

Survey on Solution Providers of Hybrid Cloud Computing

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Abstract—Cloud computing is spreading around the enterprise world, eliminates the requirement for setting high-cost computing infrastructure and services for IT solutions. With its potential, cloud computing allows numerous and varied increase in capacity and capabilities of the existing technology by the need of extending the technology across variety of clouds for inter cloud communication. “Hybrid cloud” as a latest buzz word is the deployment of contact between private, public and community clouds for the necessary of application, services and data migration. With its diverse services like SaaS, PaaS and IaaS, the hybrid cloud has made resources which was once never available on scalable and demand manner. This extensive survey paper aims to elaborate and analyze the numerous hybrid cloud computing service providers of which will provide the transparency of features, profits, fitting together clouds, choosing service providers, implementation and functionality based on internal and external resources. Each hybrid cloud solutions of this era are briefed for benefiting any organizations for deciding on a hybrid cloud provider. The objective of this paper is to review comprehensively the current hybrid cloud providers so that interested c-level executives of the enterprises in adoption of hybrid cloud could gain knowledge over the hybrid cloud solution providers and will give their organization an edge over competitors.

Index Terms—Cloud Computing, Hybrid Cloud, Service Providers, Cloud Services, On Demand Computing, Virtualization, Interoperability.

1. INTRODUCTION

Hybrid cloud is a cloud computing situation which uses a blend of on-premises, private cloud and intermediary, public cloud services with grouping between the two platforms. A hybrid cloud as an integrated cloud service, utilizes private and public clouds to carry out separate functions within the same organization [1]. All cloud computing services offer assured efficiencies to contrary degrees but public cloud services are likely to be more scalable and cost efficient than private clouds. As a result, an organization can maximize their efficiencies by utilizing public cloud services for all indifferent operations and relying on a private cloud only where they require it.

The implementation of hybrid cloud models is expected to grow at such high rates that nearly half of the larger organizations would have hybrid platforms in nearing future. A hybrid model provides businesses with a competitive edge through significant ability to switch between clouds, on-demand resource utilization and flexible high-end solutions [2] such as:

- Cloud security
- Consulting

- Cloud integration
- Cloud management

Various cloud solution providers offers hybrid computing solutions in different service model categories such as:

- SaaS (Software as a Service)
- IaaS (Infrastructure as a Service)
- PaaS (Platform as a Service)

Hybrid cloud emerged as a logical middle technology to make any organizations balance between all computational services on buildings and computational time and offloading storage to the cloud [3]. Corporate are extremely security-conscious. Hence it has been hesitant to move their data and workloads into the cloud [4]. With the underlying technology behind cloud services available for deployment inside organizations, the hybrid cloud became a new model of cloud computing in business. Dynamic or highly challengeable workloads need Hybrid cloud in particular. On very demanding holiday season, a transactional order entry system which faces significant hit becomes a good hybrid cloud candidate. Uses cloud bursting to access additional computing resources from a public cloud when computing demands spike [5]. A hybrid cloud environment model is required to connect private and public cloud resources.

2. FEATURES OF THE HYBRID CLOUD COMPUTING MODEL

The National Institute of Standards and Technology define the hybrid cloud as a mixture of at least one public and private cloud [5]. A hybrid cloud is offered in one of two ways: A partnership is made by a private cloud vendor with the public cloud provider or a partnership is made by a public cloud vendor with the private cloud platforms provider as shown in fig. 1. For an effective hybrid cloud to integrate public cloud with its existing private cloud architecture, enterprises should look at six areas: security, connectivity, portability, scalability, cost effective and flexibility.

2.1 Connectivity

The connection between the private and public clouds must provide the confidentiality of data flow, application interaction and user access. The direct WAN link or the VPN must be able to connect to a physically or virtually segmented section of the public cloud as a multi-tenant.

2.2 Scalability

Private cloud offers certain level of scalability depending on their configurations, resource from the larger cloud infrastructure is used by public cloud services that results in scalability.

2.3 Cost efficiencies

Public cloud offers more significant economies of scale and so greater cost efficiencies, than private clouds. Hybrid cloud allows to access business functions by still keeping sensitive operations secure.

