Kong

Microservices and Multi-Cloud

Building Cross-Cloud Harmony

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Content

Introduction to Microservices and Multi-Cloud

Two of the hottest trends in tech today are microservices and multi-cloud, and if you've attended a tech conference recently, you've likely seen at least a couple sessions dedicated to them. The use of microservices increases by the day as developers look to use smaller, modular services that work in tandem to enable larger, application-wide functionality.

What are microservices? Microservices refer to a method of software development that focuses on creating single-function modules with well-defined interfaces and operations.

Microservices provide us with an alternative to developing a traditional, 'monolithic' application all in one go. Microservices are driven by the central idea that breaking some types of applications into smaller, composable pieces makes it easier for us to build and maintain them.

In a microservices architecture, each component is continuously developed and separately maintained, with the application being the sum of its constituent components. As we look to make our organizations more agile, adoption of microservices in application development by enterprises is increasing rapidly.

Compared to monoliths, microservices are easier to understand, test, and maintain over the life of

the application. By helping us achieve greater agility in development, microservices significantly reduce the time needed to get working improvements to production.

In particular, microservices are extremely useful for large enterprise applications developed by teams of geographically and culturally diverse developers.

There are several benefits to this approach including:

- Developer independence
- Isolation and resilience
- Scalability
- Lifecycle automation
- Relationship to the business

In practice, the microservices approach relies on each microservice provisioning an Application Programming Interface (API) endpoint. This is often but not always a stateless REST API which can be accessed over HTTP (S) just like a standard web page. This makes consuming microservices easier for developers, as microservices only require tools and methods that most developers are familiar with.

Another factor accelerating the move to microservices by enterprises reason is that many organizations have come to recognize the benefits of componentized software in development and deployment. For example, in the cloud, componentization can bring organizations many

advantages, including resiliency and support for horizontal scaling. With microservices, these benefits can be magnified considerably.

When it comes to the cloud, we've all heard of public cloud, private cloud, and hybrid cloud, but a relatively new term for is multi-cloud: the use of more than a single public cloud.

The multi-cloud usage pattern came about as a result of organizations wanting to avoid dependence on a single public cloud provider. With multi-cloud, organizations can choose specific services from each public cloud to get the best of each.

Multi-cloud environments can help enterprises to address their broader business goals. Using multi-cloud, an organization can take advantage of the speed, capacity, or features offered by a particular provider, their own private cloud, or a cloud in a particular geography or vertical market. It can also make use of more price-competitive cloud services.

With the benefits of microservices in mind, practitioners are now using them for multi-cloud. With microservices, it becomes easier to facilitate experimentation —to see if changing a part of a process or a single task—can have a beneficial impact on the overall outcome of the process.

Unlike monolithic applications, microservice-based applications can be selectively scaled out. For example, an enterprise can scale-out a specific microservice on-demand instead of launch-

ing multiple instances of the application server. As the need to provision virtual machines shifts to provisioning new microservices instances on existing virtual machines, better value is delivered from the underlying infrastructure.

Microservices can make it easier to deploy and use a multi-cloud environment but ensuring this needs a lot more than the technology being set up to support this concept; organizations also need the culture, knowledge, and structures in the place for development teams to be able to adopt the microservices model for application development.

The culture, knowledge and structures required to implement the microservices model is discussed is this eBook. The book also discusses the history and rise of multi-cloud, what makes it different from hybrid cloud, the benefits and drawbacks associated with it, how microservices help a multi-cloud strategy, the challenges for adopting multi-cloud without microservices, and the considerations for adopting multi-cloud with microservices.

The Rise of Multi-Cloud: What It Is and Where It Came From

The risk of service availability failure and the possibility of malicious insiders in the single cloud are predicted to decrease the popularity of 'single cloud' providers amongst the users of the cloud. As a result, a new trend is starting to emerge, which is a movement towards 'multi-clouds'.[1]

Many say that multi-cloud is the future of information technology. While that is true, multi-cloud is also IT's present reality. In fact, over 80% of the organizations already have a multi-cloud strategy. [2]

Forrester reports that this increased movement towards a multi-cloud strategy is due to its ability to deliver business value.[3]

How exactly a multi-cloud strategy deliver business value is discussed later in this book. For now, it's important to dig into multi-cloud to understand what it means, what created it and why it's important for enterprises and the IT sector.

