

CI/CD PIPELINES FOR APPLICATION DEPLOYMENT: AUTOMATING THE WORKFLOW

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Abstract: This paper focuses on the use of CI/CD pipeline together with Docker in software development processes as well as Elixir/Erlang middleware. The proposed approach is more effective for constructing CI/CD pipelines through utilizing GitLab, Docker, and Elixir scaling to improve development, security, and compatibility with previous versions. The implementation of such technologies helps in enabling a faster and more reliable approach to the deployments without compromising on the performance of the system or having compatibility issues between different systems. This paper will describe these tools and their integration with agile development processes and describe the issue and solution of managing the complicated processes in the development environment.

Keywords: CI/CD pipelines, Docker, Elixir, Agile development, Middleware.

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Introduction

Continuous integration and continuous delivery (CI/CD) for applications completes a critical job in today's application development; the delivery of updates to be fast, effective, and consistent. Continuous Integration (CI) and Continuous Delivery/Deployment (CD) are two processes that combine the whole release management process starting from integration up to the delivery of the actual code into production environments. CI is about integrating changes to code into a central repository and running the tests on the integrated code each time to detect any problems. This is further complemented by CD that is used to deploy the application to other environments and guarantee that the most recent version is the one that is ready for the production or deployment process. This way they cut the involvement of people that in turn helps to reduce the time to fully launch a new feature or fix a bug. CC By the use of CI/CD pipelines, more complex application developments are now possible while increasing the pressure for faster delivery cycles, better relations between development and operations teams as well as better quality and stability of the software being developed.

Literature review

Advancements in Containerized Continuous Deployment

According to the authors Zhang *et al.* 2018, continuous Deployment (CD) is a broad paradigm shift in terms of software deployment since it automates the entire process of deploying

changes in code right from the integration level to the production level. Updated and launched continuously, new kinds of tools have appeared such as the containers, especially Docker that has made a major impact on the CD, whereby applications are packaged with all the required libraries in a single package. This approach improves flexibility, expandability, and standardization to different environments that improve the working relationship between a team of developers and operations. Containerization of Continuously Deployments has become prevalent in many organizations because it helps in the enhancement of the control of release timings, reduction of risks, and the number of defects. With containerization, the programmers can organize the application in many ways as the industry is experiencing growth of many approaches with various pros and cons. When it comes to using Docker Hub automated build or using the Continuous Integration service some processes have different preferences based on the requirements of each project.

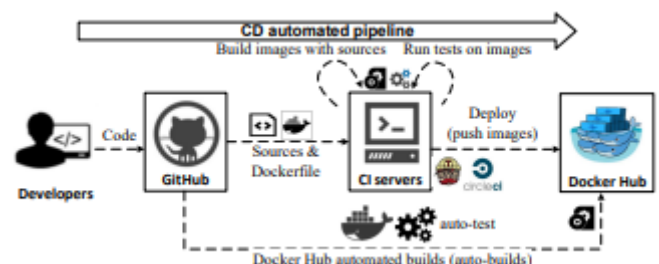


Figure 1: Overview of Docker-enabled CD workflows

(Source: Zhang *et al.* 2018)

Additionally, containerized CD has also been found useful in matters such as solving problems of dependency, thus improving on the process of distribution and other related processes. However, as with any type of workflow, there are the disadvantages of these workflows and these include dealing with issues to do with configuration and dealing with barriers that come with having to learn the tool and how to incorporate it into the project. The progression of CD to containerization, has risen as a revolution in software development that changed its paradigms when it comes to automation, agility, and deployment.

Enhancing CI/CD Pipelines with BlueOcean and Jenkins

According to the authors Rayanagoudar *et al.* 2018, continuous Integration (CI) and Continuous Delivery (CD) are at the core of current software development as it provides an opportunity for constant changes in the code and short time intervals between the deliveries. One of the most used open-source tools in CI/CD is Jenkins that can be considered as a crucial tool in CI/CD implementation (Rayanagoudar *et al.* 2018). However, it had many difficulties in its user interface design for various user bases from usability viewpoint and ease of comprehending its complicated pipeline mechanisms. To this end, the BlueOcean, the Jenkins plugin for finite environments was developed in order to enhance the display of the infrastructure.

