Topic: Introduction to DevOps

Course: INT 331

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Topics:

- Introduction to DevOps
- Need of DevOps
- Evolution & History of DevOps
- Methodologies, Principles and Strategies
- Lifecycle of DevOps
- Phases of DevOps

Introduction to DevOps

- DevOps is basically a combination of two words- **Dev**elopment and **Op**eration**s**.
- DevOps is a culture that implements the technology in order to promote collaboration between the developer team and the operations team to deploy code to production faster in an automated and repeatable way.
- DevOps helps to increase organization speed to deliver applications and services. It also allows organizations to serve their customers better and compete more strongly in the market.
- DevOps can also be defined as a sequence of development and IT operations with better communication and collaboration.

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- DevOps has become one of the most valuable business disciplines for enterprises or organizations. With the help of DevOps, **quality**, and **speed** of the application delivery has improved to a great extent.
- DevOps is nothing but a practice or methodology of making "**Developers**" and "**Operations**" folks work together. DevOps represents a change in the IT culture with a complete focus on rapid IT service delivery through the adoption of agile practices in the context of a system-oriented approach.
- DevOps is all about the integration of the operations and development process. Organizations that have adopted DevOps noticed a 22% improvement in software quality and a 17% improvement in application deployment frequency and achieve a 22% hike in customer satisfaction. 19% of revenue hikes as a result of the successful DevOps implementation

Need of DevOps.

Before going further, we need to understand why we need the DevOps over the other methods.

- The operation and development team worked in complete isolation.
- After the design-build, the testing and deployment are performed respectively. That's why they consumed more time than actual build cycles.
- Without the use of DevOps, the team members are spending a large amount of time on designing, testing, and deploying instead of building the project.
- Manual code deployment leads to human errors in production.
- Coding and operation teams have their separate timelines and are not in synch, causing further delays.

Evolution & History of DevOps

- Originally coined by Patrick Debois, DevOps has become a critical discipline for realizing the benefits of Agile that ensures that rapid, iterative code development results in rapid.

- While Agile's gained popularity, often at cross-purposes with the more formal and "heavy" ITIL methods popular with IT in the early and mid-2000s, DevOps resonated with both sides.

- Organizations that have adopted ITIL can also implement DevOps, especially for Cloud-based applications.

- Starting with The Phoenix Project, by Gene Kim, DevOps has steadily gained popularity and supporters, and is seen today as a crucial element of any Agile technology organization.

- Consequently, large corporations and all sorts of technology vendors now support DevOps.

- DevOps jobs have become ever more popular – and the norm – inhitech organizations.

- With the emergence of AI and ML in all aspects of the software lifecycle, AI for DevOps is starting to make DevOps even more smart, fast and seamless – tho’ a lot remains to be done.

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- n 2009, the first conference named **DevOpsdays** was held in Ghent Belgium. Belgian consultant and Patrick Debois founded the conference.
- In 2012, the state of DevOps report was launched and conceived by Alanna Brown at Puppet.
- In 2014, the annual State of DevOps report was published by Nicole Forsgren, Jez Humble, Gene Kim, and others. They found DevOps adoption was accelerating in 2014 also.
- In 2015, Nicole Forsgren, Gene Kim, and Jez Humble founded DORA (DevOps Research and Assignment).
- In 2017, Nicole Forsgren, Gene Kim, and Jez Humble published "Accelerate: Building and Scaling High Performing Technology Organizations".

Methodologies, Principles and Strategies

- While DevOps is seen as a natural extension of Agile, and somewhat of an anathema for ITIL, it does not have its own framework – and can potentially be relevant for a variety of situations.
- Organizations that use traditional (waterfall) methods, characterized by sequential stages of software development and long gaps between software releases, can use DevOps principles for better alignment between functions such as Dev, QA, and Operations, with a greater transparency into all functions. Organizations that have adopted one or more Agile methodologies can easily have their dev and operations folks collaborate throughout the development process.
- Newer disciplines such as AIOps, SRE (Site Reliability Engineering), SysOps, DevSecOps and BizDevOps extend and expand DevOps principles and benefits while adding other critical technology and methodologies such as AI, automation, security and collaboration to further the cause of high quality agile software development.

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One should understand the related contexts of DevOps, Agile and Waterfall development, site reliability engineering (SRE) and SysOps

- **DevOps vs. Waterfall development.** Waterfall development comprises a series of steps and gates in a linear progression to production. Its phases are requirements, analysis, design, coding and implementation, testing, operation and deployment, and maintenance. In Waterfall teams, development tests new code in an isolated environment for quality assurance (QA) and -- if requirements are met -- releases the code to operations for use in production. IT operations deploys multiple releases at once, with extensive controls. Support is operations' responsibility. Waterfall approaches engender long waits between software releases. Because development and operations teams work separately, developers are not always aware of operational roadblocks that prevent code from working as anticipated.

