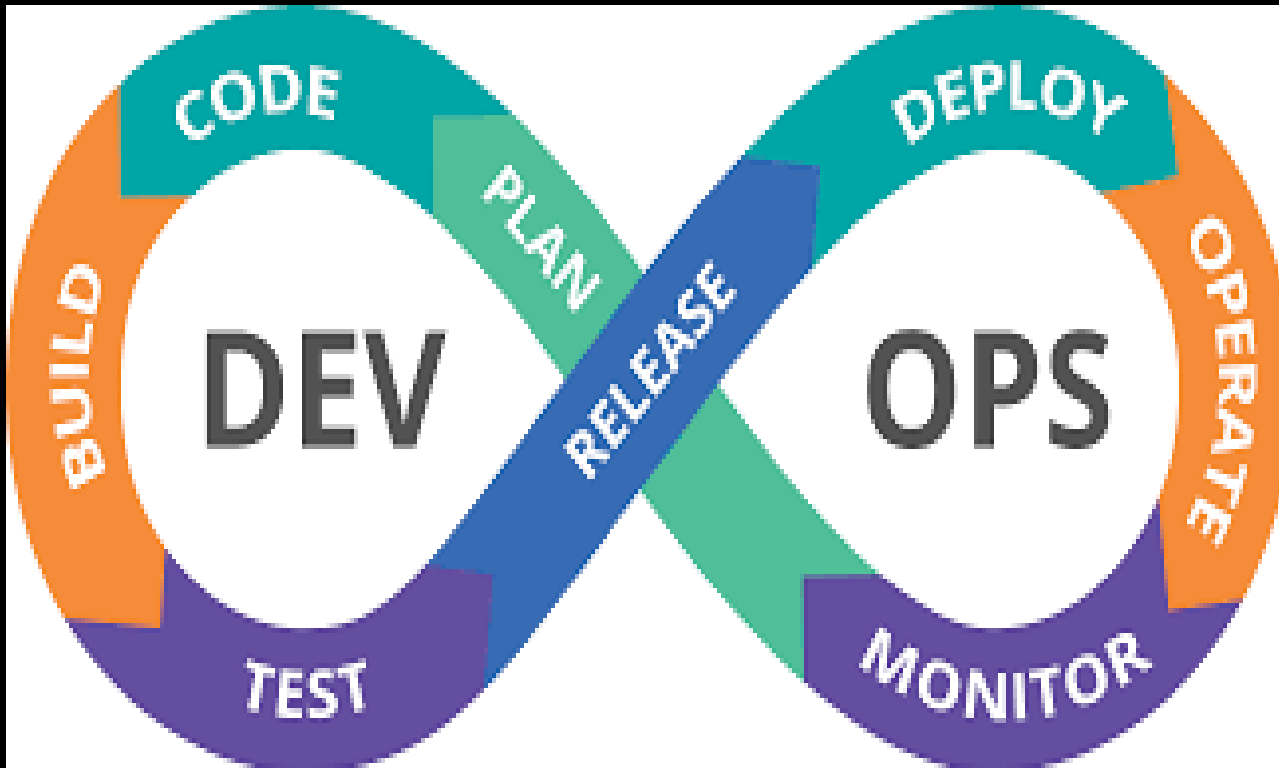




# **Continuous Integration/Continuous Deployment (CI/CD)**

# CI/CD → DevOps



# Continuous Integration (CI) - Definition

- CI is a software development practice where members of a team integrate their work frequently (daily) leading to multiple integrations per day. Each integration is verified by an automated build (including tests) to detect integration errors as quickly as possible.

*Martin Fowler*

- In software engineering, CI implements continuous processes of applying quality control - small pieces of effort, applied frequently. CI aims to improve the quality of software, and to reduce the time taken to deliver it, by replacing the traditional practice of applying quality control after completing all development.

# CI – How and Why.

- How:
  1. Maintain a single (central) source repository.
  2. Automate the build tasks.
  3. Everyone commits 'every day' to the central repository.
  4. Do the build on the CI machine.
  5. Keep the build fast, e.g. caching 3rd party libraries.
  6. Test the application on a clone of the production environment.
  7. Make it easy for everyone to get the latest executable.
  8. Make the process transparent for everyone.

# CI – How and Why.

- Why:
  1. Detect development problems earlier.
  2. Find and remove bugs earlier.
  3. Reduce risks of cost, schedule and budget overrun.
  4. Increase project visibility.
  5. Deliver new features and get user feedback more rapidly.
  6. Improve team cohesion.
  7. Have greater availability of deployable software.

