

Unit- V: Hybrid Cloud

Hybrid Cloud Fundamentals, Benefits of a Hybrid Cloud, Key Considerations for Hybrid Cloud, Components of Hybrid Cloud, Hybrid Cloud Deployment Models, Managing Hybrid Cloud Environment

What is Hybrid Cloud Computing?

Hybrid cloud computing is a deployment model which involves combining the use of multiple cloud services across different deployment models – in particular, combining the use of public cloud services with private cloud services.

The ISO 17788 Cloud Computing Overview and Vocabulary standard [2] defines hybrid cloud as “a cloud Deployment model using at least two different cloud deployment models” – where the potential deployment models are public cloud, private cloud and community cloud.

Based on this definition, there are many combinations of cloud resources that can be leveraged in a Hybrid cloud deployment. These combinations can also involve a mix of different cloud service models, Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). For example, a hybrid cloud deployment could combine an on-premises private IaaS cloud service with a publicly hosted SaaS application. It is also important to recognize that private cloud services could be hosted on-premises or alternatively hosted off-premises in a dedicated part of a cloud service provider's data center.

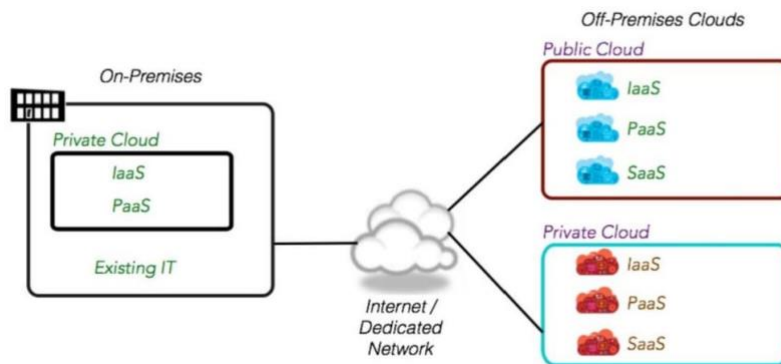


Figure 1: Hybrid Cloud provides the enabling capabilities to bridge environments, layers, and resources such that it is seamlessly automated

Most enterprises are not “born on the cloud,” therefore most cloud resources typically need to be connected to significant on-premises IT systems. For these enterprises, the most common hybrid cloud system architecture is where on-premises resources (private cloud and non-cloud) are combined with off-premises cloud resources, providing the business with a variety of new and innovative capabilities. This paper focuses on this combination.

Here are key considerations that need to be taken into account:

- **Integration:** Hybrid cloud computing is about aggregation and integration of capabilities and services from cloud service providers with on-premises resources, leveraging the best-of-breed. The emergence and evolution of core integration capabilities, such as Service Oriented Architecture (SOA), Representational State Transfer (REST) Application Programming Interfaces (APIs), and cloud management and orchestration frameworks have opened up new options for integrating cloud services. In addition, new capabilities from a wide variety of services (on-premises and off-premises) can now be aggregated to provide the business with a broader set of capabilities on which to act.
- **Composition:** Hybrid cloud is about combining services and capabilities in a way that supports desired business objectives with agility and within budget, while at the same time dealing with risks and regulations in a satisfactory way. A hybrid cloud also enables businesses to utilize these

services in varied durations and usage models. A set of services (either IT focused or business focused) could be used over a long time based on predetermined business needs, or they could be used for a limited period based on specific business events.

- **Organizational Impact:** People in many different roles are impacted by hybrid cloud in a variety of ways. The value of hybrid cloud is highly dependent on what is important to your organization.

Hybrid cloud means different things to different people

Different roles in an organization are typically concerned with aspects of enterprise IT, which at high level are either a focus on “using it”, “building it” or “running it.”