[1] Mohammed A. AlZain, Eric Pardede, Ben Soh, 2012 "Cloud Computing Security: From Single to Multi-clouds" 45th Hawaii International Conference on System Sciences, IEEE, pp: 7/12. Available at https://ieeexplore.ieee.org/abstract/document/6149560

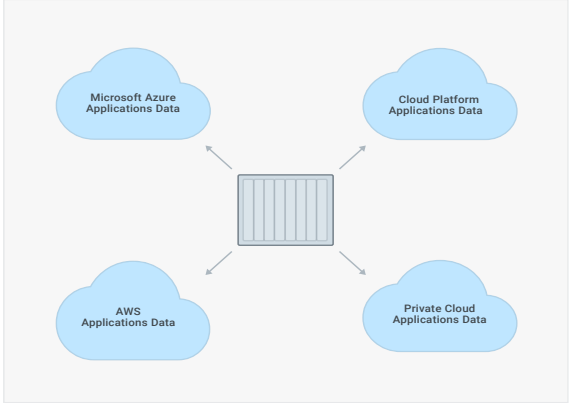
[2] https://www.techrepublic.com/article/why-86-of-enterprises-employ-a-multi-cloud-strategy-and-how-it-impacts-business/

[3] https://www.forrester.com/report/A+Clear+Multi-cloud+Strategy+Delivers+Business+Value/-/E-RES128781

Defining Multi-Cloud

As the name suggests, multi-cloud is an IT approach in which an organization relies on more than one provider to get access to multiple cloud services. A cloud computing deployment model, multi-cloud enables organizations to deliver application services across multiple private and public clouds that contain some or any combination or the following: multiple cloud accounts, multiple cloud availability zones, multiple cloud vendors or multiple cloud regions or premises.

Following is a multi-cloud diagram depicting the use of multiple cloud service providers for data by an enterprise or company:



The above is an example of a typical multi-cloud architecture utilizing two or more public clouds as well as private clouds to eliminate the reliance on any single cloud provider or instance.

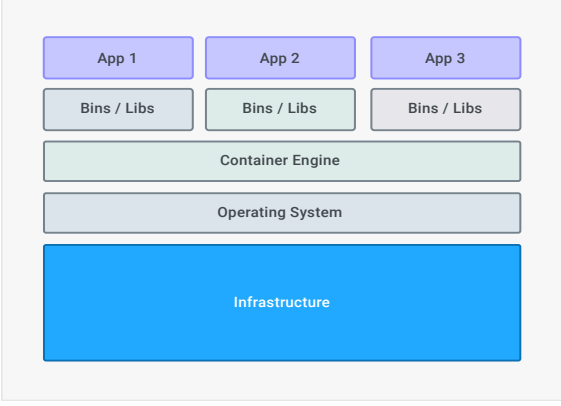
What Makes Containers So Important for Multi-Cloud

Often called this generation's Platform as a Service (PaaS), Containers as a Service (CaaS) platforms such as Azure Container Service and Google Container Engine are becoming the new infrastructure layer on which multi-cloud environments run.

One of the challenges of a multi-cloud approach is that different cloud solutions run in different software environments. At the same time, organizations want to build applications that can easily move across a wide range of these environments without creating integration difficulties. Since they isolate software from the underlying environment, containers can be ideal here. This enables developers to build applications that can be deployed virtually anywhere.

In addition to the above, componentization—which occurs in the case of microservices—allows organizations to develop faster and more reliably; smaller codebases are easier to maintain. Since the services are separate, testing specific inputs for outputs is easier.

Following is a diagram depicting Containerized Application Deployment Model:



What Created Multi-Cloud

A cloud approach composed of more than one cloud service—from more than one cloud provider or vendor—multi-cloud came about due to several reasons. These reasons are explained below:

Shadow IT

As defined by Cisco, Shadow IT is the use of IT-related hardware or software by a department or individual without the knowledge of the IT or security group within the organization. It can encompass cloud services, software and hardware.[4]

[4] https://www.cisco.com/c/en/us/products/security/what-is-shadow-it.html

Shadow IT is one of the realities contributing to multi-clouds. Shadow IT is a problem that arises as a result as of policy-compliant IT not fully meeting the needs of the organization. Not only does a multi-cloud environment solve the problem of Shadow IT by allowing groups to comply with IT policy, it also helps them to use and benefit from a specific cloud technology. This takes to us the next reason that created multi-cloud: there's no perfect solution.

No Perfect Solution

An organization might find the perfect cloud solution for one aspect of its enterprise, but no single cloud can do everything or to put it more appropriately, do everything well. This limitation prompts the need for creating a multi-cloud environment.

Proximity

With multi-cloud, it is possible to host some workloads by regional providers that operate closer to where the users are in order to reduce poor response times for cloud users thousands of miles away from an organization's headquarters. As a result, the enterprise can maintain high availability and adhere to data sovereignty laws—the concept that information which has been converted and stored in binary digital form is subject to the laws of the country in which it is located.closer to where the users are in order to reduce poor response times for cloud users thousands of miles away from an organization's headquarters. As a result, the enterprise can maintain high availability and

adhere to data sovereignty laws—the concept that information which has been converted and stored in binary digital form is subject to the laws of the country in which it is located.[5]

Failover

In a multi-cloud environment, enterprises are protected from outages. Multi-cloud as a failover solution allows organizations to have an available, highly scalable backup for data, workflows, and systems if their primary cloud goes dark.

What Makes Multi-Cloud Important for Enterprises and IT

There are several factors that make a multi-cloud approach important for enterprises and the IT sector. The top reasons for enterprises and IT to enable a multi-cloud environment are as follows.