2.4 Security

The private cloud component of the hybrid cloud provides the security needed for sensitive operations but also satisfy regulatory requirements for storage and data handling.

2.5 Flexibility

The ease of use of both secure resource and scalable cost effective public resource can provide organizations with more opportunities to explore different operational avenues.

2.6 Portability

Portability across heterogeneous clouds is a time-consuming work. Cloud help enterprise realize the actual value of hybrid cloud by being able to transfer data, computing resources, applications, programming languages.

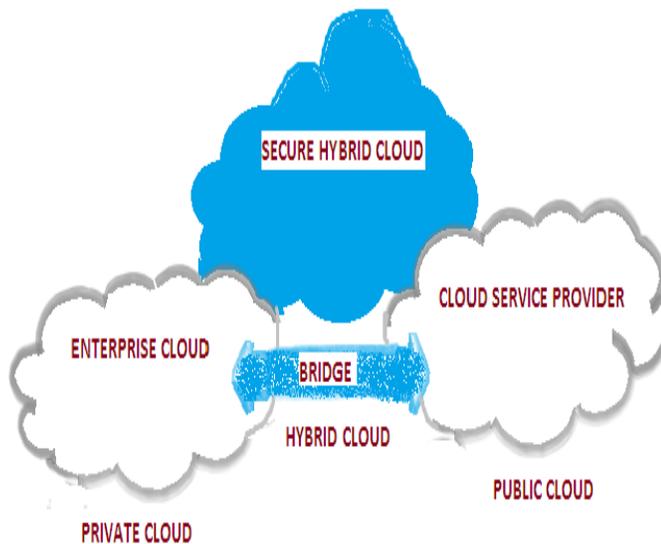


Fig. 1. Hybrid Cloud presentation

3. HYBRID CLOUD AS A COMBINATION OF PUBLIC AND PRIVATE CLOUD

Businesses found that a hybrid cloud provides the internal control and public cloud benefits. Cloud computing provides a variety of public and private cloud options, so the options to determining the right entities for hybrid cloud model requirements is a challenge [5]. Below mentioned a few options:

3.1 Interoperability

The purpose of a hybrid cloud is to move the workloads from private cloud to a public cloud during peak demand for software development testing or computing resources. The cloud platforms are interoperable when used in your private and public clouds to ensure low-resistance movement of workloads between clouds. Interoperability is achieved by operating either the platforms with a shared application programming interface (API) or the same cloud platforms.

3.2 Security

Using public clouds for some applications always has security problem. If the IT services are extended to support a hybrid cloud, consider extending the virtual private network (VPN) to the cloud. A single set of policies and access controls will help mitigate the risk of discrepancies between the clouds.

3.3 Cloud management

An integrated management system can streamline routine responsibilities working within a hybrid cloud. A management system must have a consolidated view of billing, storage resources and private and public computing.

3.4 Data management

According to High-performance computing (HPC), the computing device must keep the data close. This can reduce the risk of conflicts at a centralized data store and reduce the time required to transfer data from storage to the server. The same principle is used with hybrid cloud computing: Data that will perform the majority of the processing should be located in the cloud itself.

3.5 Service-level agreements

For both the public and private cloud providers the Service-level agreements (SLAs) should be established. Availability storage services and computing, durability of data and prices should be defined in SLAs.

4. ANALYZING TODAY'S HYBRID CLOUD ARCHITECTURES

Organizations are slowly adopting the hybrid cloud computing environment to manage workloads on-premises. In the midst of the on-demand availability of private as well as public cloud resources, hybrid cloud platform suits many enterprises. At the most basic level of hybrid cloud computing that represents the mix of private and public cloud resources has the goal of exploiting the advantages of both and reducing the drawbacks [6]. Choice of a hybrid cloud computing providers is made to reduce fears of data security, regain control of data and by attractive pay-as-you-go promises, companies turned to private clouds from public cloud. The flexibility to run mission-critical apps on-premises is provided by a hybrid cloud by combining at least one private cloud with at least one public cloud. Enabling companies to easily scale their architectures for usage spikes is provided by Hybrid clouds. Companies that are establishing hybrid clouds are put off by confusing terms and complex vendor contracts. That's not to mention user concerns about platform interoperability, uptime guarantees and data security policies. Companies considering a hybrid cloud installment need a solid understanding of service-level agreements and cloud terms to get the most from their cloud arrangements.

