloud approach towards building a globally connected network of clouds is a significant step towards providing global hybrid coverage for its enterprise customers.

## The HP Helion approach

In contrast to Cisco, HP takes an *infrastructure-centric* approach, which emphasizes open-source OpenStack technologies. HP offerings seem to focus on ease of use, with many turnkey solutions for private and hybrid cloud.

In addition to supporting commodity hardware, HP Helion—a key product for HP hybrid clouds—provides integrated compute and storage hardware offerings with HP Helion OpenStack, its own curated branch of OpenStack as cloud management platform. HP Helion OpenStack provides tools to help IT staff integrate hardware and software, plus more tools to support HP technologies and hardware. The HP Helion platform started with significant vendor lock-in, but the pending release of CloudSystem 9.0—

[5] www.cisco.com/c/en/us/solutions/data-center-virtualization/application-centric-infrastructure/index.html
[6] www.cisco.com/c/en/us/solutions/enterprise-networks/application-centric-infrastructure-security/index.html
[7] www.cisco.com/c/en/us/products/servers-unified-computing/product-listing.html
[8] www.cisco.com/c/en/us/products/switches/nexus-9000-series-switches/index.html
[9] www.cisco.com/web/solutions/trends/sdn/index.html

another key product in the HP hybrid cloud portfolio—may relax such vendor restrictions. Helion OpenStack provides several levels of automation, allowing template-based orchestration and the use of predesigned template libraries, workflows, and scripts for server, storage, and network resource management.

The HP approach to security is *data-centric*, ensuring that all data flows in encrypted form through the hybrid cloud's data paths. By using novel data encryption techniques that preserve the shape of the data, including when it's encrypted, HP clouds allow data to flow through intermediate nodes in the network transparently. Intermediate nodes that touch a data flow can access only the data to which they've been granted access, and then only in authorized ways.

HP uses HP Virtual Cloud Networking as a software-defined networking solution. In addition, with HP Distributed Cloud Networking (DCN) it enables management of a distributed, multi-datacenter environment using network virtualization and software-defined networking.[10]

HP offers and manufactures turnkey cloud solutions marketed under the HP ConvergedSystem and HP CloudSystem brands. HP has no single tool available to manage cloud hardware infrastructure; HP OpenView accomplishes this to some extent, but has limitations. The HP hardware infrastructure offerings are strong on storage, where HP storage technologies, such as HP 3PAR and HP StoreVirtual VSA, are used as backend storage for the HP OpenStack Cinder block storage management. HP provides Tier-1 enterprise storage using HP 3PAR StoreServ storage arrays.

Under the HP Helion brand, HP offers professional services and cloud consulting in many areas, including workload mobility, Big Data, and security and risk management. HP Helion Cloud Consulting provides services for integrating, building, and advising cloud solutions. HP has a growing partner network with multiple partner programs, to which HP offers certification, marketing support, and incentives for providing services with HP technologies.

[10] www8.hp.com/us/en/products/networking-switches/product-detail.html?oid=7268885

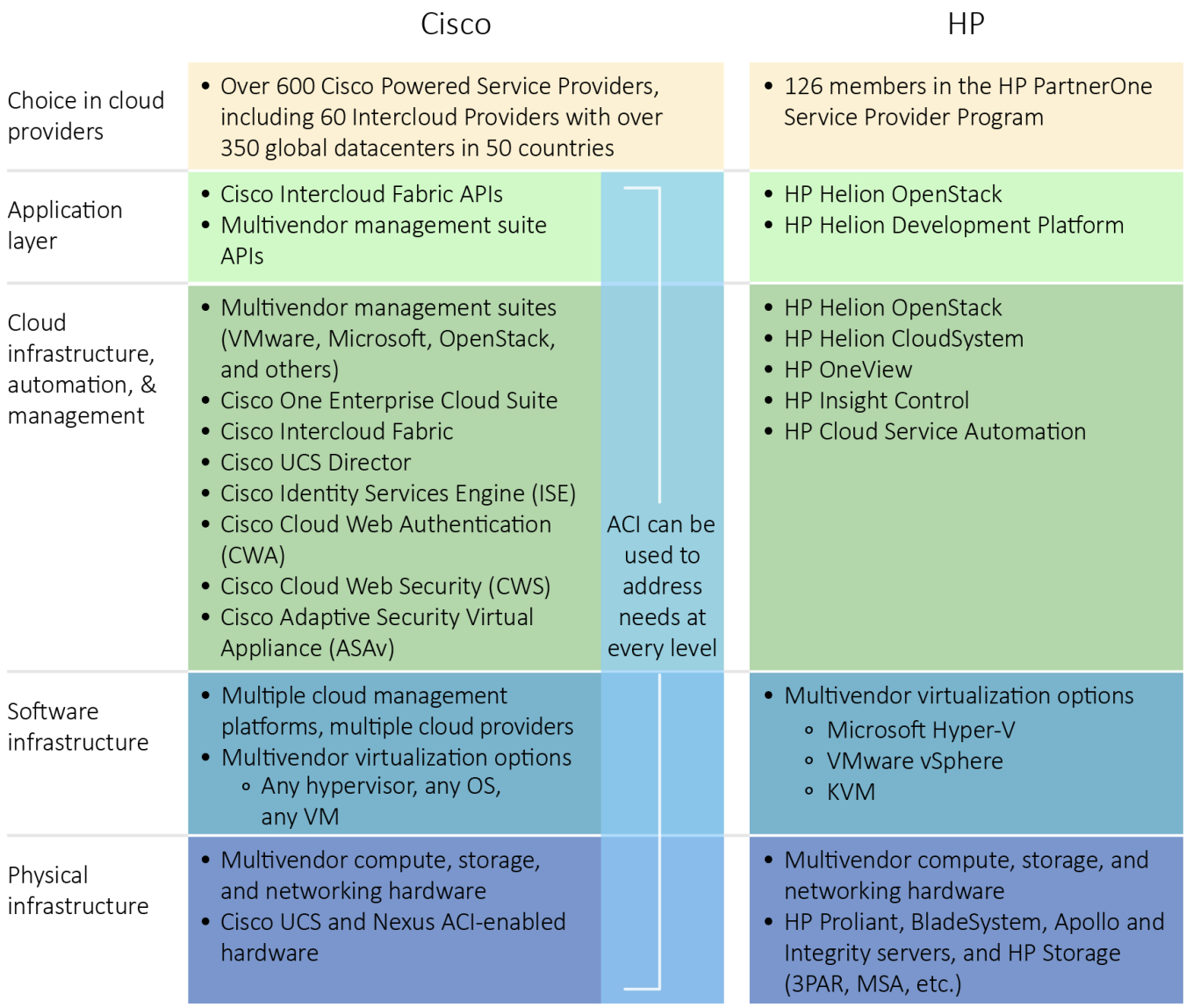


**Figure 2: A sample diagram of components for Cisco and HP Helion offerings.**

# COMPETITIVE CLOUD FEATURES

Cisco and HP take markedly different approaches to the hybrid cloud. In many cases, the approach they take determines the extent and form in which they implement specific features.

As an example, let's consider security, a central concern in cloud implementations. HP takes a data-centric approach, where the encryption of data content is fundamental. In a specific data flow, roles and access control determine which processing or storage nodes can have access to data and the kinds of access they can have. On the other hand, the Cisco view of cloud is network-centric. For Cisco,

intelligence in the network is key, and security is implemented at the network level. This allows the network to monitor and control data flow, ensuring compliance with access control and defined security policies everywhere in a hybrid cloud deployment. The network itself enforces data security.

For security and other features we compare in this paper, different perspectives on hybrid cloud lead to different implementations, and in some cases, different available functionalities.

In the following sections, we describe key competitive features of the HP and Cisco hybrid cloud portfolios; examine the approach each vendor takes; and analyze the extent to which they implement each feature with their technology and services offerings. See Appendix A for a side-by-side, detailed feature comparison.

## Cloud security

Security is often an organization's first concern when considering moving data and applications to a hybrid cloud. Companies must understand the need to have security everywhere—in addition to where data and workloads are stored and processed, the conduits that workloads travel between clouds, or between clouds and on-premises IT, must be secure, too.

In hybrid cloud environments, this means end-to-end security from mobile and IoT devices down to backend stores. On a global level, this end-to-end security is even more essential, as legal and regulatory jurisdictions in different geographies can constrain how businesses access or manipulate data as it moves around in the cloud. The security infrastructure must ensure total compliance with data migration and processing regulations in these circumstances.

There are three levels of end-to-end security:

- *Data security*, the most widely used level, applies encryption techniques to protect data objects
- *Network security* monitors and controls data flow according to uses, roles, and capabilities in the network fabric
- *Preventative security*, the newest security approach, detects and proactively prevents threats through the analysis of data flow, threat patterns, and historical behaviors using the latest data analytics technologies to catch security breaches before they can cause harm

This latest level of security responds to the fact that even in a secure network with encrypted data, cybercriminals can still penetrate the security perimeter due to a variety of reasons (social engineering, SQL injection, etc.) and do significant damage.

So how do cloud providers implement security in a hybrid cloud? Our research shows two primary approaches: a data-centric approach that focuses on using data

security and a network-centric approach that implements network security for application and data flows.

## Cisco

Cisco takes a network-centric approach to cloud security, building on traditional data encryption, and provides policy-based and end-to-end cloud security that encompasses datacenter, network, and edge device security.[11] In addition, Cisco implements preventative security above its network-centric infrastructure, with its New Generation Intrusion Prevention System (NGIPS).[12] The security of Cisco cloud deployments can extend to IoT endpoint devices that do not implement embedded device security. To achieve this, Cisco aims to ensure that the data that flows from these devices into a hybrid cloud are governed by policies, authentication, and roles and capabilities that force the data to comply with security requirements. Data, network, and preventative security from the edge can ensure secure IoT flows.

The Cisco approach can allow users to choose an appropriate balance point between security and agility for different workloads and use cases as needed. Cisco offers three key components to help provide and manage end-to-end cloud security: Cisco Identity Services Engine (ISE), Cisco Cloud Web Security (CWS), and Cisco Application Centric Infrastructure (ACI).

Cisco ISE, installed as either Cisco bare-metal instances or as a virtual appliance,[13] has components tailored and optimized for cloud, including support for BYOD models and support for VPNs or other networking access.[14] ISE provides identification of each user or device, handles provisioning, and offers a centralized view of policies and devices. According to Cisco, leveraging ISE can offer security and agility, as IT staff can gain detailed control, logged access to network resources, and policy-based automation of security tasks.