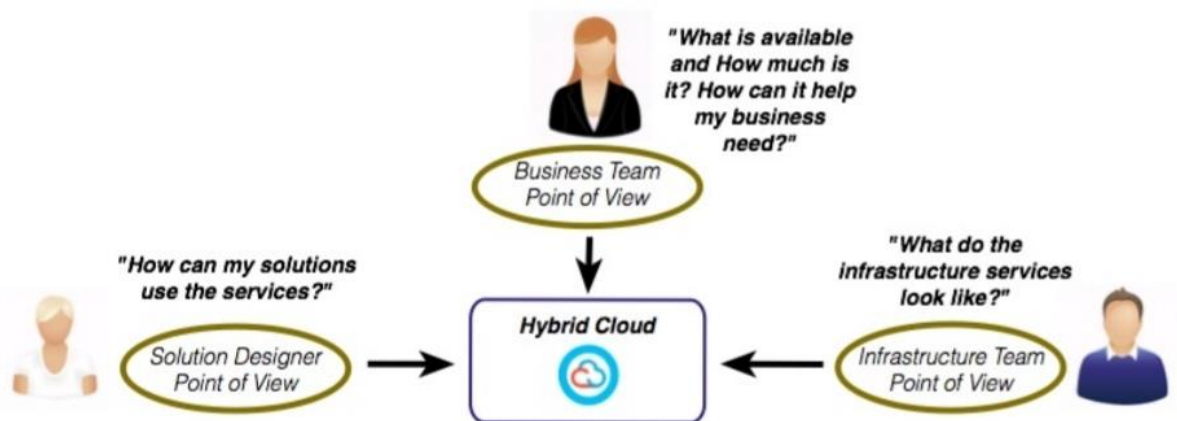


Figure 2: Cloud Service Customer Points of View for hybrid cloud computing

Solution Designer Perspective: “Give me more options”

A solution designer typically looks to hybrid cloud for options and capabilities that are not available in an on-premises or off-premises only solution.

For designers and developers some of the critical success factors related to hybrid cloud include:

- **Flexibility.** Repartition/deploy elements of a solution based on changing technology services or improved capabilities.

- **Speed.** Quickly leverage new capabilities in their solutions no matter where they are available in the hybrid cloud.
- **Capacity.** Quickly leverage the capacity of off-premises clouds to provide peak support for on-premises systems.
- **Consistency.** Support continuous delivery of applications across the hybrid cloud leveraging common tools and processes.
- **Agility.** Design and develop solutions in such a manner that where they are deployed across a hybrid cloud can be adjusted in a seamless manner.

Infrastructure Perspective: “More things to manage”

Another perspective is that of the infrastructure or service provider team. This team typically looks at hybrid cloud based on SLAs, processes, and resources (compute, storage and networking). For the infrastructure team some of the critical success factors related to hybrid cloud include the ability to:

- Have visibility into all resources and services being utilized and managed across the hybrid cloud.
- Monitor all infrastructure resources in a consolidated and federated manner following current processes.
- Access all resources on the hybrid cloud to perform activities as required (e.g., console login).
- Manage the deployed infrastructure to perform patching, auditing, and security management as required by the organization’s SLAs.
- Enforce consolidated security across the hybrid cloud, including consolidated audit logs.
- Control provisioning of workloads based on organizational policies.

Business Team Perspective: “What is available? How much is it? What value does it provide?”

For business teams, some of the critical success factors related to hybrid cloud include the ability to:

- Have a consolidated view of what is running where and what the financial implications are by organization/department.
- Understand the SLAs of a solution as a whole based on different providers.
- Have consolidated invoices that can integrate with the organization's financial systems.
- Access the systems running on the hybrid cloud without regard for where they are running. The business users should not know or care.
- Perform financial “what if” modeling leveraging the services of different cloud providers.
- Reduce costs and increase business flexibility of leveraging hybrid cloud.
- Understand software licensing exposure across the cloud providers being utilized.

As you can see, these roles can look at hybrid cloud very differently. This will come into focus more when we look at the value, the scenarios, the considerations and the challenges related to hybrid cloud.

What are hybrid cloud benefits?

Effective application governance

A hybrid approach allows you to decide where your application sits and where hybrid computing happens. This can help improve privacy and ensure compliance for your regulated applications.

Improved performance and reduced latency

Sometimes, distributed apps at remote locations benefit from a hybrid cloud solution. For applications with low latency requirements, hybrid computing happens close to the end users.

Flexible operations

Hybrid computing gives you the flexibility to operate in the environment that's best for you. For example, by building with containers, you can create portable applications and easily move between public and private clouds.