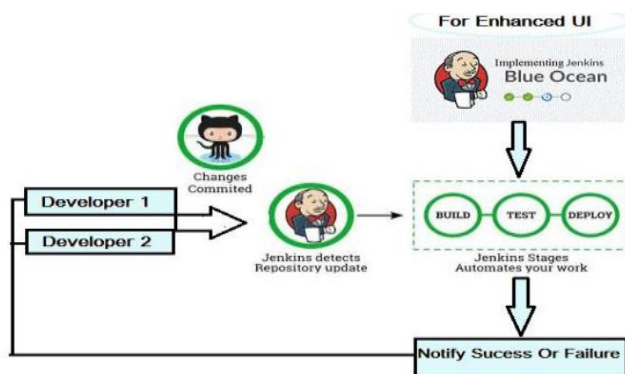


Figure 2: Flow diagram for proposed methodology

(Source: Rayanagoudar *et al.* 2018)

BlueOcean improves Jenkins by adding aesthetic value to the CI/CD process, in addition to improving the usability of the platform and making it easier to navigate while building a new interface. One of the main distinctive features is the visual pipeline editor for the pipeline configuration where one can see the entire process described as a graph; this makes it easier for people of different roles like developers, testers, and operations staff to understand the delivery process. Any bottlenecks or problems can be easily seen here and that makes the troubleshooting and optimization of pipelines much easier. Thus, using BlueOcean, organizations can ensure that more teams embrace and utilize continuous delivery, which in turn helps them to sustain a swift and credible delivery of the software. This innovation in Jenkins is a step towards enhancing the use of CI/CD processes as a common practice to more people.

Enhancing Development Speed with Agile Deployment and Modern Tools

According to the authors Jung, 2018, in every organisation today, concerns related to IT and data security are on the rise. This is mainly due to the advancement of technology, this therefore results in stricter measures on security that can in one way or the other affect productivity especially in the engineering departments. In the modern environment of software development that concerns the continuous delivery and deliveries per day mentality, a great challenge in development is security vs speed. To overcome this, organizations have resorted to integrating state-of-the-art utilization of tools that aims at developing and deploying the chosen software solutions (Jung, 2018). Applications such as GitLab that work with CI/CD pipelines are employed to exercise continuous integration and continuous delivery to make the process of handling code changes as automatic as possible by testing the changes and integrating as well as deploying it.

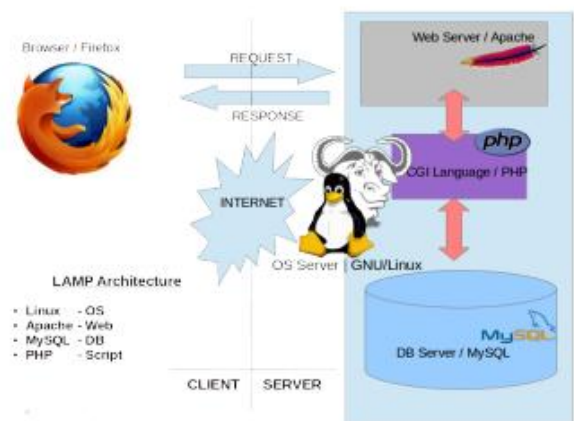


Figure 3: LAMP Architecture just as in this case

(Source: Jung, 2018)

Docker has immense importance to create an environment which is a miniature version of a system independent of the physical nature of the OS or the underlying core infrastructure. Elixir/Erlang is useful as an intermediary layer between data and is involved in handling web server responsibilities, the other technologies such as React helps in developing single-page applications (SPA). What this has helped do is to ensure that every code developed outside the enterprise local network executes in production as it does when it is being developed. This does not only enhance development speeds, but also remains compatible with previous tool sets incorporating new technologies with traditional standards to achieve fast, safe, efficient and secure software solutions.

Methods

CI/CD Pipelines with GitLab

The main approach to achieving the fast and efficient delivery of software was the GearCI/CD pipeline included in GitLab. As a result of implementing continuous integration and also the delivery, GitLab was capable of promoting integration of codes and testing and also the deployment processes. This cut out the possibility of human intervention and made a significant impact on cutting production time of the feedback loop (Shahin *et al.* 2017). The pipelines include tests that are conducted each time a new

code has been committed, checking of errors and deployment of the application to the various environments. This made it possible for development teams to work effectively and issues were not only solved early enough but new software was frequently released on the market but was not of inferior quality.

Docker for Dependency Management

Docker was also instrumental in the development environment because it produces a light container that imitates the destination server. This containerization technology procured the idea that applications could be developed and operated in a uniform environment whatsoever the host system. Docker helped growth of the agency and their clients by solving the problem of dependencies and enabled the development team to compile and deploy the code regardless of the production environment (Kubryakov, 2017). Docker containers also meant that all dependencies needed by the application were contained within the single bundle associated with the software that would allow it to work on any environment that ranged from the development to the production ones.

Elixir/Erlang for Middleware and Web Server

Elixir and Erlang were selected to be the middleware between data and views and as a proxy as well as a web server. These technologies were chosen for their scalability, availability of fault tolerance and also capability of handling many concurrent connections. Elixir's ability to handle concurrent tasks was another feature it offered that could solve the problems of modern complex web applications (Mohammad, 2018). The use of Elixir and Erlang enabled efficient and real-time processing of data and the ability of web applications to interact with the front-end parts with high responsiveness and handling of growing traffic.