The Cisco Cloud Web Security portfolio can deliver cloud security as a web service.[15] According to Cisco, CWS solutions are protected by features like physical security, logical separation, and Cisco firewall solutions (physical or virtual).[16] Cisco CWS includes connectors and clients that target mobile devices and cloud datacenter solutions. With the CWS portfolio, Cisco intends for businesses to control Web access across a broad range of devices while preventing malware. CWS solutions can secure the hybrid cloud periphery, protect against a wide variety of threats, and continuously

[11] www.cisco.com/c/en/us/solutions/enterprise-networks/cloud-web-security-connected/index.html
[12] www.cisco.com/c/en/us/products/security/ngips/index.html
[13] www.cisco.com/c/en/us/products/collateral/security/identity-services-engine/data_sheet_c78-656174.html
[14] www.cisco.com/c/en/us/products/security/identity-services-engine/index.html
[15] www.cisco.com/c/en/us/products/security/cloud-web-security/index.html
[16] www.cisco.com/c/dam/en/us/products/collateral/security/cloud-web-security/data-privacy-final-source.pdf

monitor network and file behavior, through the use of Cisco Advanced Malware Protection (AMP) and Cognitive Threat Analytics (CTA).[17]

Cisco ACI and Cisco ISE together can provide application-aware, end-to-end security, encryption, and logged access to cloud infrastructure. They can also provide a mobile security solution that spans from mobile devices to infrastructure with Cisco end-to-end network security securing IoT devices. Cisco Nexus switches and associated management tools implement Cisco ACI, which IT groups can leverage for enhanced security in the cloud. ACI provides security benefits that can tie hardware, software, cloud management, and workloads together for top-to-bottom security.[18, 19]

In addition, ACI can integrate with the Cisco Adaptive Security Virtual Appliance (ASAv), which Cisco designed to provide enterprises with consistent security across physical, virtual, and software-defined layers. Cisco ASAv runs as a virtual machine, which brings potential for high availability and flexible provisioning.[20] Use of Cisco ASAv provides essential security services that can protect data as it passes between nodes within cloud environments.

Cisco designed Adaptive Security Appliance (ASA) firewall software to offer secure access to data and network resources regardless of time, location, or device.[21] Cisco ASA supports next-generation encryption standards, including the Suite B set of cryptographic algorithms. It integrates with the Cisco Cloud Web Security solution to provide web-based threat protection and to complement this protection Cisco offers FirePOWER hardware appliances, which provide threat and intrusion detection using data analytics. Cisco ASA and Cisco firewalls include FirePOWER technologies.

The combination of Cisco ACI and Cisco FirePOWER security allows deployment of application-specific security over multi-vendor security devices, with either physical or virtual security devices inserted into an application's data flow paths. In this way, the technologies combine to secure inner application flows, going beyond traditional edge security. They also have an added advantage: In a multi-tenant cloud network, different workloads will be isolated by and in the network fabric. Neither the workloads nor users interfere with each other.

## HP Helion

HP takes a data-centric approach to cloud security that spans cloud applications and services, cloud service broker gateways, enterprise data sources, big data analytics,

[17] www.cisco.com/c/en/us/products/collateral/security/cloud-web-security/data_sheet_c78-729637.html
[18] www.cisco.com/c/en/us/solutions/data-center-virtualization/application-centric-infrastructure/index.html
[19] www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-732354.html
[20] www.cisco.com/c/en/us/products/collateral/security/adaptive-security-virtual-appliance-asav/datasheet-c78-733399.html
[21] www.cisco.com/c/en/us/products/security/adaptive-security-appliance-asa-software/index.html

and public clouds. HP does not implement network fabric security or inline preventative security for its cloud deployments. This may cause problems if security software cannot be installed on IoT devices connecting to HP cloud deployments. The HP security approach is based on the idea of selectively protecting data at the field and subfield level from the point of creation, through its transit, to its point of consumption. Cloud-hosted custom applications with key management and encryption services help control where and how data is exposed in the application architecture. IT groups can achieve data access and audit control by encrypting data and attachments in the cloud environment. In addition, HP Labs have a number of research projects designed to increase security at the edge.[22] The HP data-centric approach meets many industry standards and supports hardware security modules for hardware cryptography, security tokens, identity management, and more.[23]

The core HP security technology is HP Security Voltage for Cloud, a data-centric framework that protects enterprise data at the data level with the intention of securing movement through the data lifecycle.[24] HP Security Voltage extends to public and private cloud patterns, such as SaaS, IaaS and PaaS, spanning private and public components of the cloud ecosystem. It provides the ability to scale up by supporting compliance of data residency requirements (data sovereignty), and can control illegal data movements by triggering unintended violations in privacy and personal information records. HP claims that Security Voltage can be used in conjunction with HP Atalla to safeguard data anywhere in the cloud.[25]

HP Security Voltage aims to protect data without fixed boundaries and data in motion as it moves across application, storage, and compute environments in the cloud and aims to secure data as soon as it is acquired or upon upload or application creation. To protect data independent of the applications, storage methods, and subsystems that use it, Security Voltage can leverage encryption and management technology. How data is encrypted depends on the application using it—selected applications decrypt data only at the time it's processed, while others work with encrypted or masked data. In conjunction with Security Voltage, HP offers data-centric security through a number of underlying technologies that address different aspects of the data-centric approach: HP Format Preserving Encryption (FPE), HP Identity Based Encryption (IBE), HP Page

[22] www.hpl.hp.com/research/security-and-cloud/secured.html
[23] www8.hp.com/us/en/software-solutions/data-security-encryption/
[24] www.voltage.com/solutions/threats/insecure-cloud-data/?utm_source=google&utm_medium=cpc&utm_term=+security%20+cloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB
[25] www8.hp.com/us/en/software-solutions/data-security-encryption/?jumpid=reg_r1002_usen_c-001_title_r0002

Integrated Encryption (PIE), HP Secure Stateless Tokenization, and HP Stateless Key Management.

HP FPE is used for encrypting fields without altering their data format, i.e. the shape and size of data fields in data stores.[26] FPE works regardless of the type of data to be encrypted, providing referential integrity and data masking to users without access rights. When it encrypts data fields, it does not need to modify existing database schemas.

HP IBE can use any arbitrary string as a public key, which can enable data protection without certificates and can significantly shorten the encryption-decryption cycle.[27] A key server can control the dynamic generation of private decryption keys corresponding to public identities, which are provided as strings. IT can then dynamically control key generation on a granular, policy-driven basis. One of the advantages of IBE is that key servers can be distributed independently and geographically, and key requests can be load balanced across them.[28]

In terms of web security, HP PIE can encrypt sensitive data in the browser, which allows data to travel encrypted through intermediate application tiers.[29] This ability by HP PIE keeps user data private as it travels through load balancers and web application stacks, and PIE decrypts data only when it reaches secured inner host systems. PIE encrypts data with host-supplied single use keys, which means if someone breaches a user browser session, the attacker cannot decrypt any other data in the system.

The last two data-security tools are HP Secure Stateless Tokenization for the protection of payment card data and HP Stateless Key Management for key

[26] https://www.voltage.com/technology/data-encryption/hp-format-preserving-encryption/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

[27] https://www.voltage.com/technology/data-encryption/identity-based-encryption/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

[28] https://www.voltage.com/resource/the-identity-based-encryption-advantage-a-proven-standard-for-protecting-information-%EF%BF%BC/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

[29] https://www.voltage.com/technology/data-encryption/page-integrated-encryption/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

management. [30, 31] Stateless Key Management can allow unbounded scaling across distributed physical and logical locations with no additional overhead. It is linkable to existing Identity Management infrastructures, including roles and groups, and can implement role-based access to data at a data-field level, mapping directly to enterprise data access rules and policies.

According to HP, IT groups can use HP security technologies to implement country data privacy and data residency laws while providing the flexibility to move data to any location. By using HP Security Voltage technologies to maintain a common, identical representation of data in every instance, organizations can achieve consistency and reversibility of sensitive data as it moves around. Simultaneously, they can use HP Stateless Key Management to analyze data in protected form in one region while using data decryption de-tokenization in other regions where it's permitted.

## Hardware integration

Organizations integrating any kind of cloud solution must consider the hardware components to use, as well as the manageability and ease of control these provide. To maintain a successful cloud infrastructure, it is critical to have capable, reliable hardware to support the cloud and its network connectivity.

### Cisco

Cisco remains a leader in the networking and switching space, with over 60 percent global revenue market share in 4Q14.[32] The Cisco UCS portfolio, specifically, includes a comprehensive array of compute technologies such as rack and blade servers, blade chassis, racks, modular servers, and fabric extenders.[33]

Cisco's switch offerings for the cloud market center on the Cisco Nexus series and the Cisco MDS series, datacenter-level SAN switches.[34] The Nexus series switches include switches capable of running in ACI-mode or NX-OS mode, and virtual switches such as the Cisco Nexus 1000V.[35] Through ACI, Cisco Nexus hardware switches can

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[30] https://www.voltage.com/technology/tokenization-and-key-management/hp-secure-stateless-tokenization/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

[31] https://www.voltage.com/technology/tokenization-and-key-management/stateless-key-management/?utm_source=google&utm_medium=cpc&utm_term=%2Bsecurity%20%2Bcloud&utm_campaign=generic&utm_content=SecureDataCloudGeneric&gclid=CjwKEAjw_MisBRCTuNPfoMqU4ngSJACrJv1VV2ANF5lFrgfe4X4WLF8HmjveHAQGekKDGj5_fXGclRoC98bw_wcB

[32] www.idc.com/getdoc.jsp?containerId=prUS25453715

[33] www.cisco.com/c/dam/en/us/products/collateral/servers-unified-computing/ucs-family-poster.pdf

[34] http://www.cisco.com/c/en/us/products/storage-networking/product-listing.html

[35] http://www.cisco.com/c/en/us/products/switches/data-center-switches/index.html#~products-services

dynamically respond to changing environments and workloads with the goal of shortening application deployment times and increasing security.[36] The Cisco MDS series SAN solutions share OS language with Cisco Nexus switches for ease of use and adoption of technologies.[37]

Cisco hardware can support many different cloud services vendors through Nexus switches or UCS components and hardware. Cisco has many integrated solutions that can use third-party storage to provide predesigned building blocks for horizontal scalability.