Improved ROI

By adding a public cloud provider to your existing on-premises infrastructure, you can expand your cloud computing capacity without increasing your data center expenses.

Improved performance and reduced latency

Sometimes, distributed apps at remote locations benefit from a hybrid cloud solution. For applications with low latency requirements, hybrid computing can happen closer to the end users.

Faster innovation

Hybrid cloud models provide access to the latest technologies like AI and machine learning without having to extend or replace your existing infrastructure. You can maximize resources and increase productivity to speed up the development and delivery of apps.

Key Considerations for Hybrid Cloud Computing

Given an understanding of what a hybrid cloud is, the business value it provides, and use cases for how it can be leveraged is the first step on the journey to hybrid cloud computing. Some of the benefits of Hybrid cloud (e.g., capacity, flexibility, elasticity, service portfolio and resource cost) have to be weighed against a core set of considerations. The next step is to develop an understanding of the key considerations faced in implementing a hybrid cloud in your organization. This section provides a summary of what these are and why they are important. Here are the key considerations:

- **How to determine the placement of solution components.**

What should go where and how should it be designed? Should a solution only include the usage of private dedicated or local cloud resources? How do you leverage available public cloud services?

- **How to integrate with existing enterprise systems.**

How can existing business applications along with existing management and monitoring systems be leveraged? How will the internetworking be accomplished?

- **How to handle an increase of management complexity.**

How do I manage resources running in different cloud services, particularly public cloud services? The lifecycle of resources involved in supporting key business operations can be transient (short lived and/or move automatically). How is that handled by existing management and reporting systems?

- **How to ensure that security is considered in all aspects of the hybrid cloud.**

How do I ensure that both on-premises AND off-premises cloud environments are secure? How about the data stored off-premises? How about the data in transit?

- **How to deal with rapidly evolving and partially mature technologies.**

The speed of capabilities being deployed and or changed in a hybrid cloud changes at a different speed for fast speed resources vs. steady speed. How does the organization support this?

- **How to implement common operational services such as backup and disaster recovery in a hybrid cloud.**

Given that there are multiple providers in play, how can the different backup/recovery solution and networking options enable a seamless environment that meets an organization's SLAs?

- **How to ensure adherence to regulatory and compliance requirements.**

How will you ensure data placement, data encryption, personal information protection, contractual management (e.g., software licensing) adhere to the appropriate regulation?

Prescriptive guidance for successful implementation of Hybrid Cloud (Components of Hybrid Cloud)

This section provides a prescriptive series of steps that should be taken to ensure successful hybrid cloud computing deployment from the perspective of a cloud service customer. It takes into account differences that result based on the size of the organization and its IT maturity level. The following steps

Are discussed in detail:

- Determine cloud deployment model for applications and data
- Integrate with existing enterprise services
- Address connectivity requirements
- Develop governance policies and service agreements
- Assess and resolve security and privacy challenges
- Manage the hybrid cloud environment
- Consider a backup, archive and disaster recovery plan

Depending on the maturity of the organization and the level of adoption of cloud computing, the entry point will change for each new service being evaluated.

For the following sections, it is useful to keep in mind a picture of the components and their interconnections that are involved in hybrid cloud computing, as shown in Figure 3. This divides the components of concern to the cloud service customer into three groups – the customer's own in-house systems, components running in private cloud services (whether on-premises or off-premises) and components running in public cloud services. Figure 3 also highlights the three types of interfaces that exist between these groups – namely, the functional interfaces of the applications and services, the administration interfaces used to manage and control the applications and services (this includes security administration), and the business interfaces used to manage subscriptions, billing and payments.

The customer's in-house systems are divided into in-house applications, management applications and security systems, plus in-house datasets and databases. For both private cloud services and for public cloud loud services, the major components described include the app code (for applications

running within the cloud service) with its application environment, cloud service customer data and cloud service derived data (which includes logs) and various security components.

The major concern of hybrid cloud deployment is to ensure effective and efficient integration of all the components in the three groups in Figure 3, taking into account the interfaces between them.

