Comparison of DevOps Pipeline Setup in Public Cloud(Azure, AWS, and GCP)

Hasan, Md Rezaul
mrhasa@kth.se

Gangwal, Megha
gangwal@kth.se

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1 Introduction

In the last few years, DevOps has gained prominence in the industry as well as in academia. DevOps is a set of tools and practices to enable organizations to deliver faster [8]. DevOps combines the two paradigms of delivery and operations using unified processes and automated tools for development, delivery, deployment, and monitoring [5].

Organizations are challenged by customer expectations of fast and reliable services and products, which also creates the expectation towards IT to deliver faster, better, and cheaper. In recent years, DevOps has become the preferred choice for organizations that are looking for fast deliveries for their essential requirements. A lot of organizations have gained significantly due to DevOps adoption [12].

Cloud technologies development is fueling the DevOps adoption. The availability of on-demand private and public cloud services at the optimal price point and required performance level are ready to meet the enterprise-level requirements.

Quite a few private and public cloud platforms are available in the industry and claim to provide similar capabilities. Some of the notable private cloud DevOps solutions are from VMWare, IBM, TietoEVRY, etc. On the Public Cloud platform, DevOps solutions are provided by AWS, Azure, Google Cloud Platform (GCP), Ali baba, IBM and Oracle, etc. For this essay, we will focus on the top three Public Cloud providers (AWS, Azure, and GCP) according to Gartner [4] for the following reasons

1. The availability of information on Private Cloud DevOps Solution is limited and proprietary. Thus, it would not have been easy to secure and analyze comparable information from private cloud providers.

2. Within the Public Cloud providers, AWS, Azure, and GCP are comparable in terms of the services offered, geographical reach, and information availability. Other cloud providers are either do not have a similar level of services or a geographical presence.

Hence, we decided to focus on the top three Public Cloud providers to formulate a fair comparison.

2 Comparison of DevOps Pipeline setup

The DevOps pipeline can be built on the cloud in the following ways

1. Using the PaaS service on a public cloud platform in combination with 3rd party tools.
2. Deploying the best of breed 3rd party DevOps tools on the available core IaaS services.

We will compare the above DevOps pipeline as follow.

1. For PaaS based DevOps pipeline, we will compare the high level Set up of the DevOps pipeline on different Public Cloud platforms.
2. For 3rd party tool based pipeline on core IaaS service, we will perform the comparison for core IaaS Compute services (VMs) on the following parameters.
   (a) The breadth of service/technology coverage.
   (b) Geographical availability.
   (c) Pricing/Commercials.

2.1 Set up of DevOps pipeline using PaaS services

Each of the selected Public Cloud Platform provides capabilities to set up a DevOps pipeline using either the native IaaS services or PaaS services. Thus, users can choose to set up the pipeline either configuring the tool set of their choice on the available IaaS services or can opt for pre-configured PaaS services to deploy the pipeline quickly.

2.1.1 DevOps Pipeline Setup on Azure

Azure Cloud platform provides a fully integrated PaaS service Azure DevOps (Earlier known as Visual Studio Team Service VSTS). It is a collection of different Azure services that integrate seamlessly. A user can decide to build the entire pipeline using the components as shown in Figure 1 [9] [13].