Cisco's partnerships with storage vendors allow for multi-vendor configurations that can eliminate vendor lock-in and give users a choice for storage. Vendors such as EMC, IBM, Nimble, and Hitachi have multiple options that span from all-flash arrays to high-density spinning-disk arrays to solutions for backup and disaster recovery.

### *Hardware management*

Cisco UCS hardware can be managed by Cisco UCS Director,[38] which provides many features designed to help implement cloud solutions and integrate hardware management with cloud management. UCS Director can allow users to manage virtual networks and hypervisors. Cisco UCS and UCS Director can simplify deployments by providing open APIs. Integration tools such as Cisco Intercloud Fabric (ICF) and Cisco Integration Platform leverage deployments for a single point-of-access to cloud and hardware infrastructure.

Cisco Prime Infrastructure includes management tools to manage LAN and WAN networks by integrating with Cisco Identity Services Engine and Cisco Mobility Services Engine. To enable higher security and service assurance, Cisco Prime provides for management and views of Cisco UCS Nexus switches and servers.[39] Cisco Prime Data Center Network Manager allows users to monitor and provision SAN elements by integrating different components.

## HP Helion

In 4Q14, HP led the industry in server revenue, with a revenue share of 27.9 percent.[40] In addition to its servers, HP sells a wide array of compute and storage solutions.[41] HP ProLiant, Integrity, Integrity NonStop, Apollo and BladeSystem servers comprise the HP compute lineup, while HP 3PAR StoreServ, Modular Smart Array, disk

[36] www.cisco.com/c/en/us/solutions/data-center-virtualization/application-centric-infrastructure/index.html#~products
[37] http://www.cisco.com/c/en/us/products/storage-networking/index.html
[38] www.cisco.com/c/en/us/products/servers-unified-computing/ucs-director/index.html
[39] www.cisco.com/c/en/us/products/cloud-systems-management/prime-infrastructure/index.html
[40] www.gartner.com/newsroom/id/2997118
[41] h20195.www2.hp.com/v2/GetPDF.aspx%2F4AA0-8758ENW.pdf

enclosures, and various tape arrays provide storage options.[42] HP also offers datacenter-level networking options, including Core Switches, Access Switches, Open Network Switches, and Routers.[43]

The HP hardware portfolio caters to the cloud market with multiple preconfigured hardware systems, including HP Helion Rack and the HP ConvergedSystem lineup.[44] HP Helion Rack includes HP ProLiant servers of varying models and uses HP Helion OpenStack's Ironic bare-metal provisioning for bare-metal server deployment and management.[45]

In 2010, HP purchased 3PAR, giving HP expanded storage technologies and products to bolster the company's offerings.[46] The 3PAR storage portfolio includes all-flash arrays such as the HP 3PAR StoreServ 2450c, plus standard spinning-disk arrays like the StoreServ 7000.[47] HP 3PAR storage integrates into HP OneView for unified management.[48]

### *Hardware management*

HP offers three tools as hardware integration APIs to help provision and deploy networks on HP compute resources and multivendor networking and storage resources: OneView, HP Insight Control, and HP CloudSystem. Specifically, HP OneView plays an important part in the management and automation of many HP hardware deployments, and offers a single view for management of HP servers, storage, enclosures, and networking. HP intends for OneView to manage firmware, SANs, and BIOS/UEFI settings while monitoring systems for trouble.[49] It can integrate with Microsoft System Center and VMware vCenter. [50,51]

HP Insight Control allows users to deploy operating systems to HP ProLiant servers and migrate servers when necessary. However, OneView appears to subsume Insight Control functionality with additional features.[52] OneView includes HP Insight Control server provisioning, and together, the two can deploy an OS.[53]

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[42] h20195.www2.hp.com/v2/GetPDF.aspx%2F4AA0-8758ENW.pdf
[43] www8.hp.com/us/en/networking/datacenter/
[44] www8.hp.com/us/en/cloud/helionrack.html
[45] www8.hp.com/us/en/business-solutions/converged-systems/
[46] www8.hp.com/us/en/hp-news/press-release.html?id=597925#.VdN8oa39xfA
[47] www8.hp.com/us/en/products/data-storage/3parstoreserv.html
[48] www8.hp.com/us/en/business-solutions/converged-systems/oneview.html?jumpid=va_is95kdr6bm
[49] www8.hp.com/us/en/business-solutions/converged-systems/oneview.html
[50] www8.hp.com/us/en/products/server-software/product-detail.html?oid=5390822
[51] www8.hp.com/us/en/products/server-software/product-detail.html?oid=4152978
[52] h20195.www2.hp.com/V2/getpdf.aspx/4AA4-8543ENW.pdf
[53] h20195.www2.hp.com/V2/getpdf.aspx/4AA4-8543ENW.pdf

For cloud management, HP offers a couple key software solutions. HP Helion CloudSystem is designed to be a complete package of cloud management software tools.[54] In addition, HP ConvergedSystem 700x for cloud uses HP OneView to manage and monitor hardware. For an HP hyper-converged system, there is the HP ConvergedSystem 200-HC StoreVirtual platform, which uses the same HP CloudSystem and OneView management platforms.

## OpenStack

To make cloud computing automated, easy-to-use, cost-effective, and secure, a good cloud management suite is necessary. Many companies develop software to meet this need: Microsoft offers the System Center portfolio,[55] VMware offers vCloud Suite,[56] Apache offers open-source CloudStack,[57] and the OpenStack Foundation offers OpenStack, a widely used open source project.

The OpenStack project was formed in 2010 as a collaboration between NASA and Rackspace hosting. Since then, it has had over twelve official releases, with each release adding new features.[58] Because OpenStack is open sourced under the Apache 2.0 license, companies such as Cisco and HP can freely use OpenStack technologies and contribute back to the OpenStack project.

### Cisco

Cisco is one of the twenty-four Gold Members of the OpenStack Foundation and is currently the largest contributor to Neutron, the networking component of OpenStack. [59, 60] Cisco attends OpenStack summits and provides educational materials for users.[61]

Cisco promotes and uses OpenStack in several products, such as the Cisco OpenStack Private Cloud, a private cloud solution managed, deployed, and remotely operated at a customer's location.[62] OpenStack Private Cloud uses a Cisco-curated flavor of OpenStack that has enhanced features, including an enhanced dashboard and networking features beyond those of OpenStack Neutron.[63, 64] Other Cisco cloud

[54] www8.hp.com/us/en/products/solutions/product-detail.html?oid=6970376#!tab=features
[55] www.microsoft.com/en-us/server-cloud/products/system-center-2012-r2/
[56] https://www.vmware.com/products/vcloud-suite
[57] https://cloudstack.apache.org/
[58] https://wiki.openstack.org/wiki/Releases
[59] https://www.openstack.org/foundation/companies/
[60] stackalytics.com/?release=all&module=neutron-group
[61] www.cisco.com/c/en/us/solutions/data-center-virtualization/openstack-at-cisco/index.html#~events
[62] www.cisco.com/c/en/us/products/cloud-systems-management/openstack-private-cloud/index.html
[63] http://www.cisco.com/c/en/us/products/cloud-systems-management/openstack-private-cloud/dashboard-identity.html
[64] http://www.cisco.com/c/en/us/products/cloud-systems-management/openstack-private-cloud/cloud-comparison.html

products, such as WebEx and WebEx Spark, run on OpenStack-powered cloud infrastructure. [65]

Cisco promotes and contributes to OpenStack and supports other cloud management platforms, such as Microsoft System Center, by integrating their ACI technology.[66] By providing support, plugins, and integration tools for other cloud management platforms, Cisco gives customers expanded choice when it comes to the cloud.

## HP Helion

HP contributes heavily, in both code and funding, to the OpenStack Foundation; in fact, HP is one of a group of select members that have provided funding and other resources to the foundation.[67] As of August 2015, HP is the top code contributor to the three most recent OpenStack releases (Juno, Liberty, and Kilo) and the second place enterprise contributor of all time.[68]

The heavy HP focus on the OpenStack ecosystem means that all core HP Helion offerings use OpenStack technologies.[69] HP Helion OpenStack is a flavor of OpenStack customized and supported by HP.[70] HP Helion OpenStack includes all the standard features of OpenStack plus a few HP-developed tools, such as Sirius, which allows for enhanced storage service management; EON, which integrates with VMware vCenter; and Sherpa, a catalog of purchasable and downloadable software for HP Helion OpenStack.[71] HP CloudSystem 9.0, announced in June 2015, integrates HP Helion OpenStack and the HP Helion Development Platform to provide an open-source platform for cloud services.[72]

The HP focus on OpenStack extends into other products in the HP portfolio, including HP CSA, HP Helion Eucalyptus, HP Helion Rack, HP Helion Content Depot, and others.[73] HP, like Cisco, offers a managed onsite private cloud solution using OpenStack technologies.[74]

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[65] www.cisco.com/c/en/us/solutions/data-center-virtualization/openstack-at-cisco/index.html#~overview
[66] blogs.cisco.com/datacenter/aci-ciscos-application-centric-infrastructure-for-microsoft-system-center-windows-azure-pack-and-more
[67] https://www.openstack.org/foundation/companies/
[68] stackalytics.com/?release=all
[69] www8.hp.com/us/en/cloud/helion-portfolio.html#!&pd1=2&pd3=2&pd5=2.
[70] www8.hp.com/us/en/cloud/hphelion-openstack.html
[71] docs.hpcloud.com/#commercial/GA1/1.1commerical.services-overview.html
[72] www8.hp.com/us/en/hp-news/press-release.html?id=1998065
[73] www8.hp.com/us/en/cloud/helion-portfolio.html#!&pd1=2&pd3=2&pd5=2
[74] www8.hp.com/us/en/business-solutions/solution.html?compURI=1762950#.VdpQCFNVikr

## Networking

If the core of cloud technology is connectivity, then network availability and accessibility are essential. Cloud vendors such as Cisco and HP provide multiple networking options—in hardware and software—for catering to public, private, and hybrid clouds, both on- and off-premises.

### Cisco

The Cisco approach enables seamless networking through a hybrid-IT deployment, spanning legacy IT, on-premises clouds, hosted private clouds, and public clouds. For the hybrid cloud, the Cisco portfolio includes a number of solutions designed to create a seamless network and the heart of its approach is Intercloud Fabric (ICF).