Visibility

Getting the required visibility into their containerized applications can be difficult for organizations when there are so clusters running on so many environments. A multi-cloud approach can solve the problem of seeing what exactly is running where.

[5] https://whatis.techtarget.com/definition/data-sovereignty

Security and Governance

It can be a challenge to manage governance with clusters. Therefore, enterprises seek a way to set consistent security policies across all environment. Additionally, they need to manage configurations and place workloads appropriately, based on compliance or capability. This is easier to ensure in a multi-cloud environment.

Consistent Application Management

While many enterprises have systems with several automation functions, they lack crucial capabilities such as backing up applications, and options for managing disaster recovery or easily moving workloads across environments. With multi-cloud, enterprise can have all bases covered.

People often confuse multi-cloud with hybrid cloud. However, they are not the same thing. The next chapter discusses the difference between multi-cloud and hybrid cloud, including what gives multi-cloud the edge over the latter.

Difference Between Multi-Cloud and Hybrid Cloud

Gartner predicts that, by 2020, a corporate "no cloud" policy will be as rare as a "no Internet" policy is today.[6] Similarly, IDC predicts that, by 2020,

[6] https://www.gartner.com/newsroom/id33354117

67% of enterprise IT infrastructure and software will be cloud-based offerings. IDC also predicts that by 2020, over 90% of enterprises will use multi-cloud-services.[7]
When considering the growing adoption of a multi-cloud strategy, one must keep in mind that multi-cloud is not the same things as hybrid cloud.

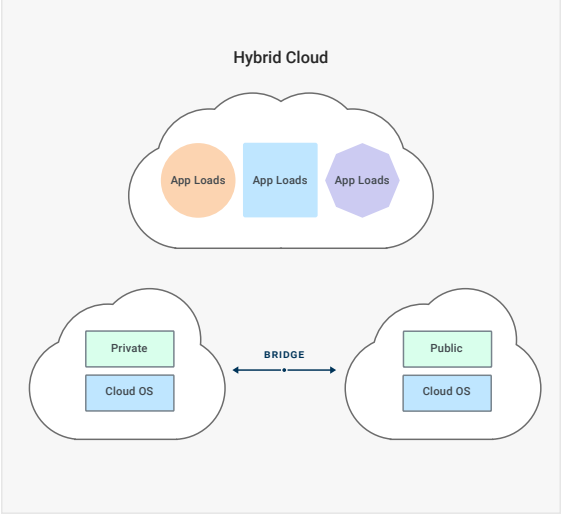
So, what's the difference? In hybrid cloud, an organization uses a combination of public cloud, private cloud and on-premises services to achieve its goals. Multi-cloud, on the other hand, uses multiple cloud services from more than one provider.

While they are often used interchangeably, multi-cloud and hybrid cloud have distinct meanings.

For example, a hybrid cloud is a pairing of a private cloud and a public cloud. Whereas multi-cloud could refer to the use of multiple public clouds with a private cloud. Following is a table that shows the major differences between hybrid cloud and multi-cloud.

[7] https://www.idc.com/research/viewtoc.jsp?containerId=US42014717

Following is a diagram depicting Hybrid Cloud:



Are Multi-Cloud and Hybrid Cloud Mutually Exclusive?

While multi-cloud and hybrid cloud are two different models, they are not mutually exclusive and can co-exist nicely. In fact, using both simultaneously is becoming common across enterprises as they seek to improve security and performance through an expanded portfolio of environments.
To draw upon the advantages of each, more robust setups may use a combination of the two cloud environments. The use of container technology combined with microservices that break applications down to component pieces is contributing to the popularity of both the multi-cloud and hybrid cloud environment.

While they can co-exist nicely, there are some situations where choosing hybrid cloud over multi-cloud (or vice versa) would make sense.

Hybrid cloud deployments are frequently found in large enterprises with significant investments in IT infrastructure and large, skilled IT team. They provide the flexibility to leverage the existing IT infrastructure to test a cloud deployment without the risk of making a full switch. This makes it an ideal approach for organizations already having a virtualized environment.

By retiring old equipment as it nears the end of it useful life and using an orchestration solution to switch virtualized workloads, hybrid cloud allows for a slow migration to the cloud.

Multi-cloud, on the other hand, can be ideal for enterprises needing more choice. A plethora of options are brought to a cloud strategy by the ability to operate from anywhere and move and deploy workloads to any cloud.

Benefits and Drawbacks of a Multi-Cloud Architecture

The luxury of using multiple services from multiple cloud hosting providers which enables several benefits for enterprises using a multi-cloud approach.

The key for the multi-cloud is connectivity that provides end-to-end reach. Efforts to extend end-to-end security and operational control across a multi-cloud architecture can either be helped or hindered by the way connectivity is provided.
Considered end-to-end, multi-cloud comprises more than just public clouds and data centers. It also includes connecting applications to each other and to branch sites where an organization's users, staff, and customers engage. Therefore, it is important for organizations to prepare themselves for the use of a multi-cloud architecture.