# CI – Objective.

- Better:
  - Build better quality software ..... because it's tested early and often ..... adheres to best practices & coding standards.
- Faster:
  - Test in parallel with development (Agile), not at the end (Waterfall).
  - Do not have 'integration days'.
  - Application builds should be a non-event.
- Cheaper:
  - Identify defects earlier.
  - Fix when it's least costly.
  - Testing should be repeatable.

# Continuous Delivery/Deployment

- Continuous Delivery is a development discipline where you build software in such a way that it can be released to production at any time.
- Continuous Deployment means that every software change goes through the pipeline and automatically gets deployed into production, resulting in many production deployments every day.

# CD – How and Why.

- How:
  1. Team must continuously integrating new features into the software.
  2. Run automated tests.
  3. Automatically deploy the application to a production-like environment, termed a staging environment.
- Why:
  1. Reduce deployment risks.
  2. Change the version in production more rapidly.
  3. Able to release new version of the application at the 'push of a button'.
  4. Get user feedback earlier.



# CI/CD - Summary

## Continuous Integration



## Continuous Delivery



## Continuous Deployment



# CI metrics

- Is our CI process successful?
- Possible metrics including:
  - Successful Build Rate.
  - Build Repair Rate.
  - Total Numbers of Static Tool Errors
    - Ex. Lint, Checkstyle, PMD, Findbugs
  - Unit Testing Line Coverage.
  - Functional Testing Line Coverage.

# CD – How and Why.

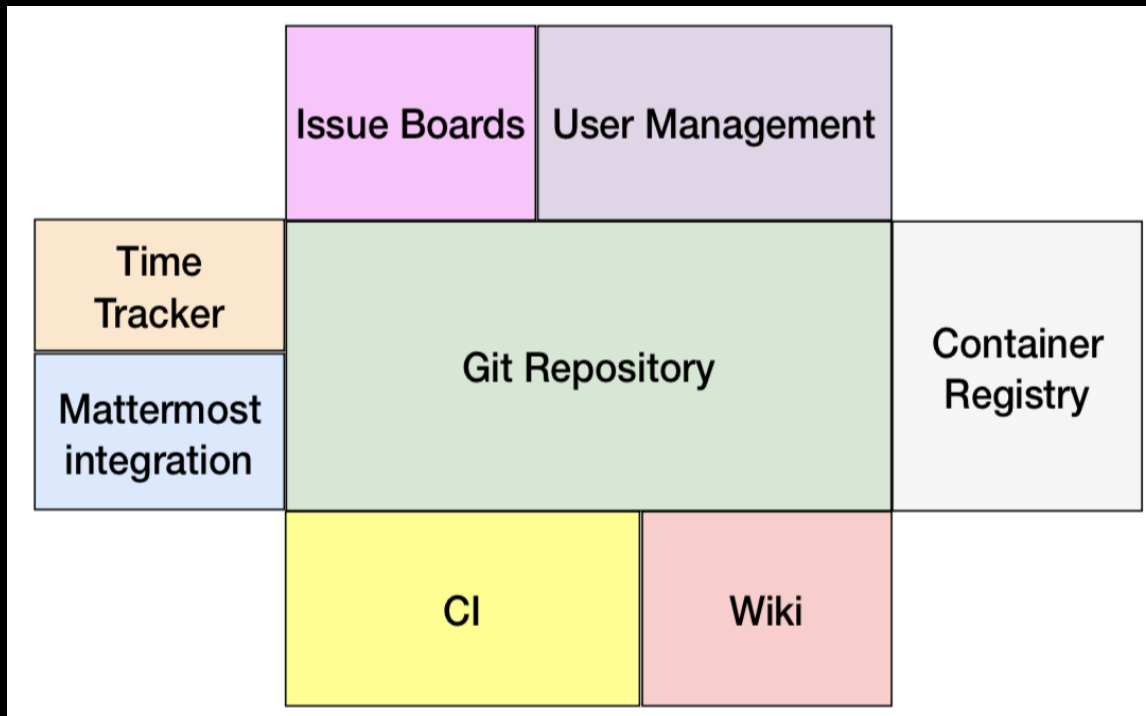
- Pay attention to your builds:
  - They should provide immediate feedback.
  - They should be easily accessible.
  - They should require no developer effort.
- CI Metrics Matter:
  - Identify key metrics and track them visually.
  - Act on them immediately.