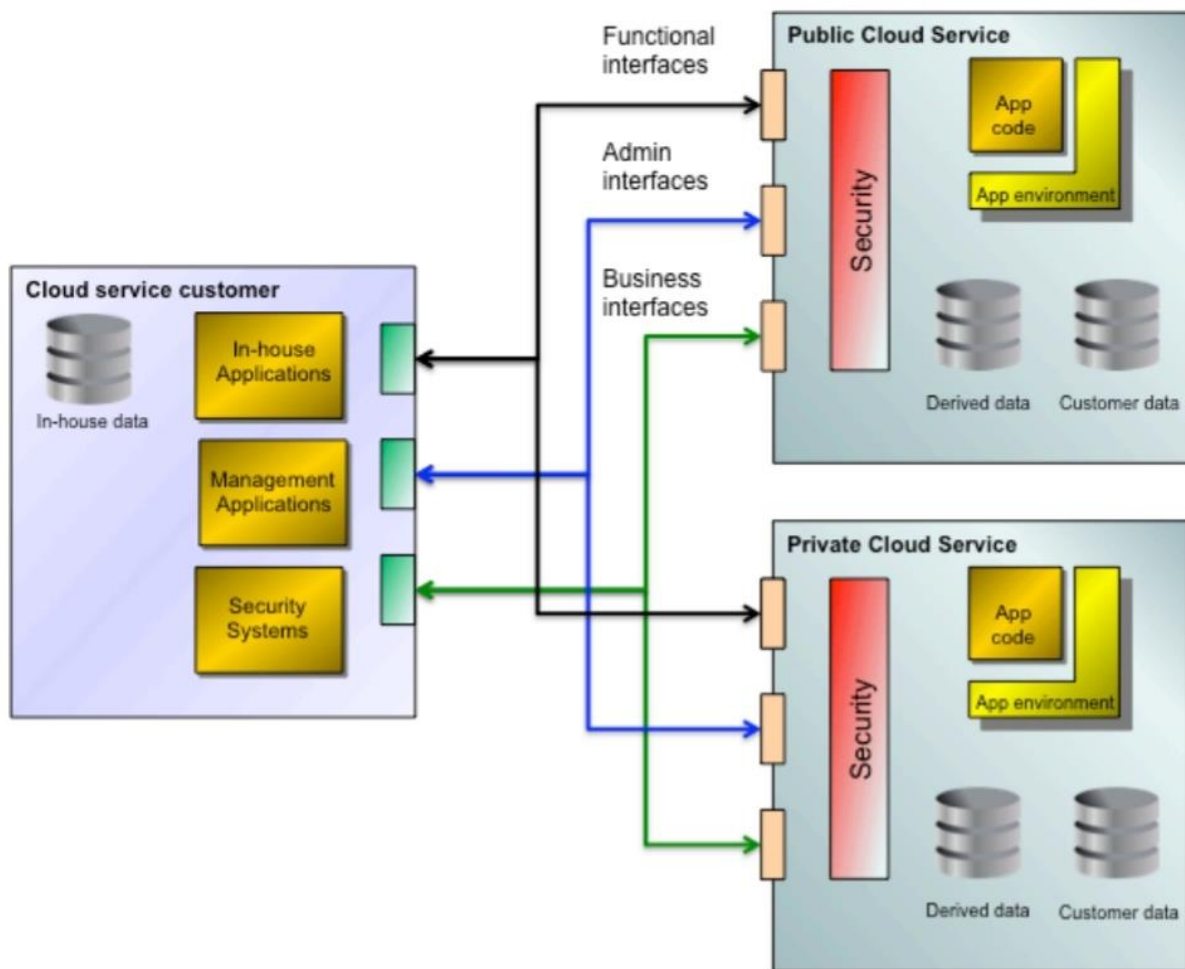


Figure 3: Components and connections for Hybrid Cloud Computing
Determine Cloud Deployment Model for Applications and Data

Defining the right application and data deployment model is a critical step in the journey to use hybrid cloud. The right deployment model positions IT to align with business needs and enable achievement of objectives. The cloud deployment model must address the following:

- What cloud resources should be deployed
- What applications, services and data should go where

The two speeds of IT is a major consideration when defining which cloud resources to deploy. In the steady speed, IT must continue to support the traditional enterprise applications to keep the business running. This implies that current on-premises services must be maintained. Additionally, off-premises services, such as private dedicated IaaS, can be used to increase infrastructure flexibility for enterprise services.