However some vendors are only offering a hybrid IaaS, but some offerings begin to blur with automation features and additional management [2]. It is a significant milestone to make a decision to select a hybrid cloud provider for any business as making it imperative for a company to understand clearly how resources are being utilized right now, it involves a hefty investment or are planned to be utilized in the

upcoming. A list of hybrid cloud solution providers and the services they offer is mentioned below.

4.1 Amazon web services (aws)

AWS is one of the most prominent hybrid cloud solution providers that offer PaaS and IaaS cloud service models. It offers the best public cloud computing services. AWS now seamlessly integrates private data centers with public cloud resources for many enterprises through services like Direct Connect. This service improves bandwidth throughput and reduces network costs and [2]. Amazon Web Services empowers integration of on-premises, role-based access control systems like Active Directory with the AWS IAM (Identity and Access Management) service for organizations that need to integrate data centers with the public cloud platform to handle peak usage spikes. Amazon web services remain focused on the hybrid approach that uses a Direct Connect Service that bridges a virtual private cloud (VPC) resource with the customer's data center.

At the same time as one of the largest public cloud providers, AWS has the resources and experience to manage the hosted side of a hybrid cloud. Amazon with the AWS GovCloud program uses AWS for onsite private cloud with the U.S. government to prove its growth in a hybrid cloud which is not by traditional definition. At present AWS customers continue to demand for private cloud management and patiently waiting for Amazon to fully embrace the hybrid cloud [6].

In the vein of other aspects of cloud computing, Amazon Web Services is considered a market leader in Amazon Web Services for hybrid cloud storage. AWS announced Glacier, a long-term, low-cost archival storage services. Recently, at its first-ever user conference, AWS announced Redshift, a cloud-based data warehousing service. AWS continues to release services and products to round out its already-market leading position though as it is an innovative company [7].

4.2 Cisco systems

The primary endeavor of this vendor is to assist enterprises in dealing with the hasty changes in the requirements for cloud computing workloads, scalability. Cisco provides access to efficient IT services with its Intercloud contribution. They facilitate enterprises to gain a competitive edge over its competitors on deciding the perfect hybrid cloud computing solution for a business

4.3 Cloudswitch

Without having to change networking, integration, and security policies or the way manage and monitor applications, CloudSwitch has developed a hybrid cloud that allows application migration to a public cloud [5]. A tool in the form of a downloadable virtual appliance will be deployed in the private cloud, along with a virtual machine runs on behalf of the appliance in the public cloud.

The appliance instance and the virtual appliance act as local control points and provide a secure data path to bridge network connectivity. Accordingly, applications running in the public cloud remain firmly integrated with internal processes and can be managed as if they are running locally in the private cloud.

4.4 Dell

Dell recommends cloud services in the form of a Cloud Manager that is available for companies as SaaS or on-premise software. Inside their own data centers, Cloud Manager gives organizations the required control [2]. Dell Cloud Manager ensures efficient management of a company's cloud infrastructure through suitable automation and availability of applications across multiple cloud platforms.

4.5 Emc corp

In the form of Federation Enterprise Hybrid Cloud, EMC offers the highly agile hybrid cloud solutions [2]. EMC deploy the pre-configured package that are built on VSPEX (virtual system specifications) and Vblock infrastructures. The Vblock system helps deliver efficient data center transformation and agile hybrid clouds, and ITaaS (IT as a Service). The Hybrid cloud of EMC is built as a combination of methods including acquisitions, internal development and partnerships [6]. Since EMC has "best in breed" advance, it provides a hybrid cloud that is an overlay of other software, such as VMware vRealize suite combined with EMC software (ViPR, PowerPath and Storage Analytics). On top of other certified service providers such as Rackspace, VMware, AT&T and Terramark these solutions can be run. EMC Virtustream is a hybrid cloud management platform acquired by EMC that has the ability to unite a number of the best of breed products under a single management interface.