# CI/CD - Platforms



# GitLab.

- A Git-based hosting and collaboration platform
- Open source.
- Hosted (free) or on premise.
- Actively maintained.

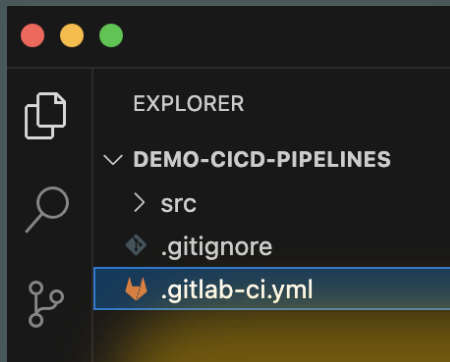


# GitLab CI.

- What:
  - Fully integrated with Gitlab repository
  - Version control of CI/CD scripts.
  - Git hooks.
  - Built on containerization model (optional).
- Why:
  - Code and build scripts in the same repo.
  - Easy to get started.
  - Scalable.
  - Isolated test environment.

# GitLab CI - Concepts.

- Three constructs:
  1. Pipelines,
  2. Stages, and
  3. Jobs.
  - We declare a CI/CD process using these constructs.
  - Pipeline >> Stages >> Jobs.
- A pipeline is a group of jobs that get executed in stages (batches).
  - All of the jobs in a stage are executed in parallel
  - If all stage jobs succeed, the pipeline moves to the next stage.
  - If one stage jobs fails, the next stage is not executed.
- Pipelines are defined in ***.gitlab-ci.yml*** (mandatory) in the project base *folder*.



# Demo

- A pipeline with 4 jobs spread across 3 stages.

```
.gitlab-ci.yml M X
.gitlab-ci.yml
1
2  stages:
3    - stage1
4    - stage2
5    - stage3
6
7  jobA:
8    stage: stage1
9    script:
10     - echo "Start of '$CI_PIPELINE_ID' pipeline "
11     - echo "This is job '$CI_JOB_NAME' in stage '$CI_JOB_STAGE'"
12
13  jobB:
14    stage: stage2
15    script:
16     - echo "This is job '$CI_JOB_NAME' in stage '$CI_JOB_STAGE'"
17     - exit 1
18
19  jobC:
20    stage: stage2
21    script:
22     - echo "This is job '$CI_JOB_NAME' in stage '$CI_JOB_STAGE'"
23
24  jobD:
25    stage: stage3
26    script:
27     - echo "This is job '$CI_JOB_NAME' in stage '$CI_JOB_STAGE'"
28     - echo "End of '$CI_PIPELINE_ID' pipeline "
29
```



# Demo – Pipeline executions

- The pipeline is executed when the repository is updated (git push)

The screenshot shows the GitLab Pipelines interface for the repository `gitlab.com/oconnordiarmuid/demo-cicd-pipelines`. The page displays a list of pipeline executions with columns for Status, Pipeline, Created by, and Stages.

Status	Pipeline	Created by	Stages
<span>Failed</span> 00:01:00 2 minutes ago	<b>Force job failure</b> #1519841833 main ed49772b latest		<span>✓</span> <span>✗</span> <span>»</span>
<span>Passed</span> 00:01:30 3 minutes ago	<b>Correct job stages</b> #1519840356 main ab7974dc		<span>✓</span> <span>✓</span> <span>✓</span>
<span>Passed</span> 00:01:31 7 minutes ago	<b>Use job names</b> #1519832208 main 3d6444a5		<span>✓</span> <span>✓</span> <span>✓</span>

# Demo – Job execution

- A job's script is executed inside a container (configurable)

