DevOps Tools in the Workplace
A Comparison of Different CI/CD Tools and Cloud Providers

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1 Introduction

One key part of the DevOps idea is the use of workflow automation. This article looks at specific tools used for continuous integration and cloud computing. These options are chosen as they are essential to the DevOps operation of any software project from big data processing all the way to deployment tests. The article provides a brief overview of the particular tools to serve as an entry point to make better judgments when comparing their niches. Within continuous integration (CI) and continuous delivery (CD), the article has compared Jenkins, Travis CI, and CircleCI highlighting tool effectiveness and use cases. Specifically the article has looked at the unique features of these products, the languages that they support, and their containerization capabilities. As for cloud providers, the article will explore Amazon Web Services (AWS), Google Cloud Platform (GCP), and Microsoft Azure focusing on pricing differences. The article discussed about the different functionality of the service and the pricing. By reading this essay, the reader should gain a more solid grasp of the compatibility of features offered by CI/CD tools depending on their project scale, and the disparity in pricing amongst cloud providers to make cost-effective infrastructure choices.

2 Jenkins vs Travis CI vs CircleCI

One type of tool that developers can encounter in their workplace is the use of automated CI/CD. On triggering a CI build, the tool runs integration tests and build an artifact for deployment on success. There are many different software tools that provide this service, the focus will be on Jenkins, Travis CI, and CircleCI. While each tool supports a team's workflow with a customized testing infrastructure, the tools differ with their unique features such as plugins and enterprise support. For a quick summary, the article highlights the defining features for each of these tools in Figure 1.

Figure 1: Summary of differences between the 3 CI/CD tools

Criterion	Jenkins	Travis CI	CircleCI
Language Support	plugins based	35	8 natively
Plugins Marketplace	yes	no	no
Parallel Build by Default	no	yes	no
Heavy Containerization Focus	no	yes	yes
Enterprise Support	by CloudBees	yes	yes
Open-Source Software	yes	no	no

Jenkins is an open-source software (OSS) product with an enterprise edition which is supported by CloudBees. It is used by multiple organizations such as Autodesk, Salesforce, and the Internal Revenue Service of the US government [6] [7]. As OSS, Jenkins is free to use unlike most competitors. However, dedicated support is available only with the enterprise edition. A unique feature that Jenkins has is the extensive support of plugins. With the plugins system, developers are able to customize their Jenkins setup to fit their need [15]. This also results in Jenkins supporting more programming languages but the downside to this is the increased complexity with increased use cases so Jenkins is not suitable for small projects. Jenkins is mainly used with large corporations with a DevOps team dedicated to building on the Jenkins CI/CD pipelines. Dependency management becomes an issue that needs more attention as plugins grow in number [28]. Legally, as OSS, Jenkins can be used in any project if the original license is included [9].

Travis CI used to be known for providing free service to the open-source community. Some high-profile Travis CI users include BitTorrent, Heroku, and Engine Yard [26]. Today Travis CI is no longer a beacon of OSS hope, as OSS-developers in particular recently experienced a decrease in quality of their services with their open source projects [18]. Travis CI currently supports 35 languages and has strong Docker integration [26]. A unique strength of Travis CI is that it does not require a dedicated server and can run Linux and Mac OS tests in parallel. In addition, the tool has a strong emphasis on containerization and is ideal for project teams of all scales who seek docker support.

CircleCI emerged as a competitor to long-standing CI/CD services with high-profile users which include Spotify, SolarWinds, Coinbase, and Facebook [14]. CircleCI is a good option for teams new to continuous integration using containerization. We can see examples of this with CircleCI offering custom pre-built docker images, testing across docker images, and the ability to run any docker commands on the platform [13]. CircleCI offers private codebases with open-source 'orbs', packages of reusable configuration elements [19]. Furthermore CircleCI supports about 8 languages natively but offers support for other languages with some tinkering.

3 AWS vs GCP vs Azure

Companies might prefer to not run their own hardware for a multitude of reasons such as reduced upfront cost, staffing cuts, and flexible load capabilities. Companies therefore outsource their needs by purchasing infrastructure and services from cloud providers. The industry leaders are AWS, GCP, and Azure and this next section highlights their pricing differences. To give more insight to the price disparity with these offerings, the article will also give an overview of the cloud provider and the unique niches they target.

AWS has a plethora of high-profile customers including Twitter, Facebook, Netflix, Spotify, and Xiaomi [24]. A free tier is offered by AWS for users to gain some experience with their products. The rate-limited services are offered as either always free, 12 months free, or request-based trials [12]. For its most popular offering which is the Elastic Compute Cloud instances, customers can pay with on-demand instances, savings plan, reserved instances, or spot instances. The on-demand option has the least vendor lock-in, while the others help save money for more committed clientele. AWS instances on-demand justify their high prices with the long-standing history of the company. The rate-limited pay-as-you-go model is seen in their other offerings such as AWS Lambda which offers server-less HTTP-triggered cloud functions, and Amazon S3 which offers high durability cloud storage. AWS offers all this information in their AWS pricing overview paper and estimation costs can be calculated using their calculator service [2].