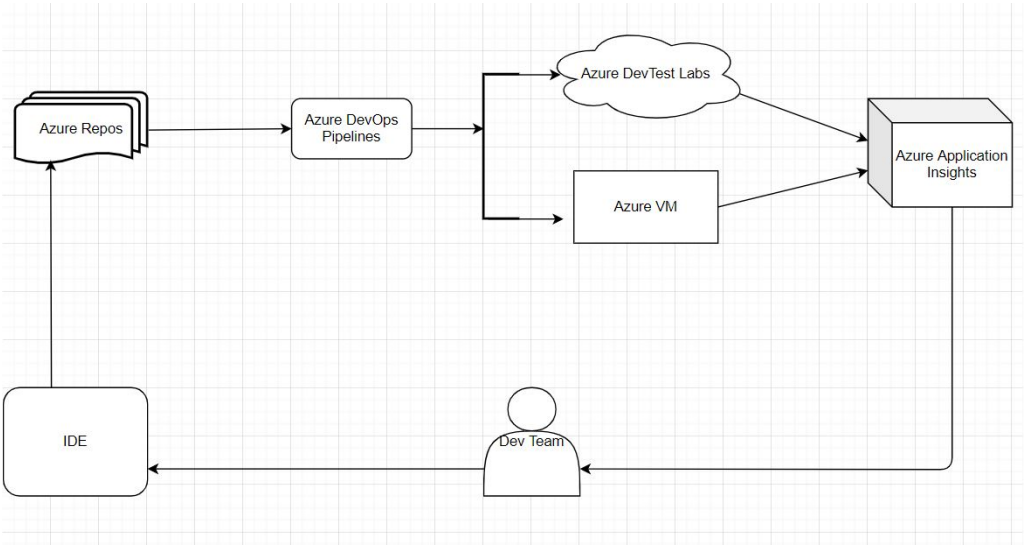

Figure 1: Azure DevOps Pipeline

Azure also provides an option to use and integrate to the commonly used 3rd party tools like Jenkins, GitHub, Chef, Puppet, etc., for building and deploying the pipeline. An example such a pipeline for a java application is shown below in Figure 2.

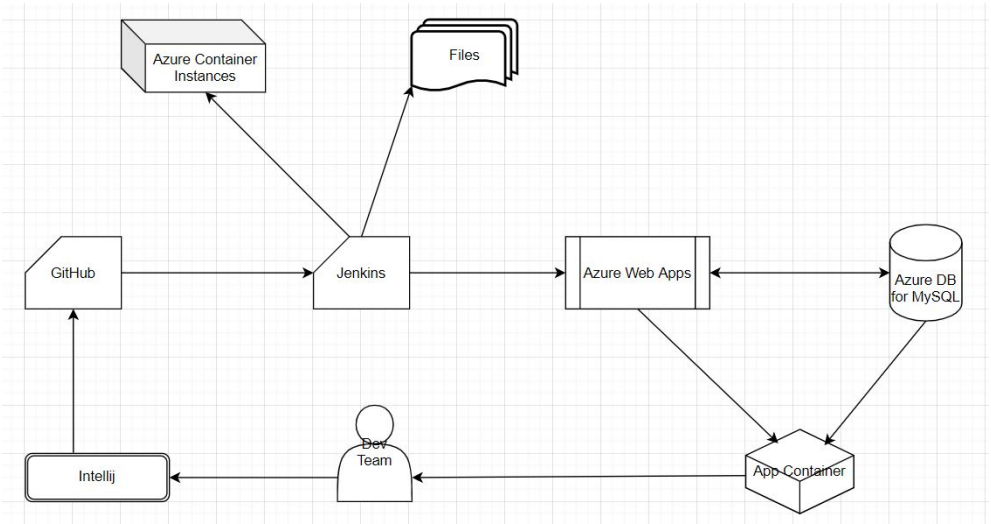

Figure 2: DevOps Pipeline using 3rd party tools

Azure also provides possibilities to integrate to multiple 3rd party add-on using the Azure marketplace and provide an open and huge extension ecosystem.[13][1]. With the acquisition of GitHub in 2018, Azure has pushed for more open-source adaption within its services and trying to address a wider developer body.

2.1.2 DevOps Pipeline Setup on AWS

AWS provides slightly more overlapping solutions to build and deploy pipeline setup.

AWS does provide individual modules like CodeCommit (Repository), Codebuild(Integrated build service), and Codedeploy(Deployment automation), which can be integrated to build an overall DevOps pipeline.[2]

AWS then introduced CodePipeline(Software release workflow) that can combine the functionalities from the above three components to build a fully functional pipeline. The Codepipeline provides integration with various AWS and 3rd parties DevOps tools like Jenkins, GitHub, Micro Focus, Code Deploy, etc.

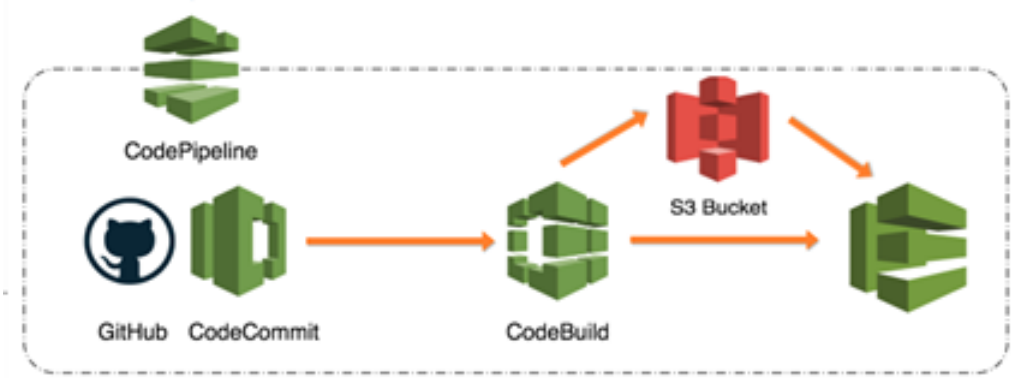

Figure 3: DevOps Pipeline using AWS and 3rd party components using CodePipeline

AWS later created another layer of abstraction called CodeStar, which combines the four services mentioned earlier into an End-2-End pre-configured DevOps Pipeline to launch their DevOps pipeline quickly.