The fast speed requires IT to deliver applications and services more quickly whether it's scaling existing services to satisfy spikes in demand or providing new applications quickly to meet an immediate business need. The use of public cloud services may be required to satisfy these requirements.

After sorting out the cloud resources to use, the next step is determining where applications and data should go. Here are the four basic options for application placement in a hybrid cloud environment:

1. Place the application and its datasets into a public cloud environment connecting to existing enterprise applications and datasets on-premises as required.
2. Place the application and its datasets into a private cloud environment connecting to existing enterprise applications and datasets on-premises as required.
3. Place the application on-premises (or into a private cloud environment) and link to public cloud services as required to obtain new or specialized capabilities.
4. Place some components of the application and its datasets into a public cloud environment while placing other components into a private cloud service and/or an on-premises non-cloud environment, linking them together as required.

Deployment decisions must consider these four options. IT architects should assess the right application architecture to achieve maximum benefit. This includes understanding application workload characteristics and determining the deployment model for multi-tier applications. For example, understanding where heavy processing is performed and the interaction between presentation, business logic, integration, and data layers is key to making the right application deployment decisions.

This has to be understood to ensure acceptable application response times are maintained in the hybrid model.

Cloud service brokerage is emerging as an important component for delivering consistent and accurate placement and prioritization planning for applications in hybrid cloud environments. Cloud service brokers function as intermediaries between cloud providers and enterprises and help strengthen the relationships providers have with customers by offering planning, integration and management services.

They provide tools to govern and control environments across private and public clouds covering cloud spend, security and resiliency aspects from the application infrastructure design through the final cloud managed services that are actually provisioned and utilized.

Regarding the related question of which cloud service model to use for the application:

- **IaaS**: well suited to cases where the application and its required software stack already exist and are well understood by the enterprise – move the whole set of software into one or more virtual machines with associated storage resources.
- **PaaS**: well suited to applications built for runtimes and services supported by a complete middleware platform, especially where the enterprise wants to be relieved of the burden of maintaining and operating complex software stacks if required by the application. Also particularly suited to creating new custom applications with minimum effort and risk.

- **SaaS:** well suited to cases where the enterprise wants to avoid the costs and risks of developing custom applications, where standard off-the-shelf cloud services provide the required business capabilities.

The summary below represents the high-level steps that need to be taken to rationalize application and data deployment. These steps should be incorporated in the IT planning process. This is recommended to ensure the model is connected to where the business and IT is going.

1. Identify the business objectives and strategic imperatives
2. Align with the IT strategy and future state architecture to achieve it
3. Develop application and data inventory
4. Map business processes to applications
5. Identify disposition of applications – retire, consolidate, maintain, upgrade/enhance
6. Define deployment decision criteria and apply to the retained (consolidate, maintain, upgrade/enhance) applications
7. Document deployment model

A key step in the process is applying decision criteria to determine the deployment of applications (step 6 above). Flexibility, security, speed, cost, control, locality, and service levels represent the criteria used when deciding between public and private (on and off-premises) cloud deployment. The team performing the analysis must have a strong understanding of application business and technology requirements in order to make informed deployment decisions.

- **Flexibility** – Elasticity requirements must be considered when assessing public and private cloud usage. Seasonal demand for services, such as Black Friday ecommerce activity, drives a significant increase in capacity requirements for a short period of time. Public cloud services are preferable when elasticity is a major concern as purchasing on-premises capacity to support this kind of demand is not cost effective. Mature organizations provide “bursting” to public cloud services when privately hosted services exceed defined thresholds.
- **Security** – Security and privacy are major considerations when evaluating application and data deployment and the data being used.

IT should understand compliance requirements and establish cloud deployment policies. Traditionally, less sensitive data such as publicly available information have been candidates for the public cloud while highly sensitive information may be better hosted on-premises or in a private cloud service. Security in public cloud services continues to mature and is improving, potentially enabling the hosting of highly sensitive information in such services to be considered. The organization has to assess the available controls in the public cloud service and architect security services to deal with the risks associated including those related to multi-tenancy.