Cisco ICF uses seamless cloud networking technologies to enable the migration and movement of workloads in the hybrid environment. Installed as a suite of virtual appliances, ICF includes many networking features such as extending Layer 2 networking functionality from private to public clouds.[75] ICF offers switching, routing, NAT, and firewall capabilities that can extend security and networking to the hybrid cloud.

Cisco Cloud Connectors can work in conjunction with Cisco ICF to help businesses use cloud applications designed for low-latency LAN environments over a higher-latency WAN environment, a configuration found in hybrid cloud settings with public or off-site private clouds. The goal of utilizing a Cloud Connector in a virtualized environment is to provide secure cloud connectivity and networking to any location, datacenter, or public cloud. Cisco Cloud Connectors provide other features critical for a hybrid cloud solution, including Quality of Service (QoS), application-aware networking, and location-aware features.

Other useful Cisco tools for creating cloud-ready networks include software-defined networking options such as the Cisco Nexus 1000V series switches for Hyper-V and vSphere.[76] Cisco ACI, a software-defined network solution, supports the use of the Nexus 9000 series switches in ACI-mode.[77] The Cisco ACI fabric provides a framework for seamless cloud networking and integrates with third parties such as VMware.[78] In addition, Cisco ACI fabrics are compatible with existing virtual switches (Cisco Nexus 1000v series) through the use of the Cisco Application Virtual Switch (AVS). Cisco AVS extends ACI control into the virtualization layer.[79]

[75] www.cisco.com/c/en/us/products/cloud-systems-management/intercloud-fabric/intercloud-fabric-for-business.html
[76] www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/dc-partner-microsoft/solution_overview_c22-687087.html
[77] www.cisco.com/c/en/us/solutions/data-center-virtualization/application-centric-infrastructure/index.html
[78] http://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/unified-fabric/solution-brief-c22-729866.html
[79] www.cisco.com/c/en/us/products/switches/application-virtual-switch/index.html

For OpenStack connectivity, Cisco and the OpenStack community have developed plugins for Neutron, the networking component of OpenStack. The Cisco UCS/Nexus Plugin and Cisco Nexus1000v Plugin allow OpenStack network integration with the Cisco Nexus Series of hardware switches and the Cisco Nexus 100v virtual switch.[80]

## HP Helion

HP tools for hybrid cloud networking all integrate with HP Helion OpenStack and can provide a framework to configure a seamless cloud. With the HP push for open-source development, new technologies may appear that can integrate with the HP networking portfolio.

The HP Helion networking portfolio includes products such as HP Distributed Cloud Networking, the HP Virtual Cloud Networking (VCN) Software-Defined Networking (SDN) Application, and the HP Virtual Application Networks (VAN) SDN Controller. Specifically, the three products focus on network virtualization.[81] In addition, HP Helion OpenStack includes many tools and plugins for integrating cloud networks.[82]

HP Distributed Cloud Networking is built on top of HP software-defined networking and virtualization technologies.[83] It becomes a full layer-2-to-layer-4 virtualization platform by using HP Virtual Routing Switch, HP Virtual Services Controller, and HP Virtual Services Directory.[84] Aimed at large enterprise or service providers, it helps users bypass boundaries, such as those of datacenter locations. It integrates with OpenStack, HP Helion OpenStack, CloudStack, HP CSA, and other products. The technology communicates using open standards, allowing developers to integrate it into their own products.

The HP VCN SDN Application is the enhanced networking module of HP Helion OpenStack, expanding on the features in OpenStack Neutron, and allows users to implement network virtualization and software-defined networking technologies to help create a cloud network.[85] HP VCN SDN uses OpenFlow to manage virtual and physical switches. In addition, HP has developed products to help integrate their SDN Application architecture to VMware NSX.[86]

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[80] https://wiki.openstack.org/wiki/Neutron
[81] www8.hp.com/us/en/networking/sdn/network-virtualization.html
[82] docs.hpcloud.com/#commercial/GA1/1.1commerical.services-networking-overview.html
[83] www8.hp.com/us/en/products/networking-switches/product-detail.html?oid=7268885
[84] h20195.www2.hp.com/v2/GetDocument.aspx?docname=4AA5-3716ENW&doctype=data%20sheet&doclang=EN_US&searchquery=&cc=us&lc=en
[85] www8.hp.com/h20195/V2/GetDocument.aspx?docname=4AA5-3224ENW&cc=us&lc=en
[86] www8.hp.com/h20195/V2/GetDocument.aspx?docname=4AA5-4307ENW&cc=us&lc=en

Ideally, IT staff can use Neutron technologies to help create and enable a seamless hybrid cloud. As part of HP Helion OpenStack, Neutron provides networking capabilities and supports several plugins that integrate third-party technologies.[87, 88]

The HP VAN SDN controller integrates with the HP VCN SDN application and can expand OpenStack networking functionality. HP VAN SDN can provide a unified control point and can simplify management, provisioning, and orchestration in an OpenFlow-enabled network. The HP VAN SDN controller enables third-party developers to develop application services that use open APIs to dynamically link business requirements to network infrastructures.[89]

## Management suites and workload mobility

IT datacenter staff can see significant benefits from cloud management automation, whether their aim is to maintain a virtualized cloud infrastructure, support the application development and deployment lifecycle, or move application or data workloads through a hybrid cloud. Any time savings achieved through automation can have high returns for the business in financial and resource utilization terms, especially as clouds scale up in the path to hybrid IT. Aside from automation, the ability to perform cloud management tasks from a "single pane of glass," i.e. a single UX interface for all management aspects, can simplify an IT organization's daily management load.

### Cisco

Cisco has an open approach to management packages as Cisco cloud management tools can, in some cases, directly manage cloud infrastructure from other vendors. The goal of Cisco hybrid cloud management tools is to offer a single, straightforward, and customizable interface for managing cloud conglomerates and seamlessly moving workloads. The Cisco cloud management and mobility portfolio includes a number of technologies, centered on the Cisco ONE Enterprise Suite. This suite includes Cisco Intercloud Fabric (ICF), Cisco UCS Director, and Cisco Prime Service Catalog and adds Cisco Virtual Application Container Services, which provides polices and network templates that can manage virtual and logical networks through Cisco UCS Director.[90] [91]

[87] docs.hpcloud.com/#commercial/GA1/1.1commerical.services-networking-overview.html
[88] https://wiki.openstack.org/wiki/Neutron#Plugins
[89] h17007.www1.hp.com/us/en/networking/products/network-management/HP_VAN_SDN_Controller_Software/index.aspx#.Vdotnngm-Zc
[90] www.cisco.com/c/en/us/solutions/data-center-virtualization/one-enterprise-suite/index.html
[91] www.cisco.com/c/en/us/solutions/data-center-virtualization/cloud-management/index.html

Cisco IAC features tools that allow management of Amazon Web Services (AWS) EC2 instances, VMware vSphere installs, and more.[92] [93] IAC installs as a virtual appliance and offers a self-service portal, tenant segregation, provisioning automation, and integration with Cisco UCS, VMware vCloud Director, and other tools in addition to AWS and OpenStack integration.

Cloud service providers, partners, and businesses can all use Cisco Intercloud Fabric (ICF), a hybrid cloud framework and management dashboard that allows for automated workload mobility and migration, for cloud management. ICF can provide seamless workload portability across third-party public cloud vendors. For businesses, this means Cisco ICF installs as a virtual appliance and can offer seamless networking for Cisco partners, Azure, and AWS.

IT staff can use Cisco UCS Director to create and manipulate virtual machines, hosts, and virtual network resources.[94] UCS Director can provide out-of-the-box, integrated support for VMware, Microsoft Hyper-V, and Red Hat KVM hypervisors. It also supports integration into other cloud management suites such as Microsoft System Center.

Along the same lines as UCS Director, Cisco Prime Service Catalog provides automation services through a UI that allows users to provision services and applications in a repeatable manner. In addition, the interface lets users order IT services from a list.[95]

## HP Helion

The HP array of cloud management products allow for flexible workload placement in a hybrid cloud environment and heavily focus on OpenStack technologies. HP cloud management products include HP CloudSystem, HP Cloud Service Automation, HP Server Automation, and HP Helion OpenStack.[96] HP CloudSystem 9.0 increases the reliance and focus on OpenStack to provide many cloud management capabilities.

HP Helion OpenStack forms the backbone of HP CloudSystem 9.0 and it includes all the standard OpenStack components in addition to HP-curated packages.[97],[98] Helion OpenStack provides tools for cloud monitoring, cloud orchestration, network and storage management, and various other tasks.

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[92] www.cisco.com/c/en/us/products/cloud-systems-management/intelligent-automation-cloud/index.html
[93] http://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/intelligent-automation-cloud/data_sheet_c78-678564.html
[94] www.cisco.com/c/en/us/products/servers-unified-computing/ucs-director/index.html
[95] www.cisco.com/c/en/us/products/collateral/cloud-systems-management/prime-service-catalog/data_sheet_c78-728748.html
[96] www8.hp.com/us/en/software-solutions/hybrid-cloud-management/
[97] www8.hp.com/us/en/cloud/cloudsystem.html
[98] docs.hpcloud.com/#commercial/GA1/1.1commerical.services-overview.html

HP Cloud Service Automation allows users to create, manage, and order cloud services, as well as manage other public clouds such as AWS and Azure.[99] It can function as a cost manager by providing bills for users of cloud services; it can deploy databases as part of cloud services or applications.

HP Server Automation and its newer sibling, HP Data Center Automation Virtual Appliance, offer cloud change management and the ability to request service and schedule tasks. To help with VM deployment, Server Automation and Data Center Automation Virtual Appliance integrate with VMware and OpenStack technologies.[100] The tools appear to just ensure compliance in a cloud environment.

HP sells CloudSystem in either HP CloudSystem Foundation or HP CloudSystem Enterprise.[101] HP CloudSystem Foundation focuses on providing a way for businesses to have an Infrastructure-as-a-Service (IaaS) solution. HP CloudSystem Enterprise goes beyond CloudSystem Foundation by allowing users to provide application-as-a-service or platform-as-a-service.[102] Announced in June 2015, the latest version of HP CloudSystem expands support to three hypervisors, allows users to choose where workloads reside, and can offer public cloud interoperability.[103] CloudSystem deployments include the latest version of HP Cloud Service Automation.