4.6 Eucalyptus

An open source hybrid cloud solution is offered by Eucalyptus with APIs which are meant specifically for AWS cloud environments. The APIs integrate with various AWS services, such as S3 (Simple Storage Service), EC2 (Elastic Compute Cloud) and Elastic Block Storage (EBS) to bridge the gap between on-premises and cloud resources [6]. Eucalyptus suggests a central management console to manage both public and private AWS clouds. Eucalyptus Systems with collaborator RightScale has Eucalyptus platform with a hybrid cloud based. It is planned to be API-compatible with Amazon EC2. Eucalyptus Enterprise Edition 2.0 created virtual images which can be migrated over to Amazon's public cloud and can also be downloaded from Amazon EC2 and run on private Eucalyptus cloud platform. Mostly because Amazon EC2 and Eucalyptus support the same cloud API, monitoring and management tools differ in the two cloud environments [5]. The vital aspire of this vendor is to ensure smooth incorporation of different AWS services between on-premise and cloud networks.

4.7 Expedient

Expedient have fundamentally expanded their existing Collocation Service, used for management automation of private storage environments, to span into their own data centers that are located on or near the east coast of the US. [6]. Intel Cloud Technology is used by Expedient servers.

4.8 Fujitsu hybrid cloud services (FHCS)

Exclusively designed hybrid cloud solution for use with Windows Azure environment is FHCS. The service connects the mixture of Hyper-V, Fujitsu cloud environments and

Microsoft Azure using Microsoft Azure Connect [6]. While FHCS does provide cloud management tools, the integration with Windows Azure is the selling point. Fujitsu Velocity which is a Software Factory extension for Visual Studio 2010 is used to help speed software deployments by FHCS.

4.9 Hp hybrid cloud management

HP's hybrid cloud contribution is based on the OpenStack architecture and it is more flexible solutions. Cloud Management of HP Hybrid includes REST APIs that has the features of the infrastructure management, usable within a heterogeneous environment that uses third-party resources and multiple hypervisors [6]. As a complete open platform Hewlett-Packard offers CloudSystem for hybrid cloud computing solutions based on OpenStack architecture. This HP CloudSystem influences available resources and tools to integrate networks, security, servers, storage, and management based on Converged Infrastructure and HP Cloud Service Automation [2]. Full hybrid cloud portfolio of HP is based on the company's open source Helion Eucalyptus platform designed to be compatible with AWS but the foundation is based on OpenStack technology. HP hybrid cloud storage platform debuted in May of 2012 and meant to work in tandem with both its compute and content delivery network (CDN), which it partnered recently with Akamai on [7]. Hp storage platform is based on OpenStack technology. According to Gartner notes HP can easily understand enterprise IT storage requirements, due to its extensive software, hardware and service offerings [7].

4.10 IBM's hybrid cloud options

IBM offers IBM Services Management Extensions for Hybrid Cloud which is customizable. IBM's hybrid cloud-oriented extensions can be selected and applied individually when it has the proper access to the chosen management product. The WebSphere Cast Iron Cloud appliance and LotusLive are the hybrid extensions of IBM cloud management solutions. IBM hybrid cloud storage is component of the SmartCloud Enterprise contribution, which includes services such as cloud-based application infrastructure and development. IBM did not use SmartCloud Object Storage on its backend for its cloud for backup and recovery because IBM partners with Nirvanix, another cloud storage provider, to run the SamrtCloud Object Storage [7].

4.11 Microsoft hybrid cloud

Microsoft has spent substantial resources in expanding its Azure cloud and its foundation is Windows Server 2012 R2 with System Center 2012 R2 for cloud offerings [6]. System Center can be a challenge which is already deployed internally and staff is trained to incorporate multiple products including Data Protection Manager, Virtual Machine Manager, Operations Manager, and Endpoint protection.

4.12 Azure

Various products like the .Net platform, Active Directory, SQL and other Microsoft services and applications are available in Azure today. Hence Azure is ideal for Microsoft shops [6]. The Azure increases the clearness between internal and external resources with a huge application catalog. Project

Photon used for Microsoft Linux containers and Project Lightwave used for access management allows for more compatibility with offered container technologies and finds a home in the hybrid cloud solution. Photon and Lightwave are intended to get closer with existing container technologies where Microsoft Nano Server is an innovation. Microsoft serves clients with IaaS for the private cloud, along with management capabilities. Microsoft has the Windows Azure platform with PaaS for public cloud services to support smooth migration of current enterprise applications to the cloud and new cloud application development to cloud [2]. Microsoft offers the new Cloud Platform System (CPS) which can handle sensitive information or legacy infrastructure of organizations on-premise, in the course of the same management tools as that of the Azure public cloud. Gartner predicts that Microsoft hybrid cloud storage is the second most widely-used cloud storage service. It supports a broad range of features including table storage, SQL Server, object storage and a content delivery network (CDN) [8].