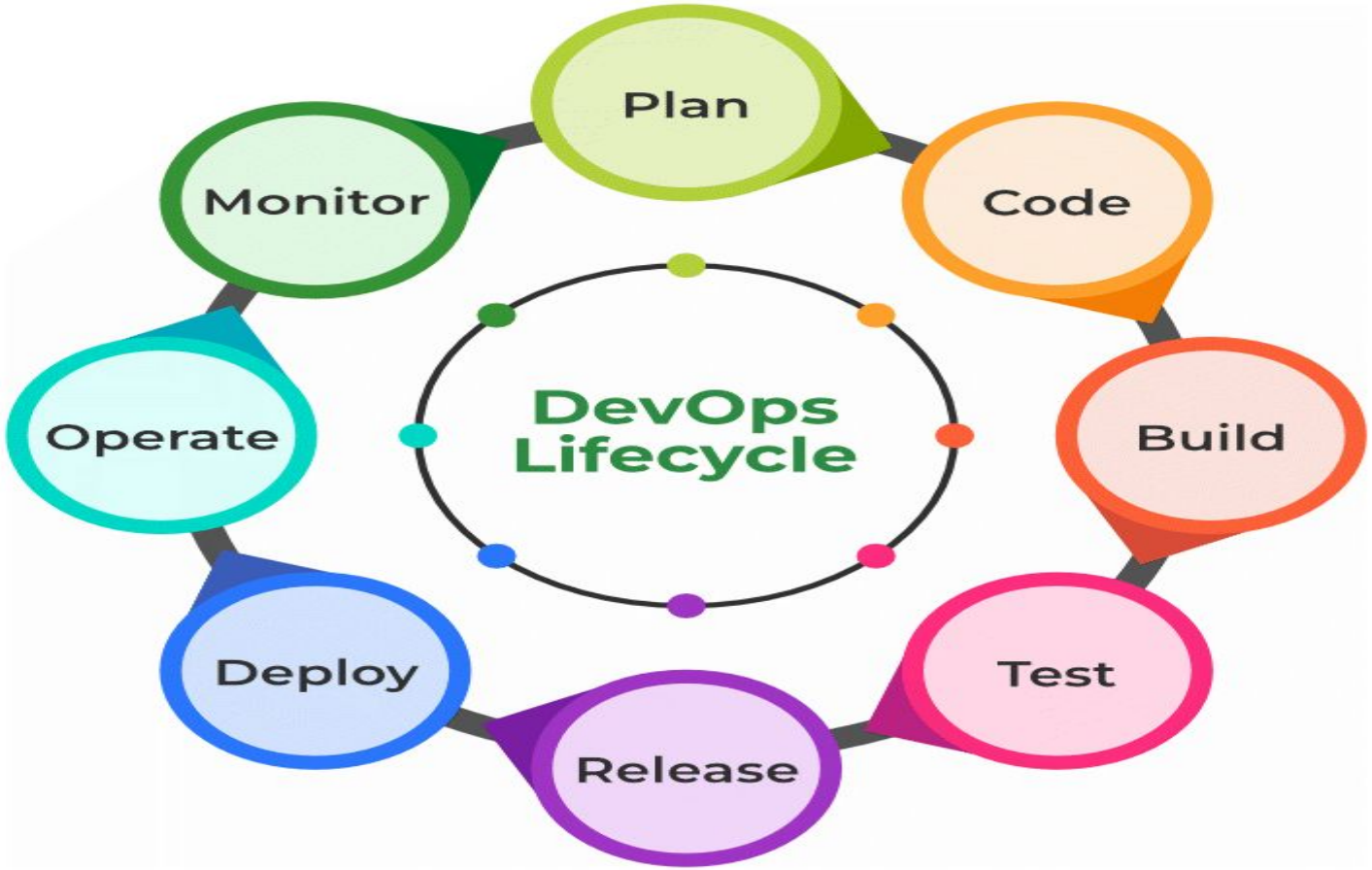
The DevOps model aligns development, QA and IT operations efforts with fewer gates and more continuous workflow. For example, some of the operations' team responsibilities shift left in the app delivery pipeline to the development team. IT operations provides feedback for code improvements. Rather than gated steps, DevOps relies on continuous development, continuous integration, continuous delivery and continuous monitoring processes.