How to Prepare for a Multi-Cloud Architecture

Considering that a multi-cloud is such a vast environment, enterprises must appropriately prepare to use and manage a multi-cloud architecture. Following are some ways to do that:

Unifying the Toolchain

This refers to an effort where developers apply logic to a base DevOps pipeline, application run-

time, and middleware stack that ideally can serve most of the organization's projects. For this, an organization must ensure that tools can work on any cloud infrastructure. Additionally, they should encourage open-source-based services that are managed in many clouds, or ones that organizations can bring and manage on their own.

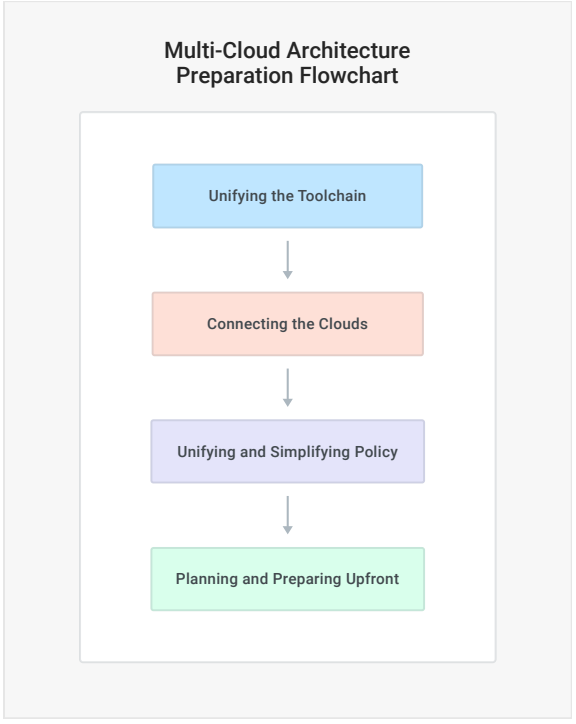
Connecting the Clouds

To allow split application tiers, enable pipeline automation, ensure backups for disaster recovery and avoidance, and secure data replication for warehousing or distributed applications, an enterprise must connect together multiple clouds.

Unifying and Simplifying Policy

An enterprise should use cloud management platforms to elevate its orchestration in and across the clouds. The use of federated or global controllers to unify configuration and management and abstraction to provision models and APIs is also recommended.

An organization can maximize its ROI while minimizing risks associated with individual cloud environments by working across multiple-cloud environments. This can be ensured with the right preparation for a multi-cloud architecture. A well-managed multi-cloud platform adds flexibility and value to an organization that leads to continued business advantage and agility. In the next section, we look at all the advantages of moving to a multi-cloud environment for an enterprise.



The Benefits of a Multi-Cloud Architecture

An approach that involves the use of different architectures, such as Software as a Service (SaaS) and Infrastructure as a Service (IaaS), to achieve an overarching business goal, multi-cloud is all about using different cloud providers to meet specific workload requirements.

The benefits of adopting a multi-cloud strategy—which include high availability, flexibility, cost savings, and a lowered risk of DDoS attacks—are a major reason for this popular trend. These benefits are explained briefly below:

High Availability

Redundancy and protection for an organization's services and data storage against security and outages is provided by a multi-cloud architecture. In a multi-cloud environment, the unavailability of one cloud is not detrimental as other clouds remain online to run applications and service users.

Flexibility

In a multi-cloud environment, an enterprise has the choice and flexibility of selecting the 'best' of each cloud type to meet their particular business needs, locations, and timing. Typically, organizations can manage their data, infrastructure, and applications using several different clouds.

Perhaps the biggest advantage of multi-cloud for enterprises is the ability to avoid vendor lock-in. In a multi-cloud environment, leverage is with the organization adopting it and not with the cloud provider. With the knowledge that workloads may end up transferring between providers, developers can build apps that work across providers.

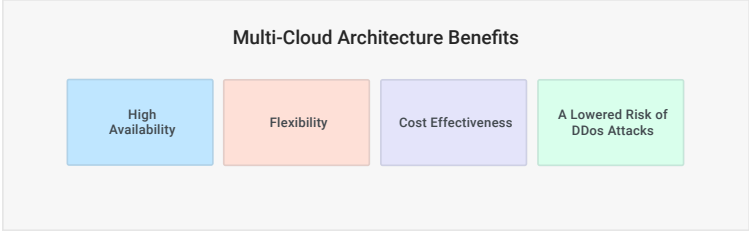
Cost Effectiveness

With a multi-cloud strategy, enterprises can control their weighing capital, economies and operational expenditures by taking advantage of public cloud and infrastructure vendors competing on price.

A multi-cloud approach forces cloud providers to compete for the business, allowing workloads to be placed on the lowest cost cloud. Additionally, organizations can optimize costs for specific-level requirements and elastic scale by planning service capacity allocation through the multi-cloud. This makes it cost-efficient to have a multi-cloud approach.