GCP offers a variety of services in Google-managed data centers. GCP has testimonials from many global-scale companies as their clients which include the likes of Twitter, King, Airbnb, Verizon, and Intel [10] [25]. GCP offers a set of modular cloud services alongside accompanying management tools, notably using the same infrastructure as Google's products like Gmail and YouTube [27]. The geographical allocation of GCP's cloud resources encompasses more than 200 countries which includes 25 regions and 76 zones [4]. These nodes work with Google's low latency internal network for microservices and big data processing. New GCP customers receive $300 in free credits and access to over 20 GCP products up to monthly usage limits [11]. Furthermore, Google offers the ability to request free migration and IT cost assessments for interested clients. GCP offers its services with a pay-as-you-go pricing structure with

discounted rates of up to 57% by pre-paying. GCP services are cheaper than most competitors, particularly for projects using Kubernetes, deep learning, big data processing, or distributed real-time systems [22].

Azure's offerings include commonly needed cloud provider functionality similar to their competitors. Azure targets itself more for the manufacturing, retail, government, healthcare and life sciences, and financial services industry [8]. It is currently used by a number of high-profile users such as 3M, The United States Centers for Disease Control and Prevention, and Starbucks [16]. The service can be paid with two different models, the first is a prepaid account called reservations which is in blocks of either one or three years and can be paid in full or monthly. This option has the benefit of providing discounts compared to the other options which is a pay-as-you-go model where you pay monthly depending on your usage for that month [3] [20] [23]. The last alternative is to pay by using azure credits but is offered as an inclusion to a Visual Studio subscription[17] [3]. Azure offers a free version of their service where you are able to explore within a certain time limit and credit amount [5]. Azure pricing generally falls on the median between GCP's cost-effective and AWS's expensive infrastructure. Figure 2 highlights the discrepancy in their virtual machine (VM) instance pricing.

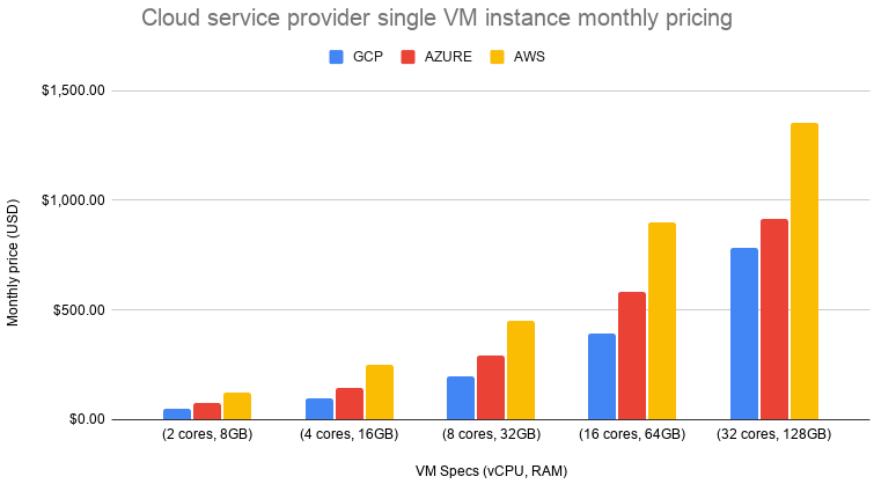

Figure 2: Summary of cloud service providers' average VM instance costs [11] [21] [1]

4 Conclusion

Choosing the best DevOps tools for your project can often lead to choice overload and analysis paralysis. The article has highlighted key differences between the tools and elaborated use cases supported by well-known companies who's market often aligns with their DevOps choices. The article hopes to have shown the main lesson that all tools support common functionality for most project teams, but each have their own particular niches such as Jenkins' plugin marketplace and GCP's big data synergy. In conclusion, the reader can choose a CI/CD tool matching their project scale and a cloud provider matching their budget.

As a a takeaway thought, when comparing the different products note that a detriment in an option can be due to its niche. For example while AWS has the most expensive VM rates, it is the most reliable cloud provider and offers the broadest selection of offerings. When doing further reading on different products, try to understand why they have their particular niches.

References

[1] *Amazon Web Services Simple Monthly Calculator*. URL: `https://calculator.s3.amazonaws.com/index.html` (visited on 04/24/2021).