- **DevOps vs. Agile development.** Agile is a software development approach defined in the Agile Manifesto. Agile teams focus on incremental and rapid cycles of code creation and delivery, referred to as *sprints*. Each sprint iterates upon the last, which makes the software highly flexible and adaptable to changing requirements. It is possible for the original vision of a project to be lost through this cycle.
- DevOps arose from Agile's success at improving development speed, and the realization that disconnects between development and operations teams -- as well as between IT and the business side of the organization -- significantly hindered the Agile software's delivery to users.
- In an Agile-only workflow, development and operations teams have separate objectives and leadership. When an organization uses DevOps and Agile together, both development and operations teams manage code throughout the software development lifecycle. While Agile work is often formalized with a framework, such as Scrum, DevOps does not have a framework.

- **DevOps vs. SRE.** Site reliability engineering arose concurrently with Agile and DevOps. Started in the early 2000s at Google, it is essentially a programming- and automation-focused approach to the software development lifecycle. Problems should be solved in a way that prevents them from occurring again. Rote tasks should be minimized.
- The SRE toolbox closely matches that for DevOps. Both disciplines aim for continuous improvement. SRE and DevOps engineers seek to abolish silos between development and operations. While DevOps also can extend to business stakeholders, SRE typically stays within the confines of IT processes.

- **DevOps vs. SysOps.** SysOps typically denotes that an IT administrator or IT team manages production deployment and support for a large distributed application, such as a SaaS product. As with DevOps adopters, SysOps teams should be versed in cloud computing and automation, as well as other technologies that enable applications to perform well at a large scale. SysOps teams troubleshoot IT outages and incidents, monitor for performance problems, enforce security rules and optimize operations.
- They also focus on high availability, fault tolerance, security and performance just like other IT admins. While SysOps professionals are likely to use some development tools and understand development processes, their work is not as enmeshed with development as in a DevOps job. However, SysOps roles can exist within DevOps and SRE organizations.

DevOps Lifecycle : DevOps lifecycle is the methodology where professional development teams come together to bring products to market more efficiently and quickly.
The structure of the DevOps lifecycle consists of Plan, Code, Building, Test, Releasing, Deploying, Operating, and Monitoring.



DevOps Lifecycle in Detail.

- **Plan:** Determining the commercial needs and gathering the opinions of end-user by professionals in this level of the DevOps lifecycle.
- **Code:** At this level, the code for the same is developed and in order to simplify the design, the team of developers uses tools and extensions that take care of security problems.
- **Build:** After the coding part, programmers use various tools for the submission of the code to the common code source.
- **Test:** This level is very important to assure software integrity. Various sorts of tests are done such as user acceptability testing, safety testing, speed testing, and many more.
- **Release:** At this level, everything is ready to be deployed in the operational environment.
- **Deploy:** In this level, Infrastructure-as-Code assists in creating the operational infrastructure and subsequently publishes the build using various DevOps lifecycle tools.
- **Operate:** At this level, the available version is ready for users to use. Here, the department looks after the server configuration and deployment.
- **Monitor:** The observation is done at this level that depends on the data which is gathered from consumer behavior, the efficiency of applications, and from various other sources.