A Lowered Risk of DDoS Attacks

With the growth in cloud deployments, the likelihood of DDoS attacks taking a site down and ultimately keeping it down has increased. The good news is that a well-crafted and managed multi-cloud architecture can provide a level of resiliency not available with a single provider. This helps in lessening the effectiveness of DDoS attacks. If a cloud provider suffers an attack, a multi-cloud strategy allows IT to immediately shift the load or only the impacted services to other cloud environments, with other services staying where they are.



Drawbacks of a Multi-Cloud Strategy

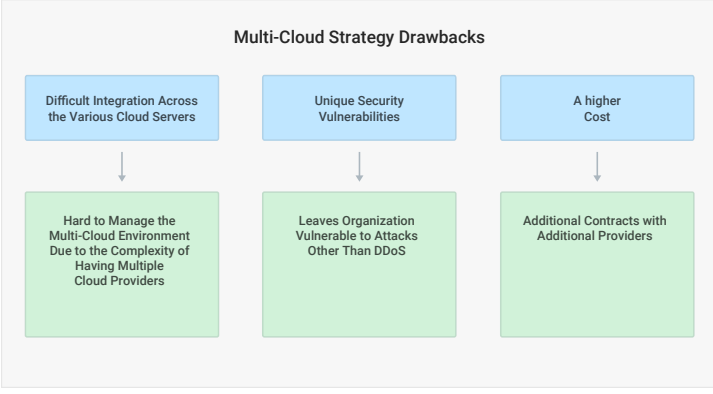
While the multi-cloud strategy offers a plethora of benefits, it has some weaknesses too. Most of them relate to complexity and a higher cost. One of the drawbacks of a multi-cloud strategy is the potential for a difficult integration across the various cloud servers.

The complexity of having multiple cloud providers makes it hard to manage the multi-cloud environment—both from a security standpoint and a task perspective. There are also unique security vulnerabilities to think about.

While a multi-cloud strategy helps to limit the effect of a DDoS attack, it can leave an organization vulnerable to other attacks. Having multiple clouds means that the organization can't apply its firewalls in the multi-cloud in its entirety to deny hackers or viruses.

The higher cost of a multi-cloud strategy comes from having additional contracts with additional providers. At times, two well-chosen public providers can be a better solution than additional providers that adds to an organization's costs.

However, in most situations, having a multi-cloud approach is beneficial. As mentioned in the introduction, microservices can make it easier to deploy and use a multi-cloud environment. How exactly can they do that is discussed in the next chapter.



How Microservices Help a Multi-Cloud Strategy

Success in a multi-cloud environment requires strategic planning to manage risk and match ap-

plications to the cloud service best suited in terms of service, pricing, infrastructure and connectivity. Adopting a multi-cloud environment means being ready or in a position to make use of the best available technologies. Microservices can help help these efforts as they:

- Bring a new way of thinking about application architecture
- Are incredibly configurable
- Fit in any product that should be scalable from the beginning
- Are ready for the new multi-cloud demands of modern high-performance applications

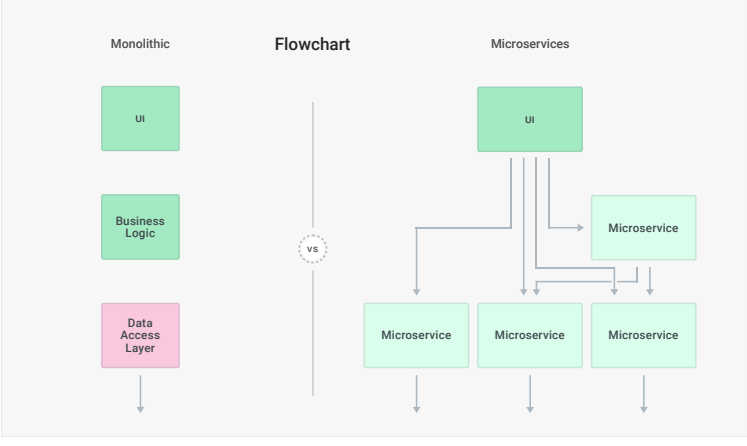
As previously discussed, an important tool enabling the multi-cloud environment are containers. By packaging and isolating apps with their entire runtime environment, containers allow users to move the contained app between clouds while retaining full functionality. With this approach, enterprises have the freedom to choose public cloud providers based on universal standards instead of whether the provider will, or won't, support the organization's workload.

This portability is facilitated by microservices—an architectural approach to writing software in which applications are broken down into their smallest components, independent from each other.

There are many benefits of adopting a microservices approach for the multi-cloud environment. These benefits include, but are not limited to,

faster software release, more frequent software updates, and quicker addition of new features. Microservices also enable an enterprise to dedicate smaller teams to smaller sections of the overall systems. As the teams work independently, they can deliver updates faster.

In microservices architecture, applications are built as a collection of different smaller services rather than one whole app. You have several independent applications—instead of amonolithic app—that can run on their own and may be built using different coding or programming languages. Simpler and independent self-executing programs can be used to build big and complicated applications and these smaller programs can be grouped together to deliver all the functionalities of the big, monolithic app.