[2] *AWS Pricing Calculator*. URL: `https://calculator.aws/#/` (visited on 04/24/2021).

[3] *Azure pricing FAQ — Microsoft Azure*. URL: `https://azure.microsoft.com/en-us/pricing/faq/` (visited on 04/17/2021).

[4] *Cloud locations*. Google Cloud. URL: `https://cloud.google.com/about/locations` (visited on 04/24/2021).

[5] *Create your Azure free account today — Microsoft Azure*. URL: `https://azure.microsoft.com/en-us/free/` (visited on 04/17/2021).

[6] *Customer Stories*. CloudBees. URL: `https://www.cloudbees.com/customer-stories` (visited on 04/05/2021).

[7] *Enterprise-Grade Continuous Integration Tools — CloudBees Core*. CloudBees. URL: `/products/continuous-integration` (visited on 04/05/2021).

[8] *Get to Know Azure — Microsoft Azure*. URL: `https://azure.microsoft.com/en-us/overview/` (visited on 04/17/2021).

[9] Ayala Goldstein. *Open Source Licenses Explained*. Jan. 24, 2019. URL: `https://resources.whitesourcesoftware.com/blog-whitesource/open-source-licenses-explained` (visited on 04/05/2021).

[10] *Google Cloud customers*. Google Cloud. URL: `https://cloud.google.com/customers` (visited on 04/24/2021).

[11] *Google Cloud Pricing Calculator*. Google Cloud. URL: `https://cloud.google.com/products/calculator` (visited on 04/24/2021).

[12] *How AWS Pricing Works: AWS Pricing Overview*. URL: https://docs.aws.amazon.com/whitepapers/latest/how-aws-pricing-works/welcome.html (visited on 04/24/2021).

[13] *If it works in Docker, it works on CircleCI*. CircleCI. URL: https://circleci.com/docker/ (visited on 04/08/2021).

[14] *Industry Leaders Choose CircleCI*. CircleCI. URL: https://circleci.com/customers/ (visited on 04/08/2021).

[15] *Jenkins Plugin Tutorial*. Plugin Tutorial. URL: https://www.jenkins.io/doc/developer/tutorial/index.html (visited on 04/05/2021).

[16] *Microsoft Customer Stories*. Microsoft Customers Stories. URL: https://customers.microsoft.com/en-us/home?sq=&ff=&p=0 (visited on 04/24/2021).

[17] *Monthly Azure Credit for Visual Studio Subscribers — Microsoft Azure*. URL: https://azure.microsoft.com/en-us/pricing/member-offers/credit-for-visual-studio-subscribers/ (visited on 04/18/2021).

[18] Jeroen Ooms. *Moving away from Travis CI*. Nov. 19, 2020. URL: https://ropensci.org/blog/2020/11/19/moving-away-travis/#a-change-of-management (visited on 04/05/2021).

[19] *Orbs Introduction - CircleCI*. URL: https://circleci.com/docs/2.0/orb-intro/ (visited on 04/08/2021).

[20] *Pay As You Go—Buy Directly — Microsoft Azure*. URL: https://azure.microsoft.com/en-us/pricing/purchase-options/pay-as-you-go/ (visited on 04/18/2021).

[21] *Pricing calculator — Microsoft Azure*. URL: https://azure.microsoft.com/en-au/pricing/calculator/ (visited on 04/24/2021).

[22] Javier Ramos. *Google Cloud Advantages over AWS*. Medium. Feb. 11, 2020. URL: https://itnext.io/google-cloud-advantages-over-aws-28751469e570 (visited on 04/24/2021).

[23] *Reservations — Microsoft Azure*. URL: https://azure.microsoft.com/en-us/reservations/ (visited on 04/18/2021).

[24] Ben Saunders. *Who's Using Amazon Web Services? [2020 Update]*. Contino — Global Transformation Consultancy. Jan. 28, 2020. URL: https://www.contino.io/insights/whos-using-aws (visited on 04/24/2021).

[25] Dave Tracey. *Who's Using Google Cloud Platform (GCP)? [2020]*. Contino — Global Transformation Consultancy. Mar. 12, 2020. URL: https://www.contino.io/insights/whos-using-google-cloud-platform (visited on 04/18/2021).

[26] *Travis CI - Test and Deploy with Confidence*. URL: https://travis-ci.com/ (visited on 04/05/2021).

[27] *Why Google Cloud*. Google Cloud. URL: https://cloud.google.com/why-google-cloud (visited on 04/24/2021).

[28] Roxanne Williams. *The Dependency and Plugin Hell That is Jenkins*. Harness. Jan. 28, 2021. URL: https://harness.io/blog/continuous-delivery/dependency-plugin-hell-jenkins/ (visited on 04/05/2021).