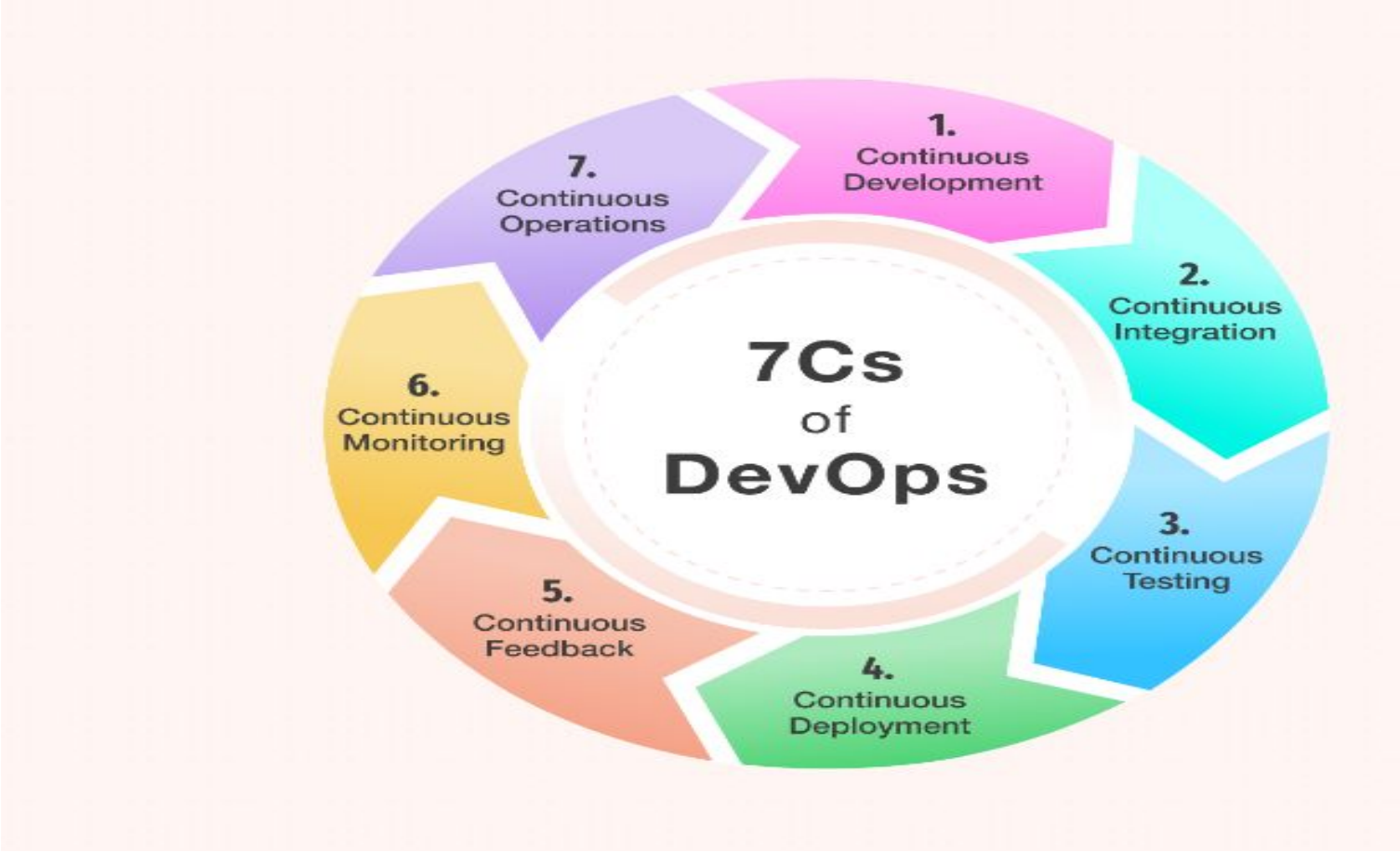
Important Links

- https://www.youtube.com/watch?v=to5H5iPZmD4
- https://www.youtube.com/watch?v=dJAxKm8La88

DevOps lifecycle phases: the 7Cs of DevOps lifecycle

- As we have discussed in Lifecycle that everything is continuous in DevOps – from **planning to monitoring**.
- So let's break down the entire **lifecycle into seven phases** where continuity is at its core.
- Any phase in the lifecycle can iterate throughout the projects multiple times until it's finished.

7 C’s of DevOps



1. Continuous Development

This phase plays a pivotal role in delineating the vision for the entire software development cycle.

It primarily focuses on project planning and coding.
During this phase, project requirements are gathered and discussed with stakeholders.
Moreover, the product backlog is also maintained based on customer feedback which is broken down into smaller releases and milestones for continuous software development.

Once the team agrees upon the business needs, the development team starts coding for the desired requirements.

It’s a continuous process where developers are required to code whenever any changes occur in the project requirement or in case of any performance issues.

Benefits of Continuous Development

Continuous Development makes the process more streamlined, completed successfully, and follows best practices. The benefits of Continuous Development are:

1. Good quality software

- Continuous Development makes it easier to fix software errors and bugs. If you measure continuous upgrades, your team will perform tests to quickly find your code's problems, bugs, and defects. As a result, ongoing development assures that an issue is resolved quickly and correctly.

2. Swift transitions

- Any new features introduced can be swiftly developed and deployed. New variations can be tested much more quickly, and automated tests can promptly reveal incompatibilities and defects that can be fixed instantly.

- **3. Lesser Risks**

You can determine whether the changes are effective and defect-free as the process makes modest, incremental upgrades to your programme. If the upgrades do not work, they can be removed from the project. This lessens the impact of changes on the rest of the team's developers.

- **4. Lesser Resources**

  Major updates may require a large number of resources for the development process. Continuous Development relies on automated processes to improve overall efficiency and reduce the time and effort required to deploy new software features.