- **Speed & Automation** – The ability to quickly deploy applications and satisfy business needs is a major consideration when making deployment decisions. The immediate availability of resources and capabilities in public cloud services makes this model desirable when fast deployment is required. Additionally, existing public cloud services can be leveraged to reduce the time to build new capabilities for the business.
- **Cost** – The cost associated with hosting the application over the term of usage is a key factor when considering application and data deployment. Thorough understanding of private cloud costs (e.g., monthly server cost) and understanding public cloud variable costs, such as outbound internet bandwidth usage, is critical to establishing an apples-to-apples comparison. The costs of developing and maintaining application capabilities in-house also need to be compared with the alternative of using off-the-shelf cloud services with an ongoing subscription model.
- **Locality** – The location of application and data must be considered when deploying services to public and private cloud. Locality considers latency of services to end users (includes application and data integration) to ensure a great user experience. For example, cross border latency can have a significant impact on response times. Hosting services in country for the user community will improve the experience. Additionally, data sovereignty concerns may encourage hosting of services in a public cloud where a data center presence does not exist.

- **Service Levels** – Service levels associated with mission critical applications are a major consideration when assessing application deployment – including availability, response times, throughput, etc. Mapping service levels associated with public cloud services and private cloud services to the requirements of applications helps to identify any mismatches. For example, availability of public and private cloud services must be understood, along with the options to architect around known limitations.
- **System Interdependencies** – How dependent is a system on other systems in your organization? This is key since you may have a workload that meets all the criteria above, however, if it has multiple integration points that cross the hybrid divide, it may not be suitable for a hybrid cloud. Thoughtful planning is required to develop a hybrid cloud deployment model that enables business to Innovate. Identifying the right resource model and working through deployment decisions are key steps

Manage the Cloud Environment

Implementing service management in hybrid cloud environments may be challenging due to different factors. For example, cloud providers may or may not provide their own management processes and tools, or public cloud services may or may not be manageable from the traditional service management tools running in an on-premises environment. However, implementing a single point of management is a must for any enterprise IT department in order to be able to fulfil the requested SLAs and QoS. This becomes even more important when part of the infrastructure or the services are not directly in the control of the IT team. The major business driver for implementing a hybrid cloud service management system or to extend the on-premises one is to get a single point of control for end-to-end resources and services. However, leveraging the services and the built-in management tools from a cloud provider sometimes might reduce the management costs in terms of licences and effort.

Here are the critical steps cloud customers must take to plan a management solution for hybrid cloud:

1 – Analyze the management processes and use cases you need to implement

Start from the major service management ITIL processes and depending on your needs decide which ones you need to implement. The following list describes the subset that makes sense in a hybrid environment:

- **Service strategy** – financial management (metering/billing), etc.
- **Service design** – availability management, capacity management, etc.
- **Service operation** – event management, request fulfilment, incident & problem management, common service operation activities (for example, backup/archive), etc.
- **Service transition** – configuration management, software asset/license management, change management, patch management, etc.

2 – Analyze on-premises management tooling

One of the simplest approaches is to extend the management processes and tools already being used and leverage them to manage the resources/workloads in the cloud. The main points to consider:

- How well do existing management tools support the new cloud infrastructure?
- At which level (application, middleware, operating system and infrastructure) do on-premises tools manage the cloud resources?
- How much will it cost (effort and licenses) to install, integrate and maintain current management agents on the cloud infrastructure?
- Do the on-premises management tools provide APIs to facilitate eventual integrations?

3 – Analyze cloud service provider management functions and the service responsibility line

Another option is to leverage the management capabilities provided by the cloud platform to manage both the cloud resources/workloads and, if possible, on-premises resources/workloads. A fundamental aspect to understand when analyzing the management capabilities from a cloud provider is the so called service responsibility line and the specific

management capabilities offered by the service provider (see Figure 4). Some CSPs supply additional management services for components above the SRL; for example, performance monitoring tools, backup tools, patch management for operating systems, disaster recovery services, etc. To exploit the cloud service provider management functions, the following points need to be considered:

- Does the cloud service provider support the necessary management processes?
- How much would it cost to manage the cloud resources/workloads?
- Can the cloud services manage on-premises resources?
- Do the cloud management tools provide APIs to facilitate integration?