Why the Need for Microservices in a Multi-Cloud Environment?

While there are several advantages of employing microservices for multi-cloud, following are the two major reasons for its implementation.

Application Proliferation

The proliferation of applications and mission-critical, customer-facing interactions being run on them makes it critical for developers to quickly and easily develop, deploy and move applications back and forth from premises to other clouds. Enabling this are microservices architectures and container-based deployments. Their rise is accelerating the adoption of multi-cloud and multi-cloud applications.

The focus of microservice architectures is on building scalable, distributed applications that support agile deployment—both on-premises and to the cloud. Many organizations today are moving apps to the cloud to modernize legacy applications and often this requires using various cloud services, which allows organizations to quickly bring new functionality to applications.

Often, the microservices will be hosted and provided through cloud/SaaS providers, allowing organizations to integrate microservices into the

enterprise by using on-premises data centers in tandem with external services. To help speed up the creation of multi-cloud applications, more and more major cloud providers are starting to support microservice access across cloud providers.

Support for Open Source

With a multi-cloud approach, organizations can avoid the pitfalls of relying on a single cloud vendor. Enterprises have the flexibility to use a cloud whenever they want when they spread workloads across multiple cloud vendors. Having multiple clouds has more benefits than drawbacks, and the good is magnified by open source software. This is because open source technologies can bring a consistent foundation to any cloud deployment.

So, where does microservices come in all this? When applications are designed from the beginning to be modular and composable, an organization can use drop-in components in many places which may have required proprietary solutions in the past.

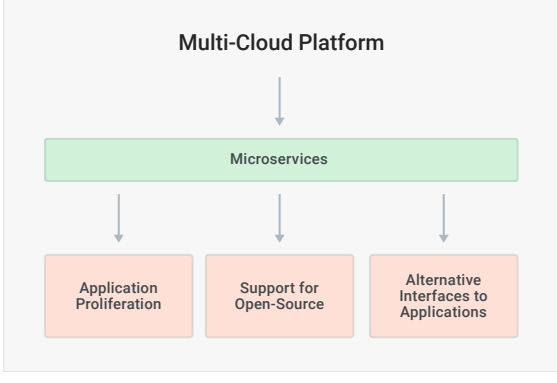
Many of the components can be off-the shelf open source tools. There are many open source projects that implement cross-cutting requirements of microservice architectures such as authentication, load balancing, service discover, scaling, logging and monitoring, and more.

Alternative Interfaces to Applications

Application developers may find it easy to offer alternative interfaces to an organization's applications when they focus on microservices. Since everything is an API, microservices standardize communications between applications components.

To make use of an organization's application and data, all that a component must do is be able to authenticate and communicate across those standard APIs. This allows both those inside and, when appropriate, outside an organization to easily develop new ways to utilize an application's data and services.

Employing Microservices for Multi-Cloud



So, we have seen how microservices can help a multi-cloud strategy. But what if an organization chooses to adopt multi-cloud without microservices? What are the implications of this? More importantly, what are the challenges that an organization will have to overcome for adopting multi-cloud without microservices? These are answered in the following chapter.

The Importance of Microservices in Cloud Adoption

Building blocks for massive architectures, microservices help to decouple big enterprise solutions into smaller blocks and assemble them, based on demand and scale.

Microservices architecture is the foundation needed by organizations to build and support future cloud services, innovate faster, and increase business agility. For organizations that embrace the API economy and those that drive digital transformations in their enterprise, adoption of microservices patterns has been the trend in the last few years.

Among the firsts to shift their platforms around microservice-based architecture to better serve their customers were technology giants such as Amazon, Google, and Netflix. Over time, many organizations have come to realize the many benefits of using a microservices architecture for cloud adoption.

Organizations adopting microservices include organizations looking to modernize their legacy systems, those undergoing a digital transformation, as well as enterprises embracing the API economy to drive new channels of growth. Considering the benefits, the trend of using microservices for cloud adoption is only likely to grow in the coming years.

With changing consumer habits and expectations, as seen in multi-cloud environments, it has become imperative for enterprises to cater to evolving user needs in a more agile, reliable, and faster manner.

Traditionally, many enterprise projects were developed and managed by centralized IT, where the project was delivered based on the business requirements for the whole organization. Such projects would typically be slow to build, hard to manage, and came with heavy operational and maintenance overhead. This resulted in a widespread adoption of microservices as enterprises looked to provide experiences across multiple channels.

Organizations that moved to the cloud, including adoption of multi-cloud, without microservices will have to face several challenges.