## Vendor lock-in and supported hypervisors

Some businesses prefer to use proven combinations of technologies, while others would rather make their technology choices independently. Cloud portfolios that support a wide array of hypervisors can offer customer flexibility and prevent vendor lock-in.

### Cisco

The Cisco cloud portfolio strives to support any workload on any hypervisor on any cloud.[104] Cisco welcomes and supports many cloud management platforms, such as Microsoft System Center, VMware vCloud, CloudStack, and OpenStack, among others. Cisco also supports various public cloud vendors, such as Azure and AWS, in Cisco Intercloud Fabric.[105] Due to its functionality, Intercloud Fabric essentially removes elements of vendor lock-in.

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[99] www8.hp.com/us/en/software-solutions/cloud-service-automation/
[100] www8.hp.com/us/en/software-solutions/server-automation-software/index.html
[101] www8.hp.com/us/en/cloud/cloudsystem.html
[102] www8.hp.com/us/en/cloud/cloudsystem-enterprise.html
[103] www8.hp.com/us/en/hp-news/press-release.html?id=1998065#.VdVWqFNViko
[104] www.cisco.com/web/solutions/trends/cloud/index.html
[105] www.cisco.com/c/en/us/products/collateral/cloud-systems-management/intercloud-fabric/datasheet-c78-732856.html

The Cisco cloud portfolio is hypervisor agnostic, supporting many management platforms and their associated hypervisors including Microsoft Hyper-V, VMware vSphere, KVM, Citrix Xen, and others. Specifically, Intercloud Fabric currently supports Hyper-V, KVM, and vSphere, and Cisco plans to expand support to more.[106]

Cisco doesn't require customers to use only Cisco hardware. By allowing compute, storage, and networking resources from third party vendors, Cisco invites customers to make the move to the Cisco cloud using existing hardware and software or their preferred infrastructure vendors.

### HP Helion

HP doesn't require users to purchase or use HP hardware to utilize hybrid cloud products such as HP Helion CloudSystem or HP Helion OpenStack.[107] HP CloudSystem 9.0 expands support to VMware vSphere, Microsoft Hyper-V, and KVM.[108] The previous version of CloudSystem supported only VMware vSphere and KVM.[109] With regard to OpenStack, HP offers products that support management platforms other than those derived from OpenStack, but many products, such as HP VCN SDN Application, require OpenStack to function.[110, 111] Many of the features available in HP Cloud Service Automation and HP Helion OpenStack support third-party tools, hardware, and plugins.[112, 113]

## Professional services and cloud support

Some companies may not have the in-house knowledge or expertise to install, configure, and use hybrid cloud technologies. For this reason, cloud providers often offer consulting or professional services to help their customers make informed decisions in their transition to the cloud. It's important to have a structure to remedy a problem as quickly as possible. Good support structures can offer help with hardware- and software-related hybrid cloud problems.

In addition, when companies make business decisions regarding the cloud—including how and where they want to use cloud technologies—they need data to justify their choices. This data can come from internal studies, consulting, online tools, and other sources.

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[106] www.cisco.com/c/en/us/products/cloud-systems-management/intercloud-fabric/at-a-glance-listing.html
[107] www8.hp.com/us/en/cloud/cloudsystem.html
[108] www8.hp.com/h20195/v2/GetDocument.aspx?docname=4AA5-9612ENW
[109] docs.hpcloud.com/#commercial/GA1/1.1commercial.install-GA-supportmatrix.html
[110] h20195.www2.hp.com/V2/getpdf.aspx/4AA5-0275ENW
[111] www8.hp.com/h20195/V2/GetDocument.aspx?docname=4AA5-3224ENW&cc=us&lc=en
[112] www8.hp.com/us/en/software-solutions/cloud-service-automation/
[113] www8.hp.com/us/en/cloud/hphelion-openstack.html

## Cisco

Cisco's consulting, professional, and support services—which Cisco sells for a fee or through a warranty—are designed to help businesses maintain, manage, and support their hybrid cloud model.[114] Cisco and Cisco partners can provide these consulting options to any cloud consumer, customizing them to business needs.

Cisco Solution Support for ACI provides cloud users with Cisco expert engineers that manage resolution for any issue with any hardware or software vendor in your Cisco ACI ecosystem.[115] Different levels of support under the Cisco model can allow coverage of hardware (Cisco Nexus 9000 switches) and can provide on-site support.[116] Cisco also offers support under the Cisco Data Center Solution Support Service brand,[117] which, Cisco claims, offers the expertise of specialists in many Cisco technologies, including product-specific experts if needed. Under the Cisco Powered Cloud Services and Cisco Powered Managed Services brand, enterprises can leverage Cisco partners to provide services such as support, managed cloud services, and Cisco Managed connectivity services.[118]

Cisco and Cisco partners offer a variety of cloud consulting services, including services to help businesses deal with their pre-existing cloud environments and to determine how much, where, and what type of cloud solutions to purchase.[119] According to Cisco, with Cisco Cloud Consumption Service, enterprises can discover what they're spending on cloud services and determine how to minimize unnecessary cloud sprawl.[120] Cisco Cloud Enablement Services for Enterprises provide services built around the Cisco Domain Ten framework,[121] a method of planning and implementing IT services and roadmaps for future transitions in a structured, repeatable manner. With the Cisco suite of Cloud Services for Building Clouds and Adopting Clouds, enterprises can learn strategies for implementing private and hybrid cloud technologies.[122]

### *Cloud assessment tools*

To help businesses create cloud strategies, Cisco recently launched the Cisco Business Cloud Advisor (BCS) Adoption Tool. This tool receives relevant company information and provides data from an in-depth IDC study, funded by Cisco, of cloud

[114] www.cisco.com/web/solutions/trends/cloud/cloud-consulting-services.html
[115] www.cisco.com/c/dam/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/sspt-aci-aag.pdf
[116] www.cisco.com/c/dam/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/sspt-aci-overview.pdf
[117] www.cisco.com/c/dam/en/us/products/collateral/data-center-virtualization/sales-tool-c96-730421.pdf
[118] www.cisco.com/web/solutions/trends/cisco-powered/services.html#~Services
[119] www.cisco.com/web/services/enterprise-it-services/cloud-enablement-services/index.html
[120] www.cisco.com/web/solutions/trends/cloud/cloud-consumption-services.html
[121] www.cisco.com/en/US/services/ps2961/ps10364/ps11104/cloud_enablement_services_aag.pdf
[122] www.cisco.com/web/services/enterprise-it-services/cloud-enablement-services/index.html

deployments.[123, 124] Cisco and IDC studied over 3,400 cloud deployments in 17 countries to gather data on the factors that affect and are affected by the cloud. The data from this research helped create a repeatable and independent framework used in BCA to help businesses make cloud decisions.[125]

## HP Helion

HP offers support, consulting, educational, and professional services for hardware and cloud solutions. With HP Cloud Consulting, businesses can use the HP Transform to Cloud methodology to build a cloud from start to finish.[126] HP Helion Professional Services include advice for companies who have access to cloud technologies but need to better integrate them into their business.[127]

Other HP consulting and support services:

- HP Big Data Consulting – designed to help with implementing, managing, and analyzing Big Data solutions
- HP Advisory Services – give customers information about the benefits, challenges, and opportunities of cloud services; offer workshops and online lectures
- HP Implementation Services – help businesses integrate and use HP technologies in their cloud environment
- HP Design Services – provide custom solutions for a user or a business
- HP Application Transformation Services – designed to move applications and data to the cloud
- HP Helion – provides various support channels for their hardware and solution implementation; offers education on HP technologies
- HP Insight Online – offers a dashboard of all covered devices and services for which a business has technical support; shows open tickets and lets customers view resolution status
- HP Helion Support Services – includes Helion educational programs, repeatable methodologies, an assigned account team, a pay-per-use model, and support for multivendor systems

### *Cloud assessment tools*

HP offers HP Helion Assessment, a tool that allows companies to receive information on what type of cloud is right for them based on their answers to five questions.[128]

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[123] newsroom.cisco.com/press-release-content?type=webcontent&articleId=1714059
[124] https://www.youtube.com/watch?v=4G5naD7qiCE
[125] https://www.ciscobusinesscloudadvisoradoptiontool.com/
[126] www8.hp.com/us/en/business-services/it-services/cloud-services.html
[127] www8.hp.com/us/en/cloud/services-overview.html
[128] www8.hp.com/us/en/business-solutions/cloud-assessment/

## Data virtualization

Data stored in a hybrid cloud may be located in many geographically distributed data stores, each with different schemas and representations. To use data in the cloud for business intelligence and analytics, those data components must be consolidated into unified views.

Data virtualization is a critical piece of hybrid cloud data management. It goes well beyond simple data federation. Data virtualization enables IT staff to use a unified schema for accessing the data they need without worrying about how the various data components are represented and stored in the cloud. This approach can increase IT agility as cloud applications on virtualized data can be developed using a single virtual schema, ignoring the details of the provenance of the various data pieces.

### Cisco

A recent white paper by Forrester, entitled "Forrester Wave: Enterprise Data Virtualization, Q1 2015," places Cisco as a leader in data virtualization. The study points to Cisco Information Server (CIS), its data virtualization platform, and to Cisco's increasing installed base, after its acquisition of Composite Software in 2013, as key factors in Cisco's leadership position.[129]

With the acquisition of Composite, Cisco has become the data virtualization vendor with the longest-standing technology platform in the market. In the past two years, Cisco has evolved the platform's scalability, security, and integration with Hadoop and IoT, gearing it for hybrid cloud and Big Data deployments.

CIS, a Java-based server that federates disparate data, abstracts distributed data, and delivers data services or logical business views to applications that consume data, is the foundation of the Cisco Data Virtualization Suite.[130] Cisco claims CIS provides advanced data querying with the highest performance. The Cisco Data Virtualization Suite includes components and options that can enhance ease of use and scalability.

According to Forrester, some Cisco customers are using its data virtualization platform to support petabyte data volumes. Forrester believes Cisco will integrate its data virtualization solution into its network routers and switches. This integration could deliver more network fabric intelligence to help optimize data movement and network traffic across global datacenters in the cloud.

