CI/CD Pipeline

1. Introduction

In modern software development, organizations need to deliver applications **faster**, with **better quality**, and with **minimal manual effort**. This is where **CI/CD pipelines** come into play.

CI/CD stands for **Continuous Integration** and **Continuous Delivery/Deployment**.
It is a **software engineering practice** that automates the process of:

- **Building the application**
- **Testing the code**
- **Deploying the application**
  into multiple environments before going **live**.

The main goal of CI/CD is to make software development **faster, more efficient, and less error-prone**.

2. What is Continuous Integration (CI)?

Continuous Integration is the practice of frequently **integrating code** from multiple developers into a shared repository, such as **GitHub, GitLab, or Azure Repos**.

Every time a developer pushes code, an **automated pipeline** is triggered to:

- Compile the code
- Run tests
- Package the application

This ensures that **integration issues** are detected **early** before they grow into bigger problems.

Steps in CI:

1. **Code Check-In** → Developers commit code to a repository.
2. **Code Merge** → The changes are merged into the main branch.
3. **Automated Build** → The system compiles the code.
4. **Automated Testing** → Unit and integration tests run automatically.
5. **Artifact Packaging** → If tests pass, the build is packaged for deployment.

6. **Example Tools for CI:**

- Jenkins
- Azure DevOps
- GitHub Actions
- GitLab CI/CD

Goal of CI:

To identify problems early, improve collaboration, and ensure all developers' code works together.

3. What is Continuous Delivery & Continuous Deployment (CD)?

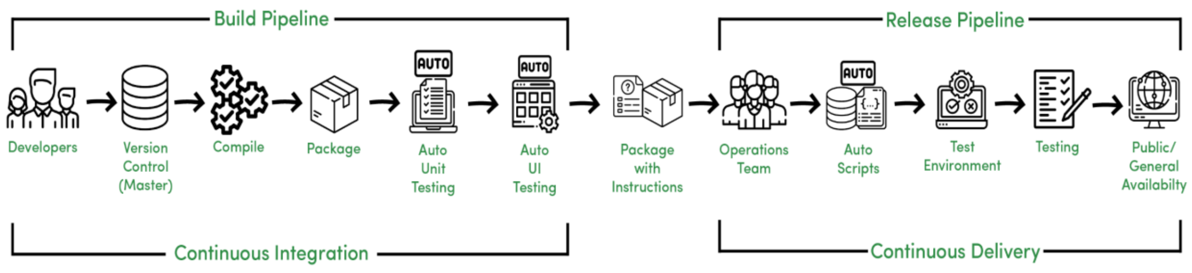
After CI, the next step is **CD**, which handles **deployment**. There are **two approaches**:

A. Continuous Delivery

- The code is automatically **built**, **tested**, and **packaged**.
- Deployment to **higher environments** (like QA, Staging, or Production) **requires manual approval**.
- Ideal for **critical applications** where stability is more important than speed.

B. Continuous Deployment

- Fully automated deployment.
- Once the CI pipeline passes, the application is **automatically deployed to production**.
- Saves time but requires **robust automated testing** to avoid production failures



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Example Tools for CD:

- Azure DevOps Release Pipelines

- Jenkins
- Spinnaker
- Octopus Deploy
- Docker + Kubernetes

4. CI/CD Pipeline Workflow

The CI/CD pipeline is made up of **multiple stages** that ensure the application is **fully tested** and **stable** before reaching **production**.

Stages of a CI/CD Pipeline:

Step 1: Development (Dev Environment)

- Developers write, test, and commit their code.
- Local testing ensures basic functionality.
- Once ready, they push code to the repository.

Step 2: Continuous Integration

- CI pipeline starts automatically.
- Builds and tests the code.
- If the build fails, developers fix and push changes until **GREEN** (successful).

Step 3: Quality Assurance (QA Environment)

- The build is deployed to a **QA environment**.
- The QA team tests the application for bugs, performance, and usability.
- If bugs are found, developers fix them and redeploy.

Step 4: Staging / Integration Environment

- This stage tests **integration with other services** like orders, payments, and APIs.
- Ensures all modules work together smoothly.

Step 5: User Acceptance Testing (UAT)

- Business analysts and stakeholders test the application.
- They verify whether the app meets **business requirements**.
- If approved, the app moves to pre-production.

Step 6: Pre-Production Environment (PPE)

- This environment is **99% identical to production**.
- Final performance, security, and compatibility tests are done here.
- Ensures stability before live deployment.

Step 7: Production (LIVE)

- The application is released to real users.
- Continuous monitoring ensures smooth functioning.

5. CI/CD Environments Overview

Environment	**Purpose**	**Who Uses It**
Dev Environment	Developers build and test features locally.	Developers
QA Environment	Testers validate functionality and report bugs.	QA Testers
Staging/Integration	Integration testing with APIs, payments, etc.	Testers + Devs
UAT	Business validation of features.	Business Analysts
PPE (Pre-Prod)	Final verification before live deployment.	Testers + Stakeholders
Production	Live environment where end-users use the app.	Customers

6. Tools Used in CI/CD

Different tools are used at different stages:

- **Version Control:** Git, GitHub, GitLab, Azure Repos
- **CI/CD Orchestration:** Jenkins, Azure DevOps, GitHub Actions
- **Build Tools:** Maven, Gradle, npm
- **Testing Tools:** Selenium, Postman, JUnit, PyTest
- **Deployment Tools:** Docker, Kubernetes, Ansible

7. Advantages of CI/CD Pipelines

A. Faster Development

- Automates repetitive tasks like builds, testing, and deployments.

B. Early Bug Detection

- Errors are caught during integration, preventing production failures.

C. Higher Quality Releases

- Each environment validates code functionality.

D. Improved Team Collaboration

- Developers, testers, and business teams work in sync.

E. Reduced Downtime

- Automated rollback mechanisms ensure smooth deployments.

8. Example CI/CD Flow

Let's visualize the typical CI/CD pipeline flow:

Developer → Commit Code → CI Pipeline → Build → Automated Testing →

QA Environment → Bug Fix → Staging → UAT → Pre-Prod → Production (LIVE)