Advantages of Microservices in Multi-Cloud Adoption

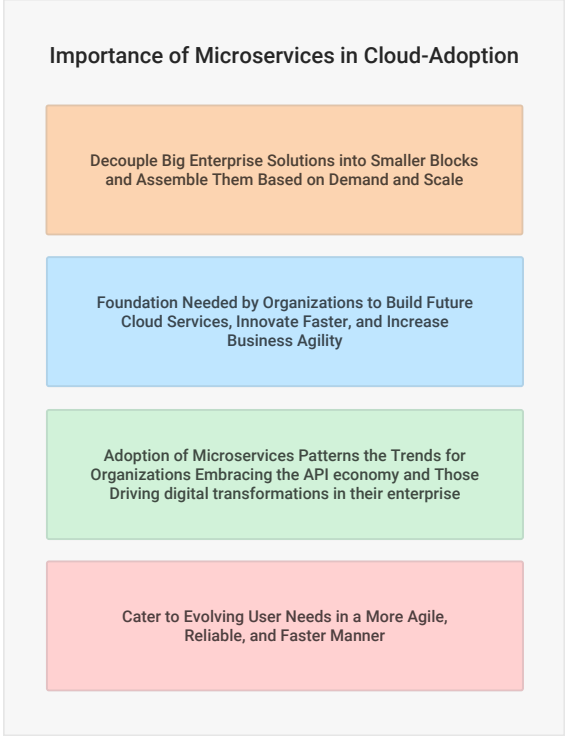
While an organization doesn't necessarily need a microservices architecture to get value from a multi-cloud environment, running monolithic applications instead of microservices can make it challenging for the enterprise to adopt multi-cloud.

Since they are small pieces of functionality, microservices can divide applications into many successive requests for an external service. This is not possible with a traditional monolithic approach. Unlike the latter, microservices architecture utilizes cross-functional teams, making each team responsible for building specific products based on one or more individual services communicating via message bus.

Another advantage of using microservices architecture is that it is an evolutionary design ideal for evolutionary systems, such as multi-cloud, where you can't fully anticipate the types of devices that may one day be accessing an application. What also makes microservices ideal for adopting multi-cloud is that they are designed to cope with failure.

Since several unique and diverse services are communicating together in multi-cloud, it is more than possible that a service could fail, for one reason or another. In such cases, the affected services must be able to bow out gracefully while allowing other services to function as usual. Monitoring microservices can help to avoid the risk of a failure.

When an organization chooses to adopt multi-cloud without microservices, they let go of the above advantages of using microservices. This, in turn, can make multi-cloud adoption challenging for an organization.



Adopting Multi-Cloud Without Microservices: The Challenges to Overcome

In recent years, a popular topic in the industry has been migration to the cloud. Despite the several benefits presented by the cloud, such as high availability and scalability, most of the on-premise application architectures are not designed to fully exploit the benefits of this environment. Adapting them to the cloud is a significant task.

A novel architectural style native to the cloud that has appeared recently are microservices. Since they are cloud-native architectures, microservices can facilitate migrating on-premise architectures to fully benefit from the cloud environment. That's because non-functional attributes, like scalability, are inherent in this style.

The existing approaches for migrating to the cloud rarely consider cloud-native architectures as their first-class citizen. The outcome of this is a final product that may not meet its primary drivers for migration. If an organization chooses to adopt multi-cloud without microservices, then it will be giving up all the benefits offered by microservices for migrating to the multi-cloud environment. As a result, the organization will have to face and ultimately overcome several challenges in the adoption of multi-cloud that are not experienced with microservices. The challenges for adopting multi-cloud without microservices are detailed below.

Reusability

Reusability means using a segment of source code that can be used again to add new functionalities with slight or no modification. Migration to the cloud is a challenging task for many organizations, especially those wanting reusability.

It is important to understand that cloud computing applications are practically limitless. Users from anywhere can access different services and pay for their usage according to one of the provided methods of payment. A service of cloud computing which provides a single version of an application based on the user's requirements to multiple users is Software as a Service (SaaS).
Service Oriented Architecture (SOA) is one of the technologies that SaaS is based on. A way to architect software and solve the problems of distributed software, SOA enables several benefits for SaaS such as reusability and ability to build multitenant architectures that support configuration by their customers. The fundamental principles of SOA need to be followed to ensure and improve reusability in SaaS.

SOA principles advocate that a service must be visible across the entire organization. They also prescribe its use specific projects to avoid redundancy and duplication. The service must be associated with the business and governed throughout the entire lifecycle, from design time to runtime. Additionally, service reuse must be measured, and should always relate to the corresponding business value that was the original driver for the development of the service.

Autonomy

An enabler for service reuse is autonomy. The more services are independent from one another—having their own resources i.e. database, legacies etc. —the more reuse and composition will be possible with these services. This autonomy will facilitate service adoption to changing constraints in terms of availability, QoS, SLA, scalability etc. Additionally, it will prepare services to take advantage of what virtualization has to offer in terms of dynamic allocation of resources.

On the functional level, autonomy should be achieved for all services belonging to the same functional building block. Those services can and should be completely autonomous, relative to other services belonging to other functional building blocks.

Automating Governance

The enforcement of policies across technology and cloud platforms, governance can be a manual process to validate that policy is being followed. However, governance should be automated in a cloud environment to maximize agility for users of the cloud platform.