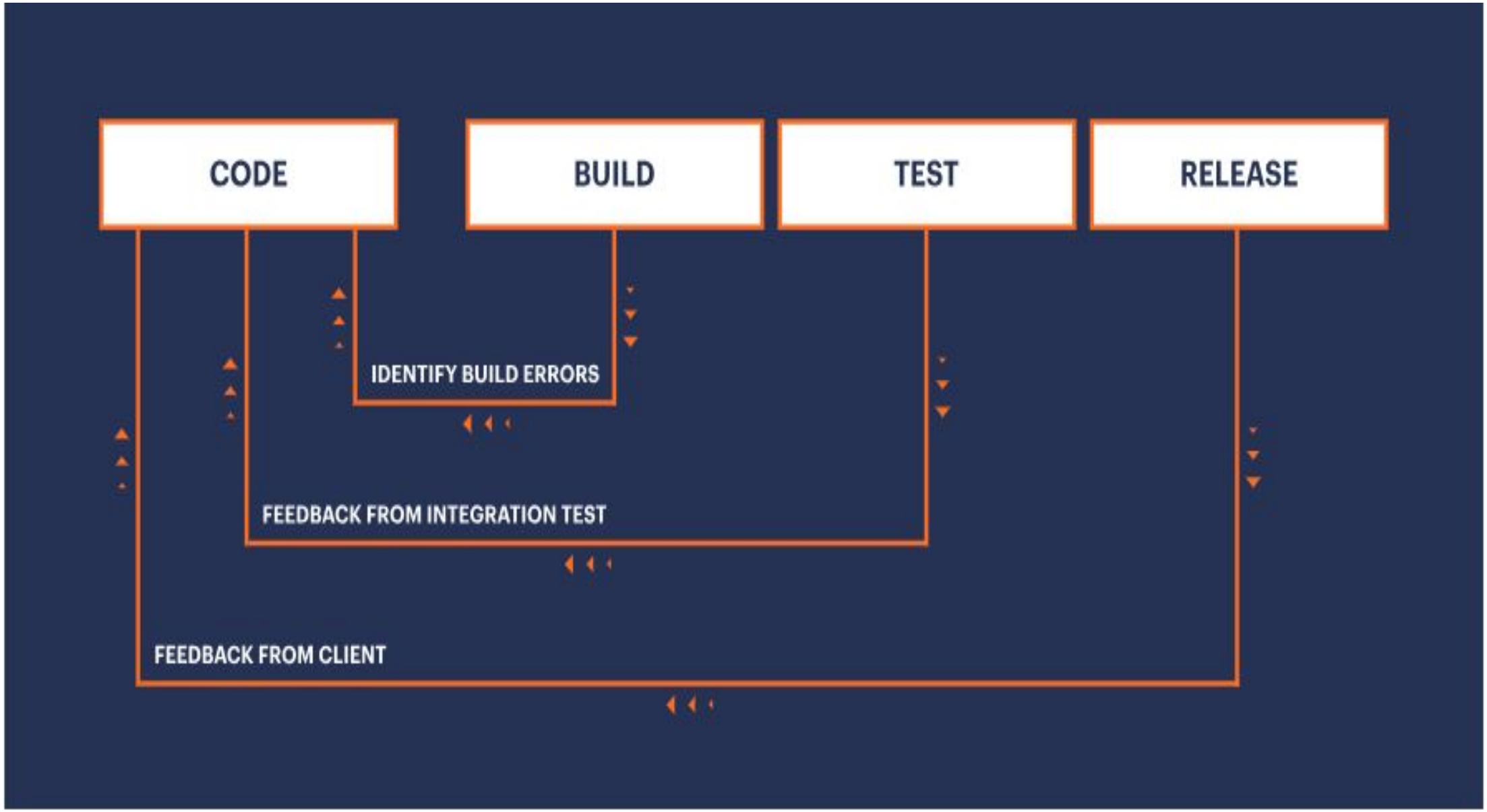
- **5. More Productivity**

- We receive constant feedback during the project, which gives a clear understanding of the project, and an automated Continuous Development DevOps process can be established. Your developers can concentrate on Development and generate more value for the software.