[129] https://www.forrester.com/The+Forrester+Wave+Enterprise+Data+Virtualization+Q1+2015/fulltext/-/E-res117844
[130] www.cisco.com/web/services/enterprise-it-services/data-virtualization/documents/cisco-information-server-ds.pdf

### HP Helion

HP had a strong collaboration with Composite on its own data virtualization initiatives for several years prior to the Cisco acquisition. Although HP currently doesn't appear to have any data virtualization technologies in its portfolio, HP Helion cloud deployments could conceivably use data virtualization solutions from a number of data virtualization providers, including Cisco.[131, 132]

## Data sovereignty

Data sovereignty is the idea that data stored in a host country must abide by those laws, regardless of the owner of the data. Many countries have laws pertaining to their ability to subpoena the data.

### Cisco

As of August 2015, there are over 600 Cisco Powered Service Providers including 60 Intercloud Service Providers covering over 350 datacenters in 50 countries.[133, 134] This creates an ecosystem in which cloud data can reside where it is used and needed, to obtain good performance and to maintain data sovereignty. Cisco provides as many on-premises private cloud solutions, self-managed or managed, as a business' policies or needs require.[135]

### HP Helion

HP has two points of entry to cloud via partners: The HP PartnerOne partner network and the HP Helion network.[136, 137] As of August 2015, we counted a total of 126 members in the HP PartnerOne network. Of these, around 100 were cloud builders. The list also included cloud resellers and cloud service providers.

The HP Helion network promotes collaboration between channel and service provider partners. Launched in June 2015, the HP Helion Partner Marketplace is a key part of the network in the US and HP plans to expand to other geographies in the future.[138] HP Helion Public Cloud has two datacenter regions in the United States: East (located in Reston, NJ) and West (located in Las Vegas, NV).[139] HP Helion works to assure customers that their data meets sovereignty laws and abides by the US Patriot Act.[140]

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[131] www.idevnews.com/stories/4135/HP-Composite-Team-To-Improve-Data-Virtualization-Middleware
[132] www.compositesw.com/news-events/pages/composite-software-data-virtualization-now-interoperates-with-hp-neoview-da/
[133] blogs.cisco.com/partner/igniting-the-intercloud-partner-ecosystem
[134] blogs.cisco.com/cloud/carrier-class-cloud
[135] www.cisco.com/c/en/us/solutions/data-center-virtualization/private-cloud/index.html
[136] h22168.www2.hp.com/us/en/partner-one-service-provider/index.aspx
[137] www8.hp.com/us/en/cloud/helion-network-overview.html
[138] https://us.helionmarketplace.com/
[139] https://www.openstack.org/marketplace/public-clouds/hp/hp-helion-public-cloud
[140] www8.hp.com/uk/en/campaigns/your-cloud-your-way/sovereignty.html

HP, through its Helion cloud, provides many options for creating on-premises private clouds, whether managed or self-managed, for companies that require them.[141]

## Software Development and DevOps

One of the major benefits of the cloud is flexibility. The best cloud solutions make it easy to move code from development to quality assurance to production and beyond. Being able to move seamlessly from development to deployment can potentially shorten the development lifecycle.

### Cisco

The Cisco cloud platform provides an open set of development APIs that a number of third-party developers can leverage for product development. Cisco UCS has programmability that decouples software and hardware on the compute platform to create portable service profiles. Cisco ACI achieves the decoupling and programmability for network fabric by providing a highly secure and programmable infrastructure for flexible hybrid cloud workload deployment that doesn't put up boundaries between physical and virtual servers.

Cisco DevNet provides development labs and APIs for many Cisco products such as Intercloud and Prime Home.[142, 143] Products such as Cisco ONE Enterprise Cloud Suite can help move applications from development to production.[144] The newly announced Cisco Intercloud Services allow developers to write and use code that spans many clouds and vendors.[145]

Cisco Project Shipped, announced in mid-2015, includes features that allow developers to easily, quickly move their code into production.[146] Cisco is still developing features for Project Shipped, such as the ability to build hybrid cloud apps.[147]

### HP Helion

HP Helion Development Platform provides Cloud Foundry technologies to enable the development, deployment, and scalability of cloud applications.[148] These technologies integrate with OpenStack, thus allowing developed applications to run in OpenStack compatible environments. HP Helion provides a number of developer tools to help cloud application and infrastructure development.

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[141] www8.hp.com/us/en/business-solutions/solution.html?compURI=1762950#.VduMGtNViko
[142] https://developer.cisco.com/sandbox
[143] https://developer.cisco.com/cloud
[144] www.cisco.com/c/en/us/solutions/service-provider/prime-cloud-automation/index.html
[145] https://developer.cisco.com/site/cis/
[146] https://www.youtube.com/watch?v=V_Ff85o_KmM
[147] https://developer.cisco.com/shipped
[148] www8.hp.com/us/en/cloud/helion-devplatform-overview.html

The HP Helion Development Network supports many programming languages and databases and can help with packaging applications.[149] This network provides a community and resources for development with HP solutions.[150]

HP CODAR is a solution that enables continuous deployment in the enterprise.[151] Announced in December 2014, CODAR is compatible with a variety of third-party tools, including VMware vCenter, Jenkins, Chef, Puppet, and AWS.[152] CODAR helps to fulfill the promise of DevOps, with ties to Agile code development practices. As the product moves through the release cycle, HP CODAR manages aspects from development to quality assurance to production. CODAR integrates with HP Cloud Service Automation and is compatible with OpenStack.

# CONCLUSION

Thanks to the advent of public and private clouds, both IT and business have become more agile – more able to quickly respond to fluctuating needs and demands in information processing. However, to achieve a fully agile infrastructure, businesses need to integrate their traditional IT with clouds in all their variants. Hybrid clouds provide that path forward.

For companies considering a hybrid cloud infrastructure, there are significant concerns, with security being number one. Companies must protect corporate data and applications, even as that data moves in a geographically distributed IT infrastructure. Simultaneously, they must ensure the security of data from point of capture at the edge to consumption and storage in the back end. A second concern is ease of infrastructure management and maintenance. This concern becomes more relevant as the number of vendors and management interfaces increase. A related concern has to do with simplifying management and maintenance with automation. For automation to succeed, it requires a policy-driven infrastructure. Finally, because businesses are ultimately looking for greater agility from hybrid clouds, another key concern is the ease of application development and application deployment to production.

For this paper, we used publicly available information to compare two major hybrid cloud technology and service companies: Cisco, through its hybrid cloud portfolio, and HP, through its Helion portfolio. Although it is difficult to pinpoint exactly where each vendor falls in the hybrid cloud spectrum, we can draw a few broad

[149] www8.hp.com/us/en/cloud/helion-devplatform-howitworks.html
[150] hdn.hpcloud.com/
[151] www8.hp.com/us/en/software-solutions/codar-continuous-deployment/
[152] h30499.www3.hp.com/t5/Grounded-in-the-Cloud/Announcing-HP-Codar-Your-new-DevOps-secret-weapon-to-automate/ba-p/6680261#.VdtqydNViko

conclusions. The Cisco approach is *network-centric* and *application-centric*. The HP approach, on the other hand, is more *infrastructure-centric*, with an emphasis in developer support, and includes some elements to support the software development lifecycle. The differences between the two companies' approaches are clearest in the question of security. From our research, it is clear that HP and Cisco are both strong contenders. Their offerings span compute, storage, and network for hybrid clouds and offer different approaches to and levels of security, automation, SDLC support, network virtualization, cloud management, workload mobility technologies, and more. Each company has its own specific target niche in enterprise cloud deployments.

As the interconnectivity between private and public clouds grows, the world of the hybrid cloud is quickly changing. We expect significant changes in the near future – not only in offerings from Cisco and HP, but in the hybrid cloud ecosystem generally. We look forward to watching how Cisco, HP, and other cloud vendors adapt to the expansions and shifts in the future of the hybrid cloud.

# APPENDIX A – DETAILED FEATURE COMPARISON

## Feature categories: Infrastructure

### Hardware infrastructure

| Cisco cloud | HP Helion |
|---|---|
| • Allows both Cisco infrastructure and client-provided infrastructure<br>• Cisco UCS provides validated, converged solutions for cloud, such as FlexPod, VCE Vblock, and Cisco Cloud Architecture/Microsoft Cloud Platform<br>• Provides a fully managed Cisco OpenStack to on-premises private clouds built on Cisco UCS hardware<br>• All Cisco UCS hardware infrastructure can be managed with a single API and unified view with Cisco UCS Manager<br>• Infrastructure can easily be expanded, monitored, and managed while maintaining application awareness thanks to the way in which UCS hardware integrates into the cloud | • HP offers and manufactures turnkey cloud solutions marketed under the HP ConvergedSystem and HP CloudSystem brands, both of which are built on HP BladeSystem server hardware<br>• HP offers a hyper-converged variant of the ConvergedSystem stack based on the EVO:RACK platform<br>• HP has no single tool available to manage hardware infrastructure—currently, HP offers HP OneView to manage infrastructure, but it has limited functionality and has yet to be integrated into other levels of management |

### OpenStack cloud infrastructure

| Cisco cloud | HP Helion |
|---|---|
| • Cisco provides OpenStack clouds with unified networking and next-generation cloud-building technology<br>• OpenStack is the foundation of the Cisco hybrid cloud infrastructure platform<br>• Clients can operate their on-premises cloud themselves, use Cisco's fully-managed on-premises solution (Cisco OpenStack Private Cloud®), or work with cloud providers in the Cisco Cloud Services ecosystem<br>• Cisco OpenStack Private Cloud delivers an on-premises true public cloud experience behind the firewall, with full administrative control but remotely operated by Cisco 24/7/365<br>• Cisco completely supports the open source model through blueprints, code contributions, and reviews. Cisco is the number-one contributor to the OpenStack Neutron networking project and the lead contributor to the Group Based Policy project<br>• The use of Cisco Intercloud Fabric with OpenStack allows cloud applications or services (or parts of applications or services, known as containers) to be transparently moved from one cloud environment to another | • HP provides OpenStack support and HP Helion OpenStack, a modified version of OpenStack to manage cloud platforms<br>• HP Helion OpenStack includes the standard OpenStack features and also provides HP-specific services like Sirius (storage management), EON (vSphere integration), and Sherpa (catalog)<br>• HP is a strong proponent of open-source infrastructure for cloud. It is a Platinum Sponsor of the OpenStack Foundation and one of its top code contributors<br>• Cloud software includes Helion CloudSystem (with Cloud Services Automation), Helion OpenStack, Helion Development Platform (CloudFoundry-based PaaS from ActiveState), and Helion Eucalyptus (AWS-compatible private cloud software)<br>• HP CloudSystem 9.0 is built on HP Helion OpenStack, which includes many tools for cloud automation and OpenStack integration The HP CloudSystem Portfolio includes several managed services, like Helion Managed Virtual Private Cloud, Helion Managed Private Cloud (dedicated), and Helion Managed Cloud Applications (ERP, CRM workplace apps)<br>• In March 2015, HP announced its preconfigured, pretested Helion Rack complete private cloud solution with integrated IaaS, combining OpenStack and Cloud Foundry technologies integrated with HP server hardware |