2.1.3 DevOps Pipeline Setup on GCP

GCP also provides different services like Cloudbuild (CI/CD platform), Artifact Registry (for managing packages and Docker container image), and Cloud Source Repository (for version control) to build the serverless DevOps pipeline

[6]. As Google has led the development of Kubernetes, it is a preferred platform for developers for Kubernetes-related development.

For non-serverless applications, GCP is using Spinnaker, which is an open-source multi-cloud continuous delivery platform. Spinnaker also allows direct integration to a variety of CI tools such as Jenkins, Travis CI, Google Cloud Build. One such example is shown below.

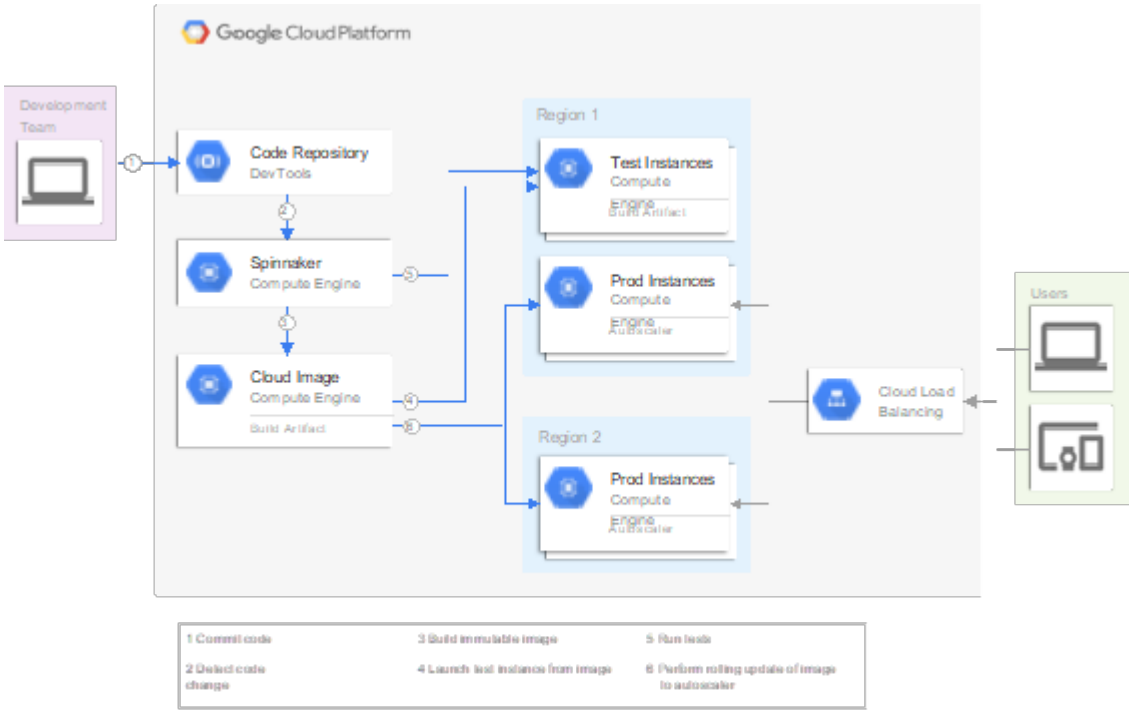

Figure 4: DevOps Pipeline Spinnaker and GCP service components

GCP has also invested into and launched Anthos, a managed application platform capable of managing multi-cloud and hybrid cloud setup. It also provides the possibility to build an End-2-End DevOps pipeline while navigating the complexity of on-prem, hybrid cloud, and multi-cloud environments.[7]

2.1.4 Analysis result from these three DevOps pipeline

From these above explanations, we can say that AWS is good for a large-scale product where developers can easily integrate different types of third-party libraries, similar to a platform-independent. On the other hand, GCP and Azure are more used for their own tech tools. They are not platform-independent, but we can make them independent by following some rules and restrictions.