4.13 Nimbula

With Nimbula Director the capability to manage both public and private clouds is provided by Nimbula. The migration of existing private cloud applications to the public cloud is provided by Nimbula's service using an API that permits all cloud resources management. Nimbula Director also supports controlled access to Amazon EC2 which is a hybrid cloud option and very similar to Eucalyptus offerings [5].

4.14 Rackspace hybrid cloud

Rackspace offers resources with different combinations of infrastructure which may be customize hybrid environment [6]. This is offered by Rackspace by including cloud servers configured with scalability and load balancing, VMware-based virtual servers with SAN storage capabilities and Cisco ASA (Adaptive Security Appliance) Firewall protected connections to servers. RackConnect used to connect the cloud resources. To fulfill the diverse cloud necessities of an organization, this hybrid cloud vendor offers a mixture of dedicated hardware hosting, and multi-tenant systems of virtual hardware resources.

RackConnect establishes connections between a Cisco ASA Firewall and cloud resources that ensures the security of the server connections. Rackconnect technology is used by Rackspace to provide the connection from on-premises resources to offsite. Rackspace also has a sturdy focus on infrastructure with a committed high performance hardware option in a scalable and flexible model. OpenStack is used to deploy Hybrid. Rackspace for hybrid cloud storage is a major player in the cloud storage ecosystem. Its Cloud Files service are augmented by a vigorous set of accompanying services, including a CDN (Content Delivery Network)network powered by Akamai and compute infrastructure. It has Cloud Block Storage for high-performance storage need which has high input-output capabilities [7].

4.15 VMware vcloud hybrid service

The three services of VMware's hybrid cloud offering are: Disaster Recovery Cloud, Dedicated Cloud and Virtual Private Cloud. VMware Vcloud Hybrid Service (vCHS) uses VMware

vSphere to control cloud environment [6]. The Disaster Recovery Cloud customized for an automatic failover testing, virtual environment with VM recovery and migration capabilities.

The Dedicated Cloud and Virtual Private Cloud services are a multi-tenant virtual private cloud and a single-tenant private cloud options. vCloud Hybrid Services have several vCloud tools such as vCenter Configuration Manager, vCloud Automation Center and vCloud Connector. VMware is connecting private clouds created using the vCloud API with its vCloud express public clouds. Both the public and private clouds are created by VMware. vSphere is used by VMware's vCloud Hybrid Service (vCHS) to establish control over the business cloud environment. vCHS is considered as a secure hybrid cloud service that support to new application development, current workloads and third-party apps [2]. Tools like vCloud Connector, vCenter Configuration Manager and vCloud Automation Center used by VMware for seamless transition from the data center into the public cloud. VMware's products were one of the first cloud operating systems because of its performance, reliability, experience, technology and virtualized deployments. VMware vCloud Air is vendor nonbeliever when it comes to running Linux, Microsoft or other operating systems. VMware uses the vCloud software for both the internal and external cloud frameworks which helps to keep simplicity for the administration of resources. VMware has experience in software defined networking (SDN) and applied that experience to the hybrid cloud in its NSX (networking and security software) product [6].

5. CONCLUSION

Cloud Computing is assisting users around the world to benefit with the best services available across the world on their machines through web. This paper has focused on the investigation of solution providers of hybrid cloud computing is given which can make the current IT architecture rapidly migrate to cloud computing, reduce the investment, the efficiency of IT management, simplify the integration of resources and substantially improve the ability of business support. Hybrid cloud adoption can be an effective strategy for a wide variety of businesses that have a tighter focus on security or unique physical presence demands. Ultimately, hybrid cloud allows organizations to assemble a private cloud to switch a standard workload, with burst compute offloaded to the public cloud. This provides a great arrangement of elasticity in computing tasks, while keeping the most vital components within the company firewall.

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