Result

Accelerated Development and Deployment

Moving to GitLab allowed the work of the software development team to be more efficient and automate such processes as testing, integration, and release, as a part of CI/CD pipelines. This helped in reducing the time taken to perform manual interferences curtailing the development cycle time tremendously (Poth *et al.* 2018). An automatic pipeline also ensured that the software went through various checks and was deployed frequently, thus reducing the amount of time it took before the system would be fully operational. Thus, it became possible to push the changes to production more frequently and organize software delivery in a more effective manner.

Improved Security and Flexibility

Docker was used effectively in making the development and production environment to be similar hence there would be very few problems arising because of issues like different versions of the same package, different settings or configurations. This is also because Docker containers enabled applications to be tested in a sandboxed manner to ensure all dependencies were effectively catered for (Ivanov and Smolander, 2018). The reference to this process can be made with the specifics that the ability to simulate the production environment locally resulted in quicker identification of security issues and bugs. Also, containerization was secure and elastic to scale the applications and meet the

security compliances without making much impact on performance.

Compatibility with Legacy Tools

The fact that Elixir runs on the Erlang virtual machine to become its part of the stack, provided a reliable middle tier that connected front and back ends of the software. These technologies enabled new development to fit into the established functions of old and familiar tools, which proves to be a typical issue in software development (Fahad and Hussain, 2018). Scalability and fault tolerance of Elixir allowed for the development of applications that would naturally fit into older systems and systems would not have to be reconstructed from the ground up, which preserved current structures. It's compatible with the previous design tools, the development process could go on without breaking any of the existing systems.

Discussion

Introducing CI/CD pipelines, using application containers through Docker, and the implementation of Elixir and Erlang middleware were identified as the effective approach to such problems. CI/CD pipeline implementation also helped in enhancing the gitlab by integrating the testing and integration of the application with the production environment and in turn reducing the time or change of cycles from the development phase (Yarlagadda, 2018). Docker containers were important in terms of managing dependencies and ensuring the implementation is coherent and aligned in all circumstances, especially in production usage since issues concerning mismatch usually occur. It also made it easier for the development team to provision similar environments like the production one, which helped in shortening the time it takes to fix issues, due to the fact that the environments could be easily duplicated thereby easily configured. In addition, with the help of Elixir and Erlang as middleware the development of media scalable and high performance applications which can handle more than one request at the same time is possible for today's web application (Shah *et al.* 2018). Another positive aspect was the possibility of incorporating these new technologies into the current working tools and keeping compatibility with them meant utilizing all the old equipment as well.

Future Directions

Software development progresses, automation and scaling is set to improve in future with enhanced CI/CD technique, containerization as well as intermediate layers of middleware. This could be achieved by the most advanced application of AI and machine learning in CI/CD where it can be used to make intelligent decisions during the testing, deployment and monitoring phases. AI-based algorithms effectively could make a prognosis on what could go wrong, recommend proper configurations, and adjust settings on their own (Tatineni and Mulukuntla, 2017). Furthermore, the continuous emergence of serverless computing presents the ability to decrease the extent of infrastructure management, meaning developers will not have to worry about the infrastructure side of their applications while they can create a dynamic infrastructure which is event-based. It can be predicted that the container orchestration platform, for example, Kubernetes will advance even further and have more capacity in terms of scalability, fault tolerance, and resource utilization in bigger applications. The organising of containerisation and the

reinforcement of microservices shall become more apparent in the future so that advanced applications for tracking and exercising security solutions to solve the deteriorating issues of distributed systems will be more relevant. In addition, there are novel web technologies like WebAssembly, that could be helpful in enhancing the front-end and back-end interaction, performance.

Conclusion

The usage of CI/CD pipelines, application with Docker containers, and Elixir/Erlang middleware in the described technology stack is considered to be a highly effective method of software modernization. In this way, through automation of such forms as testing, integration, and/or deployment, the CI/CD pipelines help to significantly reduce the amount of time it takes to go through the cycle, and the quality remains high throughout the development process. This comes in hand in removing issues of dependency conflicts mostly for development and other issues surrounding deployment in production environments. The development of Reliable and Scalable Middleware: Elixir defines both the synchronous and Distributed GenStage Behaviors of Elixir and the ability of Elixir and Erlang to offer high availability, network latency, and complete throughput under high loads. This also fastens development and comprises security, total compatibility with pre-existing applications, and the ability to increase the size of applications at will. That being said, the advantages of this approach bring a lot of significance for those organizations that are trying to remain flexible and on top of the game in today's landscape of digitization.

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