Amazon W x | diarmuidoc x | docker-con x | jobA (#822 x | Mail - Diarmuid x | Predefined x | How to fail x | +

gitlab.com/oconnordiarmuid/demo-cicd-pipelines/-/jobs/8226798573

Diarmuid O Connor / demo-cicd-pipelines / Jobs / #8226798573

Search visible log output

```
9 Getting source from Git repository 00:01
10 Fetching changes with git depth set to 20...
11 Initialized empty Git repository in /builds/oconnordiarmuid/demo-cicd-pipelines/.git/
12 Created fresh repository.
13 Checking out ab7974dc as detached HEAD (ref is main)...
14 Skipping Git submodules setup
15 $ git remote set-url origin "${CI_REPOSITORY_URL}"
16 Executing "step_script" stage of the job script 00:00
17 Using docker image sha256:243309b48f4ab04a5de198e1ef7ec6b224a276924f096f188dd6c616c3a71233 for
   ruby:3.1 with digest ruby@sha256:ba4d592a4fc6e3f5d2a9a52a1a3bbefde53308e786de4f66ba72237b18
   b15676 ...
18 $ echo "Start of '$CI_PIPELINE_ID' pipeline "
19 Start of '1519840356' pipeline
20 $ echo "This is job '$CI_JOB_NAME' in stage '$CI_JOB_STAGE'"
21 This is job 'jobA' in stage 'stage1'
22 Cleaning up project directory and file based variables 00:01
23 Job succeeded
```

Duration: 29 seconds  
Finished: 18 minutes ago  
Queued: 0 seconds  
Timeout: 1h (from project) ?  
Runner: #12270807 (j1aLDqxS) 1-blue.saaS-linux-small-amd64.runners-manager.gitlab.com/default

Commit ab7974dc  
Correct job stages

Pipeline #1519840356 ✓ Passed for main  
stage1

# Demo – Job container image

```
jobA:
  stage: stage1
  image: busybox
  script:
    - echo "Start of '$CI_PIPELINE_ID' pipeline "
```

Search visible log output

9 Getting source from Git repository 00:01

10 Fetching changes with git depth set to 20...

11 Initialized empty Git repository in /builds/oconnordarmuid/demo-cicd-pipelines/.git/

12 Created fresh repository.

13 Checking out da7cb4e9 as detached HEAD (ref is main)...

14 Skipping Git submodules setup

15 \$ git remote set-url origin "\${CI\_REPOSITORY\_URL}"

16 Executing "step\_script" stage of the job script 00:01

17 Using docker image sha256:27a71e19c95622dce4d60d4a3760707495c9875f5c5322c5bd535214799593ce for busybox with digest busybox@sha256:768e5c6f5cb6db0794eec98dc7a967f40631746c32232b78a3105fb946f3ab83 ...

18 \$ echo "Start of '\$CI\_PIPELINE\_ID' pipeline "

19 Start of '1519885638' pipeline

20 \$ echo "This is job '\$CI\_JOB\_NAME' in stage '\$CI\_JOB\_STAGE'"

21 This is job 'jobA' in stage 'stage1'

22 Cleaning up project directory and file based variables 00:00

23 Job succeeded

Duration: 10 seconds

Finished: 1 minute ago

Queued: 0 seconds

Timeout: 1h (from project) ?

Runner: #32976687 (nN8vMRS9) 6-blue.saas-linux-small-amd64.runners-manager.gitlab.com/default

Commit da7cb4e9

Use busybox image

Pipeline #1519885638 Passed for main

stage1

# Job Structure

	<code>job1:</code>
	<code>  stage: build</code>
Variables	<code>  variables:</code>
	<code>    DATABASE_URL: "test"</code>
Before script	<code>  before_script:</code>
	<code>    - execute-before-script-for-job1</code>
Script	<code>  script:</code>
	<code>    - execute-script-for-job1</code>
	<code>    - something else</code>
After Script	<code>  after_script:</code>
	<code>    - execute-after-script-for-job1</code>
Artifacts	<code>  artifacts:</code>
	<code>    paths:</code>
	<code>      - .variables</code>
	<code>    expire_in: 1 week</code>
Only/ Except	<code>  only:</code>
	<code>    - master</code>
	<code>  except:</code>
	<code>    - develop</code>
Tags	<code>  tags:</code>
	<code>    - ruby</code>
	<code>    - postgres</code>
When	<code>  when: manual</code>

# GitLab CI/CD Architecture

- GitLab CI/CD service uses registered Runner nodes to execute pipeline jobs.
- GitLab Runner:
  - An application to run jobs and send results back to GitLab
  - Installed on cloud / on-premise machines.
  - Written in Go and can be run as a single binary.
  - Works with Linux, Windows and OSX.
  - Acts as an agent (worker) for GitLab CI/CD service
- GitLab Executor:
  - A Runner passes a job to an Executor.
  - Executor determines the environment a job runs in .
  - Lots of Executor types:
    - PowerShell, VirtualBox, Docker, Kubernetes, Custom, etc,