- HP offers Helion Managed Private Cloud available on-premises or in a third-party datacenter. HP also offers Helion Managed Virtual Private Cloud solutions in 24 global locations across five continents. HP offers options to add high availability for 99.999% uptime SLAs and a range of professional and advisory services

## Data virtualization

### Cisco cloud

- Cisco Information Server is the core of the Cisco data virtualization platform
  - Developers use CIS studio to create data views and data services
  - Cisco purchased Composite Software in 2013, which provided technologies that are now integrated into the Cisco Data Virtualization solution

### HP Helion

- Because the solution is based on OpenStack, it uses many OpenStack data virtualization technologies but doesn't have a data virtualization product

## Storage

### Cisco cloud

- Cisco partners with EMC and NetApp to support most storage solutions but is compatible with a wide range of technologies, including solutions from IBM, HP, Dell, NEC, and Fujitsu, among others
- Cisco provides solutions with bundled storage such as Vblock and FlexPod through a wide range of storage vendors
- UCS provides for FibreChannel (FC), FC over Ethernet (FCoE), iSCSI, and other storage network protocols and media
- No vendor lock-in, ample choices for storage infrastructure

### HP Helion

- HP Helion OpenStack uses technologies such as Ceph; Firefly (management of storage volumes); or Cinder (block storage management). Uses HP technologies such as HP 3PAR and HP StoreVirtual VSA as a backend to Cinder
- Using such technologies allows HP to support commodity hardware such as Cisco
- HP provides Tier-1 enterprise using HP 3PAR StoreServ storage arrays. HP Helion OpenStack can configure 3PAR StoreServ arrays to implement block storage within the cloud only when using KVM hypervisor support

## Supported hypervisors, VMs, and OSs

### Cisco cloud

- Supports any hypervisor or VM on any x86-based OS in addition to specific hypervisors and OSs listed below
- Cisco Intercloud Fabric (ICF) supports the following (as of 7/15/15):
  - *Hypervisors*: Citrix Xen, Microsoft Hyper-V, and VMware V-Sphere
  - *OS:* any from the list below
- Cisco cloud platform supports the following (as of 7/15/15):
  - *Hypervisors*: VMware V-Sphere, Microsoft Hyper-V, Red Hat KVM, Citrix Xen, Oracle OVM
  - *OS:* any x86-based OS
- Cisco supports the following OSs (as of 7/15/15):

### HP Helion

- HP Helion OpenStack supports both Linux KVM and VMware vSphere hypervisors; however, the current HP Helion OpenStack v 1.1.1 hasn't qualified vSphere 6.0 yet
- Supports following OSs under Linux KVM:
  - *Microsoft* – Windows Server 2012, Windows Server 2012 R2, Windows 8, Windows 8.1, Windows 7, Server 2008, Windows Server 2008 R2, Server 2003, Windows Small Business Server 32-bit, Windows Vista, Windows XP Professional, Windows 2000, Windows NT, Windows 3.1, MS-DOS
  - *Red Hat* – RHEL 6.6, RHEL 7.0, CentOS 7, CentOS 6.5

- *Microsoft* – Windows Server 2012, Windows Server 2012 R2, Windows 8, Windows 8.1, Windows 7, Server 2008, Windows Server 2008 R2, Server 2003, Windows Small Business Server 32-bit, Windows Vista, Windows XP Professional, Windows 2000, Windows NT, Windows 3.1, MS-DOS
- *Red Hat* – RHEL 6, RHEL 5, RHEL 4, CentOS
- *SUSE* – SEL 11, SEL 10
- *Oracle* – Linux 6, Linux 5, Linux 4; Oracle Solaris for X86
- *Ubuntu* – Ubuntu Linux and other Linux
- *Ubuntu* – Ubuntu Linux 14.10, 14.04
- *Debian – Debian 7.6, Debian 8*

- Under vSphere, supports any guest OS supported by VMware vSphere
- HP Helion CloudSystem 9.0 supports Microsoft Hyper-V, in addition to Linux KVM and VMware vSphere

## Networking

| Cisco cloud | HP Helion |
|---|---|
| • Cisco provides seamless networking via connectors installed on third-party VMs (Cisco Cloud Connectors) | • Offers technologies such as HP Virtual Cloud Networking for a software-defined networking solution |
| • Cisco and Cisco partners provide multiprotocol label switching (MPLS), Quality of Service (QoS), and virtual private networks (VPNs) and use routers and switches that run Cisco IOS for end-to-end networking and solutions | • Uses OpenStack Networking technologies such as OpenFlow |
| • Cisco ICF connects provider clouds and on-site datacenters or private clouds, allowing seamless mobility for workloads between on-premises clouds and hosted private and public clouds | • HP Helion OpenStack networking tools are built on Neutron – part of the stock OpenStack suite |
| • Implements secure connections between hypervisors—the same security used by Cisco Intercloud Fabric in the on-premises datacenter is used for the connection to public clouds (secure, key-based, cryptographic connections) | • OpenStack Networking is open source and supported by HP |
| • Implements end-to-end fabric policy management and security | |

## Integration

| Cisco cloud | HP Helion |
|---|---|
| • Simple, uniform multivendor integration through the use of Cisco tools such as Cisco Integration Platform and Cisco Intercloud Fabric | • HP Helion OpenStack provides tools for integration of hardware & software; however, HP has added many tools to their OpenStack variant that support only their own technologies and hardware and lack support for their out-of-band management iLO |
| • Cisco Integration Platform integrates data, applications, and other endpoints using end-to-end APIs; it integrates with UCS Manager for hardware integration | |

## Choice of cloud provider

| Cisco cloud | HP Helion |
|---|---|
| • Has a wide range of cloud provider and virtualization options | • In June 2015, HP announced that Helion CloudSystem 9.0 expands support to multiple hypervisors and clouds, integrating Helion OpenStack and HP Helion Development platform |

## Public cloud support

| Cisco cloud | HP Helion |
|---|---|
| • Supports Cisco Intercloud Providers and Cisco Powered Cloud Service Providers, as well as AWS and Azure | • HP Cloud Service Automation includes support for HP Helion public cloud, AWS, and Azure<br>• HP Cloud Service Automation is compatible with multiple hypervisors, guests, and multi-vendor hardware |

## Network virtualization

| Cisco cloud | HP Helion |
|---|---|
| • Cisco ACI is a comprehensive software defined networking solution that goes further—built from intelligent switches, it provisions network resources on the fly and provides robust end-to-end network fabric-centric security<br>• Cisco Network Virtualization Solutions provide features such as access control, path isolation, and services edge<br>• Path isolation can utilize technologies such as MPLS, virtual routing and forwarding (VRF), and generic routing encapsulation (GRE) to support VPNs<br>• Cisco markets Cisco Catalyst series switches for network virtualization | • HP Virtual Cloud Networking (VCN) SDN application allows for virtualized network resources and unified physical and virtual controls<br>• HP has partnered with VMware to create a solution that integrates HP Virtual Application Networks SDN controller with VMware NSX |

## Internet of Things (IoT) / Internet of Everything (IoE)

| Cisco cloud | HP Helion |
|---|---|
| • Cisco is pushing for a distributed cloud model, facilitating this goal by using a secure end-to-end networking model<br>• By using Cisco Fog Computing with IOx, data analysis and filtering are done at the edge instead of the cloud<br>• Cisco provides a spectrum of products, solutions, and services to support IoT and IoE<br>• Cisco's IoT supports device interconnection from embedded solutions to field networks and industrial networks<br>• Offers industrial-network IoT supported with Cisco Connected Grid Network Management<br>• Supports industrial sensor networks via Cisco Field Network Distribution Architectures (e.g. energy grid)<br>• Embedded networks use Cisco 59xx ESRs (Embedded Services Routers) and Cisco 2020 Embedded Services Switches to extend networks to extreme edge devices<br>• Cisco management and analysis tools use Cisco IOx, which builds on Cisco IOS, to extend coverage to compute, storage, and memory at the network edge; IOx makes these resources accessible via an open environment for application development<br>• Cisco has the IoE Index to survey and calculate potential value for IoE initiatives | • HP has pushed for developers to use their HP Helion OpenStack technologies and APIs to develop for the IoT<br>• HP Distributed Mesh Computing places compute and storage everywhere for low latency, instead of placing all of the resources in the cloud<br>• HP has extensive resources in both the consumer and industrial sectors for IoT—HP has created IoT devices such as printers, etc. |

## Feature categories: Cloud management

### VM migration

| Cisco cloud | HP Helion |
|---|---|
| • ICF provides uniform and transparent VM and workload movement from one cloud location to another (whether on-premises or off-premises, hosted or public)<br>• Cisco's vision for ICF is to support "anything running on anything"<br>• Cisco ONE Enterprise Cloud Suite provides comprehensive cloud management from infrastructure anything-as-a-service (XaaS) platforms, using a single, unified interface providing lifecycle, governance, and consumption management views for each user type | • HP Helion OpenStack supports workload migration<br>• HP Cloud Service Automation provides technologies that enable workload migration<br>• HP Helion OpenStack supports the use of many different hosts and can live migrate storage or VMs as necessary |

### Cloud operations management

| Cisco cloud | HP Helion |
|---|---|
| • Cisco uses an open model and provides its own tools—for instance, Cisco supports Microsoft System Center, OpenStack, CloudStack, and other cloud management platforms<br>• Cisco UCS Director allows users to provision hardware and software for a cloud environment<br>• Cisco Intercloud Fabric allows users to manage and move cloud resources<br>• Cisco ONE infrastructure management allows users to provision and protect WANs<br>• Cisco ONE Enterprise Cloud Suite provides cloud provisioning and building<br>• Cisco ONE for Data Center and Cisco ONE Enterprise Cloud Suite provide tools that can be scalable and cost effective for private and public clouds, with features such as application policy mapping, multi-tenancy, and unified management | • HP Helion OpenStack provides modified OpenStack and HP dashboards, such as the Horizon Dashboard, as well as others that allow for provisioning and change management or updating the entire OpenStack build<br>• Other HP products, such as HP OneView, Insight Control, and Matrix, allow users to provision and prepare hardware for cloud environments by deploying hypervisors, configuring networks, etc. |