Scalability and Elasticity

The traditional operating model has been to provision virtual machines upon which applications will be deployed subsequently. It is assumed by the cloud model that the infrastructure will be

provisioned in infinite quantities, on-demand by many teams and then destroyed when no longer required.

Operations teams adopt the notion of infrastructure as code since cloud providers expose their services using APIs. This means that an infrastructure topology should be codified as a simple script and then executed each time that infrastructure is required.

Statelessness

A reusable cloud service such as a multi-cloud service must be stateless. The service must not have an intermediary state waiting for an event or call-back. The state-related data must not be retained beyond a request/response on a service.

A lot of resources are consumed by state management, which can affect the scalability and availability required for a reusable service. In some cases, an organization may need to deal with state information for conversational services, or for long running business processes.

Long running processes will have a state and can be invoked as services. However, they should be regarded as special cases, and should be referred to as composite applications rather than reusable services.

To promote agility, long running processes should not be reused within a composition of services. Rather, they can be invoked/activated using SOAP

Web Services. The same reasoning applies to presentation services. A presentation service should be stateless and autonomous.

Composability

Composition means combining services to produce composite applications or composite services. A composite application is the aggregation of services to produce an enterprise portal or enterprise process. A composite service—on the other hand—is the aggregation of services to produce another reusable service.

Service Component Architecture (SCA) offers a model for creating service components. A service component exposes services, references other services, and has properties common to all services in the component.

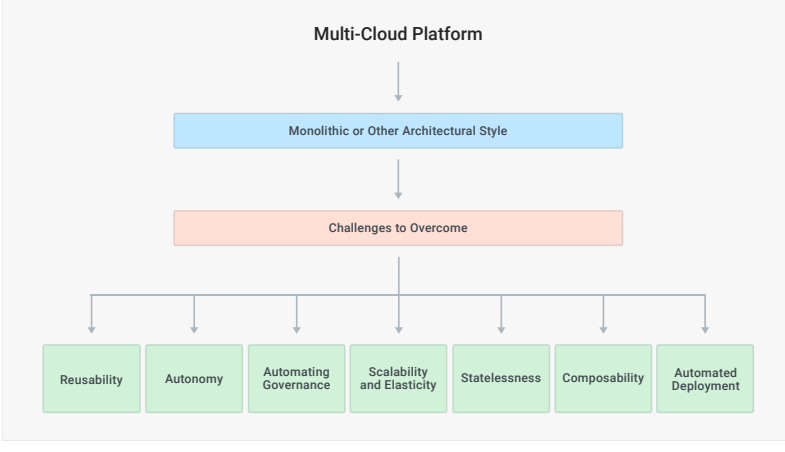
SCA defines a service-based model for assembling services to compose other reusable composite services and defines the wiring that connects the service components within a composite. The composite also exposes services, references other services, and has a set of properties. SCA also defines a way to deploy those assemblies on multiple runtimes within an SCA domain.

Automated Deployment

Running a multi-cloud environment can be daunting, but with the right strategies and automation tools, an enterprise can confidently move workloads across clouds, taking advantage of the resiliency and flexibility the multi-cloud model offers.

With cloud orchestration and automation, it is possible to move workloads from cloud to cloud. Therefore, any organization adopting multi-cloud must ensure automated deployment in the cloud environment.

Challenges for Adopting Multi-Cloud without Microservices



Conclusion

As they move beyond their initial cloud deployments and application migrations, many organizations are looking to shift to a multi-cloud strategy to enable teams to access specialized capabilities available from different providers.

Organizations are moving to a multi-cloud strategy to satisfy the demands of multiple applications and departments. With careful planning and management, organizations adopting multi-cloud can gain elevated performance, reliability, flexibility, and lower costs, all carefully aligned with their business needs. While the multi-cloud strategy offers a plethora of benefits, it has some weaknesses too. Most of them relate to complexity and a higher cost. Also, the benefits of multi-cloud can only be realized with a solid strategy that maps out opportunities as well as access to a well-crafted management tool.

With the benefits of microservices in mind, practitioners are now using them to enable multi-cloud. With microservices, it becomes easier to facilitate the process needs of an organization. Trying something out becomes far easier. Changes can be brought to a part of a process to observe any beneficial impact on the overall outcome of the process. As mentioned above, more and more organizations today are adopting a multi-cloud strategy. The benefits—which include high availability, flexibility, cost savings, and a lowered risk of DDoS attacks—are a major reason for this.

There are many benefits of adopting a microservices approach for the multi-cloud environment. These benefits include, but are not limited to, faster software release, more frequent software updates, and quicker addition of new features. Microservices also enable an enterprise to dedicate smaller teams to smaller sections of the overall systems. As the teams work independently, they can deliver updates faster.

While an organization doesn't necessarily need a microservices architecture to get value from a multi-cloud environment, running monolithic applications instead of microservices can make it challenging for the enterprise to adopt multi-cloud. With these things considered and addressed, an organization can guide itself into a position from where adopting multi-cloud without microservices is both possible and viable. However, microservices should be the first choice for any organization looking to adopt a multi-cloud strategy.

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