2.2 Set up of DevOps pipeline using 3rd party tools on core IaaS services

So far, we have focused on the PaaS services provided by different public cloud providers to enable a DevOps pipeline. There is an alternative approach to build the DevOps pipeline on any of the public cloud platforms by utilizing the core IaaS services and hosting the DevOps tools of one's choice on them. This approach will require more effort from the organizations implementing the DevOps. Still, it will provide far more flexibility and help reduce the vendor lock-in to a certain extent. We will analyze the core IaaS services for VM, storage, and database services on each platform to create a meaningful comparison.

2.2.1 Virtual Machine(VM or Compute services)

When the three service providers started providing the Compute services, it was a pre-configured VM with VCPU and memory. Now the VMs are available in a different optimized configuration as described and compared in the table below.

Table 1: Types of VMs

Type of VM	Description
General purpose	General-purpose VMs are suitable for normal use Dev and Test setup. The underlying technology is upgraded frequently, and it provides the user with better and faster VMs at the same or reduced price.
Memory Optimized	These VMs provide high memory-to- CPU machines. These VMs at times becomes expensive. Azure provided constrained CPU Memory-optimized VMs to reduce the cost of the VMs [10]
Compute Optimized	These VMs provide a high CPU-to-memory ratio and suitable for running web or application servers. The higher configured VMs can be utilized for running intensive AI or graphic applications. With respect to the breadth of the services, AWS provides a broader set of options in terms of configuration than either Azure or GCP. [3]
Storage Optimized	Storage Optimized VMs provides high I/O and disk throughputs which make them ideal for big data and NoSQL databases. Both Azure and AWS provides the Optimized storage instances, but GCP does not have an out of the box service for these VMs

2.2.2 Geographical coverage

Public cloud providers define geographical coverage in terms of region and availability. The customers are very sensitive towards the presence of a public cloud provider in the home or nearby geography due to latency-related challenges and regulatory compliance issues. The public cloud providers also don't support all the services in all the regions, e.g., Azure does not provide Machine Learning Studio in Northern Europe region, but it is available in the Western Europe region [11]. In terms of the geographical reach, both AWS and Azure are comparable in terms of their presence, while GCP lags behind and is investing heavily in bridging the gap. Figure[5] below provides a high-level view of the geographical presence of the three public cloud providers

Figure 5: Public Cloud Providers providers geographical reach

2.2.3 Pricing/Commercials Aspects

All three public cloud providers provide different pricing and commercial options to their customers. In the past few years, all public cloud providers have started providing discounted prices based on committed consumption over 1 to 3 years (Reserved Instance (RIs) in AWS and Azure and Committed Usage Discount (CUD) in GCP). However, GCP CUD covers fewer services than AWS and Azure RIs.

In terms of contractual flexibility to cancel the RIs or CUD-based services, AWS is the most flexible that allows to resell the RIs on the Amazon marketplace. Azure charges 12% of the remaining service charge as cancellation fees, while GCP does not provide any documented option.

At the enterprise level, the prices are normally negotiated with certain discounts based on the projected consumption. However, the majority of the cus-

tomers will either use Pay as you go or reserved instances.

One thing to note here is that all public cloud providers are updating the prices quite frequently. Hence for price comparison, it is advisable to use the pricing calculator available at each public cloud provider site.

3 Conclusion

Each of the Public Cloud providers provides multiple ways to implement the DevOps pipeline. By utilizing the core IaaS services on the public cloud platform, a user can have complete flexibility and specific capabilities in the DevOps pipeline through the use of 3rd party tools. However, it will increase the effort in the management of underlying infrastructure and 3rd party tools. One of the key benefits of this approach could be that it may offer portability across the Public and private cloud platforms.

Another approach for building the DevOps Pipeline is to use the available PaaS services to build an E-2-E pipeline transparent to the underlying infrastructure. Public Cloud providers also provide integration towards the major 3rd party tools, enabling more flexibility to the user. Most of the users are adapting to it, as it reduces the management effort for underlying infrastructure, and users can focus on developing the application.

All three cloud providers provide the relevant services, and from a technical perspective, they are similar. Hence the user needs to keep few considerations when selecting the public cloud service. In a large, distributed environment, it is important to keep latency and data security in mind. Hence location for public cloud data center, associated security, and compliance certification and protocols take the prime spot in the decision making.

In conclusion, the advancement in public cloud technology has helped many organizations to adapt to DevOps, and in the future, this trend will become even stronger.

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