- **Factors of Continuous Development**
- *As we read above, Continuous Development revolves around four major factors: continuous integration, continuous delivery, continuous deployment, and continuous testing.*

Process of Continuous Development

- Thanks to the Continuous Development method, we can create and launch software projects in the most efficient, effective, and optimal way possible.
- The best technique in Continuous Development is to test each aspect individually rather than the entire batch.
- As a result, the software can be launched immediately after completion and is error-free.
- When we talk about its structure, the main branch may be the master, mainline, default, or trunk, depending on the control system in use.
- You may be perplexed by the phrase branches; in this case, the branches are smaller and have fewer lines of code, making them infinitely easier to test.
- Code branches are an excellent way to organize tiny development features, but they're only helpful if they become part of the trunk, just like branches on a tree.
- In Continuous Development, branches should be short and merged quickly.
- **Many big companies like Netflix, Google, Facebook, and even Tesla use the Continuous Development process to complete multiple releases per week or month.**


CODE
BUILD
TEST
RELEASE
IDENTIFY BUILD ERRORS
FEEDBACK FROM INTEGRATION TEST
FEEDBACK FROM CLIENT

Why is Continuous Development Important?

- The importance of Continuous Development in DevOps is that it helps faster software development as it removes code conflicts and code incompatibilities early.

- In Continuous Development, developers are provided with immediate feedback on changes which helps them identify vulnerabilities, errors, and defects early in Development.

- Quality checkpoints are also established. Every update to your software can be merged, tested, and confirmed using Continuous Development.

- This ensures that your team can provide a safe, secure, dependable, and high-quality product on time.

- The foundational dependency of CI is a version control system (VCS). If the target code base for a CI install does not have a VCS, step one is installing a VCS.
- The absence of a VCS should be very unlikely on modern codebases. Some popular VCSs are Git, Mercurial, and Subversion.
- Once version control is in place, finding a version control hosting platform is the next move. Most modern version control hosting tools have support and features built in for CI.
- Some popular version control hosting platforms are Bitbucket, Github, and Gitlab.
- After version control has been established on the project, integration approval steps should be added. The most valuable integration approval step to have in place is automated tests.
- Adding automated tests to a project can have an initial cost overhead. A testing framework has to be installed, then test code and test cases must be written by developers.

- Some ideas for other, less expensive CI approval mechanisms to add are syntax checkers, code style formatters, or dependency vulnerability scans.
- Once you have a version control system setup with some merge approval steps in place, you've established continuous integration!
- CI is not purely an engineering specific business process. The rest of the organization, marketing, sales, and product teams will also benefit from a CI pipeline.
- .

- Product teams will need to think how to parallelize execution of simultaneous streams of development.

- Product and engineering will work closely to determine the qualifying business functionality expectations that will make up the automated test suite.

- Marketing and sales will be able to reference the CI pipeline to coordinate with customer facing communications efforts and events.

- CI gives a level of transparency to the rest of the organization on how engineering execution is progressing.

- This transparency and communication utility integrates gracefully with an agile project development workflow

2. Continuous Integration

- Continuous integration is the most crucial phase in the entire DevOps lifecycle.
- In this phase, **updated code** or add-on functionalities and features are developed and integrated into existing code.
- Furthermore, bugs are detected and identified in the code during this phase at every step through **unit testing**, and then the source code is modified accordingly.
- This step makes integration a continuous approach where code is tested at **every commit**. Moreover, the tests needed are also planned in this phase.

Benefits and challenges of continuous integration

- Continuous integration is an essential aspect of DevOps and high-performing software teams.

Yet CI benefits are not limited to the engineering team but greatly benefit the overall organization. CI enables better transparency and insight into the process of software development and delivery.

These benefits enable the rest of the organization to better plan and execute go to market strategies. The following are some of the overall organizational benefits of CI.

• Enable scaling

CI enables organizations to scale in engineering team size, codebase size, and infrastructure.

By minimizing code integration bureaucracy and communication overhead, CI helps build DevOps and agile workflows. It allows each team member to own a new code change through to release.

CI enables scaling by removing any organizational dependencies between development of individual features. Developers can now work on features in an isolated silo and have assurances that their code will seamlessly integrate with the rest of the codebase, which is a core DevOps process.

Improve the feedback loop

Faster feedback on business decisions is another powerful side effect of CI.

Product teams can test ideas and iterate product designs faster with an optimized CI platform.

Changes can be rapidly pushed and measured for success. Bugs or other issues can be quickly addressed and repaired.

Enhance communication

- CI improves overall engineering communication and accountability, which enables greater collaboration between development and operations in a DevOps team.
- By introducing pull request workflows tied to CI, developers gain passive knowledge share. Pull requests allow developers to observe and comment on code from other team members.
- Developers can now view and collaborate on feature branches with other developers as the features progress through the CI Pipeline. CI can also be used to help QA resource expenses.
- An efficient CI pipeline with high-confidence automated test coverage will safeguard from regressions and ensure that new features match a specification.
- Before new code is merged it must pass the CI test assertion suite which will prevent any new regressions.
- The benefits of CI far outweigh any challenges in adoption. That said, it is important to be aware of the challenges of CI.
- The real challenges of CI arise when transitioning a project from no CI to CI. Most modern software projects will adopt CI from early inception stages and alleviate the challenges of later adoption.