### Cloud application templates

| Cisco cloud | HP Helion |
|---|---|
| • Cisco Prime Service Catalog provides integration with many third party tools to deploy new services and solutions using process templates that provide consistency and repeatability. These are available for download<br>• Cisco Prime Service Catalog provides ordering, delivery, and change tracking functionality<br>• Cisco welcomes third-party management platforms that provide cloud templates, such as OpenStack and Microsoft System Center<br>• Cisco ACI can help facilitate application templates by automating the networking provisioning process | • HP Helion OpenStack includes an Orchestration Service, Heat, that allows users to provide template-based orchestration for their cloud<br>• HP provides Cloud Maps, pre-designed templates, workflows, and scripts used to deploy and manage server, storage, and network resources as a service for specific software applications. These are designed to work with HP CloudSystem, now based on HP Helion OpenStack |

- Cisco Prime Cloud Automation for Service Providers allows service providers to provision and deploy templates
  - Each Cloud Map includes components to build a service catalog entry for fast and consistent delivery of cloud-based services

## Usability and unified dashboard

| Cisco cloud | HP Helion |
|---|---|
| • Through Cisco Intercloud Fabric (ICF), users can have a single dashboard view of cloud resources spanning multiple cloud instances, whether private, hosted, or public, and using multiple vendors<br>• Cisco UCS Director gives users a dashboard for the management of Cisco branded compute, storage, and network resources, while also enabling deployments and other functionality<br>• Cisco ONE provides networking tools and dashboards for the management of networks from WAN, LAN, and wireless security<br>• Cisco Prime offers integration with the Cisco Identity Services Engine & Cisco Mobility Services Engine<br>• Cisco supports the use of third-party management suites like Microsoft System Center and OpenStack, which include dashboards for cloud resources | • HP Helion OpenStack offers a dashboard that allows management over an entire hybrid cloud solution<br>• Different users can have access to different parts of infrastructure<br>• HP Cloud Service Automation also provides dashboards for cloud management<br>• HP OneView provides a dashboard that helps users manage hardware solutions like SANs, compute, and storage infrastructures |

## Cloud elasticity

| Cisco cloud | HP Helion |
|---|---|
| • Allows users to build or buy workload capacity using cloud service providers, on-premises UCS, or managed services | • Provides their Amazon Web Services (AWS)-like HP Helion public cloud solution, while also offering converged, turnkey private cloud solutions and managed private cloud solutions |

## Metrics and monitoring

| Cisco cloud | HP Helion |
|---|---|
| • Cisco Prime offers 360 degree views of fault, configuration, accounting, performance, and security (FCAPS) monitoring and management for Cisco servers and ACI-ready Cisco Nexus-based infrastructure<br>• Cisco Prime provides wired and wireless lifecycle management and application visibility and control, with policy monitoring and troubleshooting via Cisco Identity Services Engine (ISE) and location-based tracking of mobile devices via Cisco Mobility Services Engine (MSE)<br>• Cisco Cloud Consumption Services collects metrics on cloud services consumed by an organization, which can enable IT to handle shadow IT while allowing multiple vendors and cloud providers; can also provide detailed and consolidated reporting capabilities<br>• Cisco ACI-enabled and Cisco IOS routers and switches provide built-in tools for measuring bandwidth, latency, and other important network metrics | • The HP Helion OpenStack platform provides dashboards & tools for gathering metrics – Icinga gathers storage metrics, Kibana gathers and centralizes logging across the cloud, and Celiometer gathers information on the performance of OpenStack components<br>• The HP Helion OpenStack Telemetry and Reporting Service uses Celiometer to monitor physical devices in the HP Helion Infrastructure<br>• HP OneView can report compute, networking, and storage utilization for a datacenter<br>• HP 3PAR storage includes robust monitoring and reporting software and also integrates into HP OneView<br>• HP CloudSystem 9, now based on HP Helion OpenStack, includes monitoring features that allow the capture of key data points, like CPU, RAM, storage, and network usage<br>• Monitor security practices and data through use of HP ArcSight |

- Cisco IP SLA uses metrics to calculate and determine network SLA uptimes and other fabric metrics
- Cisco Energy Management Suite allows users to view and monitor the energy use of all connected devices, even across distributed locations. It is designed to help cut costs by 35 percent and gain 100 percent visibility into the energy use of every device in your datacenter

### Performance benchmarks

| Cisco cloud | HP Helion |
|---|---|
| • Has Intercloud Providers and Cisco partners with many configurations<br>• Customizable configurations enable tuning architecture to desired performance<br>• Recent studies (e.g. IDG's study on SAP Hana and Cisco UCS/Nexus) show that Cisco flexible and scalable infrastructure may be well matched to edge data processing of in-memory applications that require clustering and cooperative processing between nodes<br>• Cisco UCS service profiles can reduce time to deployment<br>• Other studies point to increased flexibility and scalability, as well as reduced risk and cost, using Cisco UCS and Oracle in deployments of JD Edwards EnterpriseOne 9.1 on SmartStack | • HP Helion OpenStack provides many different sizes and scalable performance for its public cloud solutions<br>• HP Helion OpenStack supports multi-vendor hardware, allowing users to choose hardware that meets their performance needs |

## Feature categories: Security and compliance

### Security

| Cisco cloud | HP Helion |
|---|---|

- Cisco ISE and ACI provide application-aware, complete, end-to-end security, encryption, and logged access to infrastructure
- Cisco ISE and ACI can provide a complete mobility solution, spanning infrastructure and mobile devices
- Cisco end-to-end network security enables securing IoT devices
- Cisco ACI, combined with Cisco FirePOWER security, enables the following:
  - Deployment of application-specific security over multi-vendor security devices
  - Physical and virtual security devices to be inserted into an application's data traffic flow
  - Secure inner application flows, going beyond standard edge security
  - Different workloads or users can't interfere with each other in a multi-tenanted cloud network
  - FirePOWER technologies, acquired in 2013 through the purchase of SourceFire (one of the best manufacturers of intrusion detection software using data analytics), are included with Cisco ASA and Cisco FirePOWER hardware appliances and firewalls

- HP Atalla and HP Security Voltage solutions provide many security features for cloud
- Meets industry standards (see www8.hp.com/us/en/software-solutions/data-security-encryption/)
- Supports hardware security modules for hardware cryptography, security tokens, identity management, etc.
- HP Labs has projects increasing security at the edge: www.hpl.hp.com/research/security-and-cloud/secured.html

### Data sovereignty

| Cisco cloud | HP Helion |
|---|---|
| • Cisco has 600 Cisco Powered Service Providers and resellers, offering over 575 services worldwide | • HP PartnerOne partner network has 126 members and around 100 are cloud builders |
| • Cisco Intercloud Providers have many locations around the globe, currently with over 350 global datacenters in 50 countries | • Has only two regions corresponding to two datacenter locations in the United States—Las Vegas, NV and Reston, VA |
| • Using either Intercloud Provider networks or other Cisco Powered Cloud Service Providers, customers can increase availability zone coverage | • Each region has three availability zones that provide separate fault domains, i.e. failures in one availability zone do not affect the other availability zones |

## Feature categories: Ecosystem and partner network

### Marketplace

| Cisco cloud | HP Helion |
|---|---|
| • Cisco Marketplace: Services and technology partners, plus a validated solution catalog for analytics, mobility, enterprise networking, datacenter, security, and collaboration | • HP Helion Marketplace: Allows users to choose providers, software, and other HP Helion OpenStack ready solutions |

### Consulting and professional services

| Cisco cloud | HP Helion |
|---|---|
| • Cisco offers consulting programs that provide many cloud-focused benefits; programs include Cisco Cloud Consumption Services, Cisco Services for Adopting Clouds, Cisco Services for Building Clouds, and Cisco Cloud Enablement Services for Adopting Clouds | • Provides consulting for cloud, workplace/mobility, Big Data, and Security/Risk Management |
| • Cisco also offers consulting programs that provide services for collaboration, virtualization, networking, routing, and video and wireless, among other technologies | • Under the HP Helion Cloud Consulting banner, HP provides services for integrating, building, and advising cloud solutions |
| • Cisco professional services include solution support, optimization, and operational management | • HP offers cloud workshops where attendees can learn from HP cloud experts |
| • Cisco Domain Ten Strategy provides a repeatable methodology to maintain cloud compliance and standards | |
| • Cisco offers workshops for cloud services via WebEx or via instructor-led conferences | |

### Standards

| Cisco cloud | HP Helion |
|---|---|
| • Open standards based, multi-vendor | • Open standards based, single vendor |

| Partner cloud service provider network | |
|---|---|
| **Cisco** | **HP Helion** |
| • Cisco's partner-centric cloud includes Independent Software Vendor (ISV) partners, Intercloud Providers, and Cisco Powered Service Providers—these are Cisco-validated solution providers, delivering end-to-end QoS<br>• The Cisco Powered Services Catalog/Cloud and Managed Services program offers over 600 Cisco Powered Service Providers and resellers with more than 575 deployments. | • HP Helion has multiple partner programs:<br>  ○ HP Helion Ready Program allows participants to certify their solutions, either hardware or software<br>  ○ HP Helion Network provides a framework for vendors to market themselves as Helion service providers<br>  ○ HP PartnerOne Service Provider Program allows third-party vendors to provide services using HP technologies |
| **Open Source development and tools** | |
| **Cisco cloud** | **HP Helion** |
| • Cisco is the largest contributor to the OpenStack Neutron component, which provides the OpenStack platform with all of its networking features and capabilities<br>• Cisco provides public, documented APIs to developers with OpenStack, ONE Enterprise Cloud Suite, Prime Home, and Intercloud Fabric<br>• Cisco hosts developer training sessions | • HP Helion OpenStack claims to be one of the largest supporters of the OpenStack software stack<br>• Provides many resources for cloud developers, such as a developer network and open source software<br>• The HP Helion Developer Network provides documentation and Cloud Foundry-based resources |

**Figure 3: Detailed information about Cisco and HP hybrid cloud offerings**

# ABOUT PRINCIPLED TECHNOLOGIES


Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, websites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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