Adoption and installation

- The challenges of continuous integration are primarily around team adoption and initial technical installation.
- If a team doesn't currently have a CI solution in place, it can require some effort to pick one and get started.
- Thus, considerations need to be made around the existing engineering infrastructure when installing a CI pipeline.

Technology learning curve

- CI functionality comes with a list of supportive technologies that may be learning curve investments for the team to undertake.
- These technologies are version control systems, hosting infrastructure, and orchestration technologies.

CI best practices

1. **Test driven development**

Once a project has established a CI pipeline with automatic test coverage, it is a best practice to constantly develop and improve the test coverage. Each new feature coming down the CI pipeline should have an accompanying set of tests to assert that the new code is behaving as expected.

- Test Driven Development (TDD) is the practice of writing out the test code and test cases before doing any actual feature coding. Pure TDD can closely involve the product team to help craft an expected business behavior specification, which can then be transformed into the test cases. In a pure TDD scenario, developers and product team will meet and discuss a spec or list of requirements. This list of requirements will then be converted into a checklist of code assertions. The developers will then write code that matches these assertions.

Pull requests and code review

- Most modern software development teams practice a pull request and code review workflow.
- Pull requests are a critical practice to effective CI. A pull request is created when a developer is ready to merge new code into the main codebase.
- The pull request notifies other developers of the new set of changes that are ready for integration.
- Pull requests are an opportune time to kick off the CI pipeline and run the set of automated approval steps.
- An additional, manual approval step is commonly added at pull request time, during which a non-stakeholder engineer performs a code review of the feature.
- This allows for a fresh set of eyes to review the new code and functionality. The non-stakeholder will make edit suggestions and approve or deny the pull request.

Optimize pipeline speed

- Given that the CI pipeline is going to be a central and frequently used process, it is important to optimize its execution speed.
- Any small delay in the CI workflow will compound exponentially as the rate of feature releases, team size, and codebase size grows.
- It is a best practice to measure the CI pipeline speed and optimize as necessary.
- A faster CI pipeline enables a faster product feedback loop. Developers can rapidly push changes and experiment with new feature ideas to help improve the user experience.
- Any bug fixes can be quickly patched and resolved as discovered.
- This increased execution speed can offer both an advantage over other competitors and an overall higher-quality experience to your customers.

CASE STUDY

- Let's take the example of Docusign, which developed e-signature technology back in 2003.
- It helps its clients automate the process of preparing, signing, and managing agreements.
- Their development teams used to follow Agile methodology for years to collect customer feedback and make small and quick releases.
- But, they lacked collaboration between the development and operations team, which led them to many failures.
- Moreover, their business was solely based on the transaction of signatures and approvals.
- So, the biggest challenge for their business was continuous integration and delivery.
- A single mistake could cause a serious problem and ruin the entire operation process. Hence, the organization decided to move to DevOps. DocuSign implemented a tool – mock for their internal API to speed up the product development and delivery.

- This tool helped the organization in integrating critical functionalities such as incident management. This tool also makes the testing with simulation simple.

Tools Used in Continuous integration

- Jenkin, Bamboo, GitLab CI, Buddy, TeamCity, Travis, and CircleCI are a few DevOps tools used to make the project workflow smooth and more productive.

- For example, Jenkin (open-source tool) is used widely to automate builds and tests.
- CircleCI and Buddy, on the other hand, are commercial tools.

Well, whatever tools you select for continuous integration, pick the one that can fit your business and project requirements.

Continuous Testing

- Some teams carry out the continuous testing phase before the integration occurs, while others do it after the integration.
- Quality analysts continuously test the software for bugs and issues during this stage using **Docker containers**.
- In case of a bug or an error, the code is sent back to the integration phase for modification.
- Automation testing also reduces the time and effort to deliver quality results.
- Teams use tools like ***Selenium*** at this stage. Moreover, continuous testing enhances the test evaluation report and minimizes the provisioning and maintenance cost of the test environments

Tools Used in Continuous Testing

- JUnit, Selenium, TestNG, and TestSigma are a few DevOps tools for continuous testing.

- **Selenium** is the most popular open-source automation testing tool that supports multiple platforms and browsers.

- **TestSigma**, on the other hand, is a unified AI-driven test automation platform that eliminates the technical complexity of test automation through **artificial intelligence**.

Continuous Deployment

- This phase is the crucial and most active one in the DevOps lifecycle, where final code is deployed on production servers.
- The continuous deployment includes configuration management to make the deployment of code on servers accurate and smooth.
- Development teams release the code to servers and schedule the updates for servers, keeping the configurations consistent throughout the production process.

- Containerization tools also help in the deployment process by providing consistency across development, testing, production, and **staging environments**.

- This practice made the continuous delivery of new features in production possible.

Tools Used

- Ansible, Puppet, and Chef are the configuration management tools that make the deployment process smooth and consistent throughout the production process.

- Docker and Vagrant are another DevOps tool used widely for handling the scalability of the continuous deployment process.

- Apart from this, Spinnaker is an open-source continuous delivery platform for releasing the software changes, while ArgoCD is another open-source tool for Kubernetes native CI/CD.

Continuous Feedback

Continuous feedback came into existence to analyze and improve the application code.

During this phase, customer behavior is evaluated regularly on each release to improve future releases and deployments.

Businesses can either opt for a structural or unstructured approach to gather feedback.

In the structural approach, feedback is collected through surveys and questionnaires.

In contrast, the feedback is received through social media platforms in an unstructured approach.

Overall, this phase is quintessential in making continuous delivery possible to introduce a **better version** of the application.

CASE STUDY

- One of the examples of continuous feedback is Tangerine bank.

It’s a Canadian bank that embraced continuous feedback to enhance its customers’ mobile experience.

After opting for continuous feedback, this Canadian bank collected a considerable amount of valuable feedback within a few weeks, which helped the bank reach the cause of the problem quickly.

Furthermore, this has helped them improve the application as per their customers’ needs.

This is how Tangerine bank managed to repurpose the resources and money on other crucial things excellently after adopting DevOps.

Tools Used:

Pendo is a product analytics tool used to collect customer reviews and insights.

Qentelli's TED is another tool used primarily for tracking the entire DevOps process to gather actionable insights for bugs and flaws.

Continuous Monitoring

- During this phase, the application's functionality and features are monitored continuously to detect **system errors** such as low memory, non-reachable server, etc.

- This process helps the IT team quickly **identify issues** related to app performance and the **root cause** behind it.
- If IT teams find any critical issue, the application goes through the entire DevOps cycle again to find the solution.
- However, the security issues can be detected and resolved automatically during this phase.

Tools Used:

- Nagios,
- Kibana,
- Splunk,
- PagerDuty,
- ELK Stack,
- New Relic, and
- Sensu

These are a few DevOps tools used to make the continuous monitoring process fast and straightforward.

Continuous Operations

- The last phase in the DevOps lifecycle is crucial for reducing the planned downtime, such as **scheduled maintenance**.

- Generally, developers are required to take the server offline to make the updates, which increases the downtime and might even cost a significant loss to the company.
- Eventually, continuous operation automates the process of launching the app and its updates.
- It uses container management systems like Kubernetes and Docker to eliminate downtime.
- These container management tools help simplify the process of building, testing, and deploying the application on multiple environments. The key objective of this phase is to boost the application's uptime to ensure uninterrupted services. Through continuous operations, developers **save time** that can be used to accelerate the application's time-to-market.

Tools Used:

- **Kubernetes and Docker Swarm** are the container orchestration tools used for the high availability of the application and to make the deployment faster.

Overall Summary with Tools

	Tools		
DevOps Phases	Continuous Planning & Development	• GitLab • GIT • TFS • SVN • Mercurial • Jira • BitBucket • Trello	• Maven • Gradle • Confluence • Subversion • Scrum • Lean • Kanban
	Continuous Integration	• Jenkin • Bamboo • GitLab CI	• TeamCity • Travis and CircleCI • Buddy
	Continuous Testing	• JUnit • Selenium • JMeter • Cucumber • TestSigma	• Microfocus UFT • TestNG • Tricentis Tosca • Jasmine
	Continuous Deployment	• Ansible • Chef • Docker • IBM Urban Code • Kubernetes	• Puppet • Go • Vagrant • Spinnaker • ArgoCD
	Continuous Monitoring	• Nagois • Grafa na • Kibana • Prometheus • Logstash • AppDynamics	• ELK Stack • New Relic • Splunk • Sensu • PagerDuty
	Customer Feedback	• Webalizer • W3Perl • ServiceNow • Slack	• Flowdock • Open Web Analytics • Pendo • Qentelli's TED
	Continuous Operations	• Kubernetes	• Docker Swarm

Tools Across DevOps Phases

SIMFORM