CSIT314 Software Development Methodologies

Principles and practices of continuous integration and delivery (CI/CD)

Acknowledgement: Materials from these slides are adapted from the following sources: “Continuous Integration” by Martin Fowler and GitLab documentation.

What is integration?

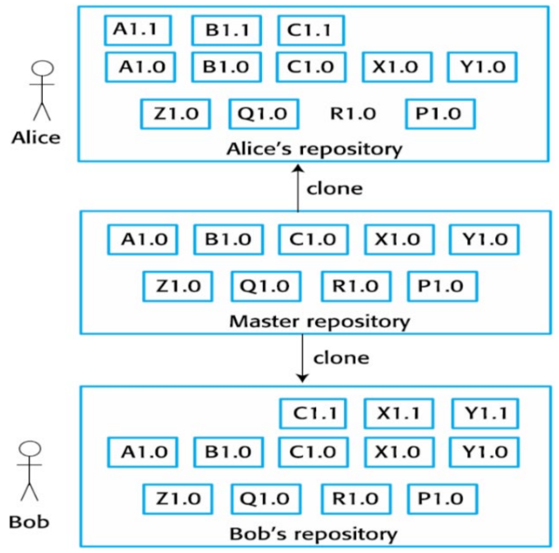
- Software teams often have multiple developers working on the **same codebase** at the **<u>same time</u>** (**independently**):
- E.g. Developer A works on feature 1 while developer B works on feature 2.
- E.g. Developer A works on class 123.java while developer B works on class 456.java
- Once they have finished, they needs to **integrate** their work into the main codebase.
  - Question: What issues could arise at integration?

What is continuous integration (CD)?

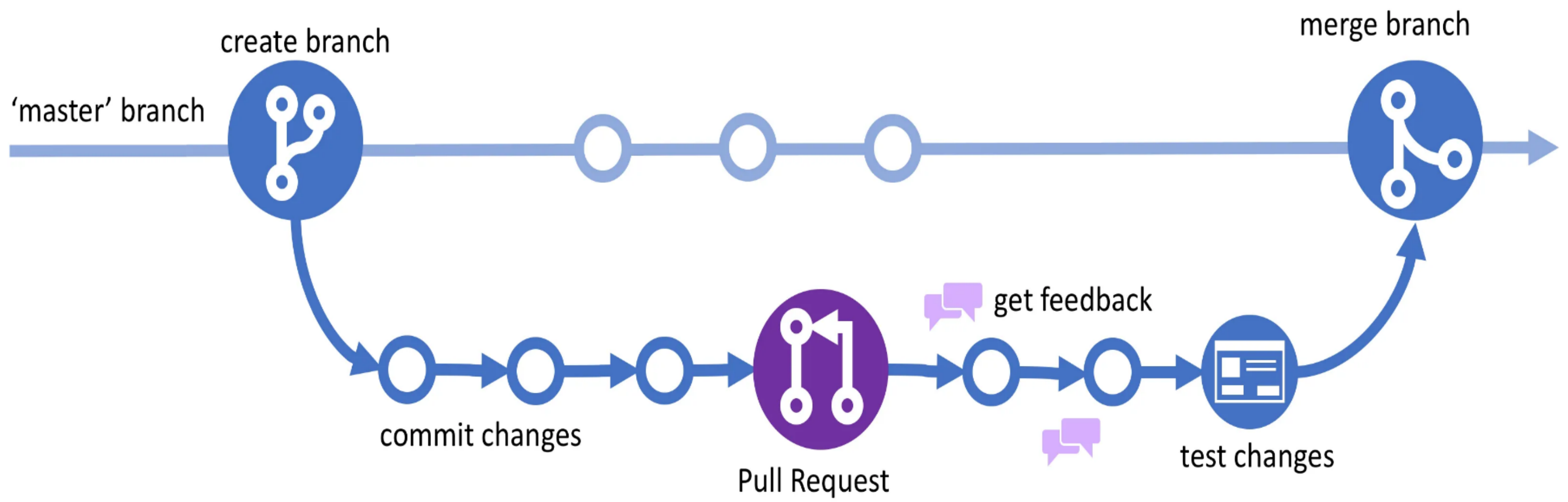
- Continuous integration (CD) is a software development practice where developers in a team **integrate** their work **frequently**.
- Developers usually integrates several times a day.
- Each integration is verified by an **automated build**: compile the code and also run automated tests?
  - Question: Why are automated tests run?

Practices of Continuous Integration

- **Maintain a Single Source Repository**
  - Use a version control system such as Git/GitHub
  - Everything required to build the software app should be in the repository (code, test scripts, test data, properties files, database schema, third-party libraries, etc.)



GitHub Flow



Practices of Continuous Integration

- Automate the build
  - Automate the whole process of turning the source code into a running software app
    - Often include compiling, moving files around, loading schemas into the databases, etc.
  - Issuing a single command and the whole build process will run automatically.

Practices of Continuous Integration

- Make your build self-testing
  - Include automated tests as part of the build process.
  - All automated **unit tests** (refer to test-driven development) should be run as part of the continuous integration practice (e.g. JUnit, NUnit, etc.).
  - All automated **acceptance tests** should be run as part of the continuous integration practice (e.g. Selenium).

Practices of Continuous Integration

- Everyone **commits** (*integrate their changes*) to the main codebase every day (or even better, multiple times a day)
  - Integration is a way in which developers can "inform" other developers about the changes they have made: frequent integration means frequent communication!
  - By integrating their changes frequently, developers **quickly find out** if there is a **conflict** between the changes.
  - Errors, conflicts, bugs, etc. can be detected early and rectified quickly.

Practices of Continuous Integration

- Every commit should build the mainline (the main codebase) on an integration machine
  - Regular builds happen on an integration machine and only if this integration build succeeds should the commit be considered to be done.
  - Use continuous integration server (e.g. Jenkins, Travis CI, Bamboo, GitLab, etc.)

Practices of Continuous Integration

- Fix Broken Builds Immediately
  - A key part of doing a continuous build is that if the mainline build fails, it needs to be fixed right away.
  - “nobody has a higher priority task than fixing the build”

Practices of Continuous Integration

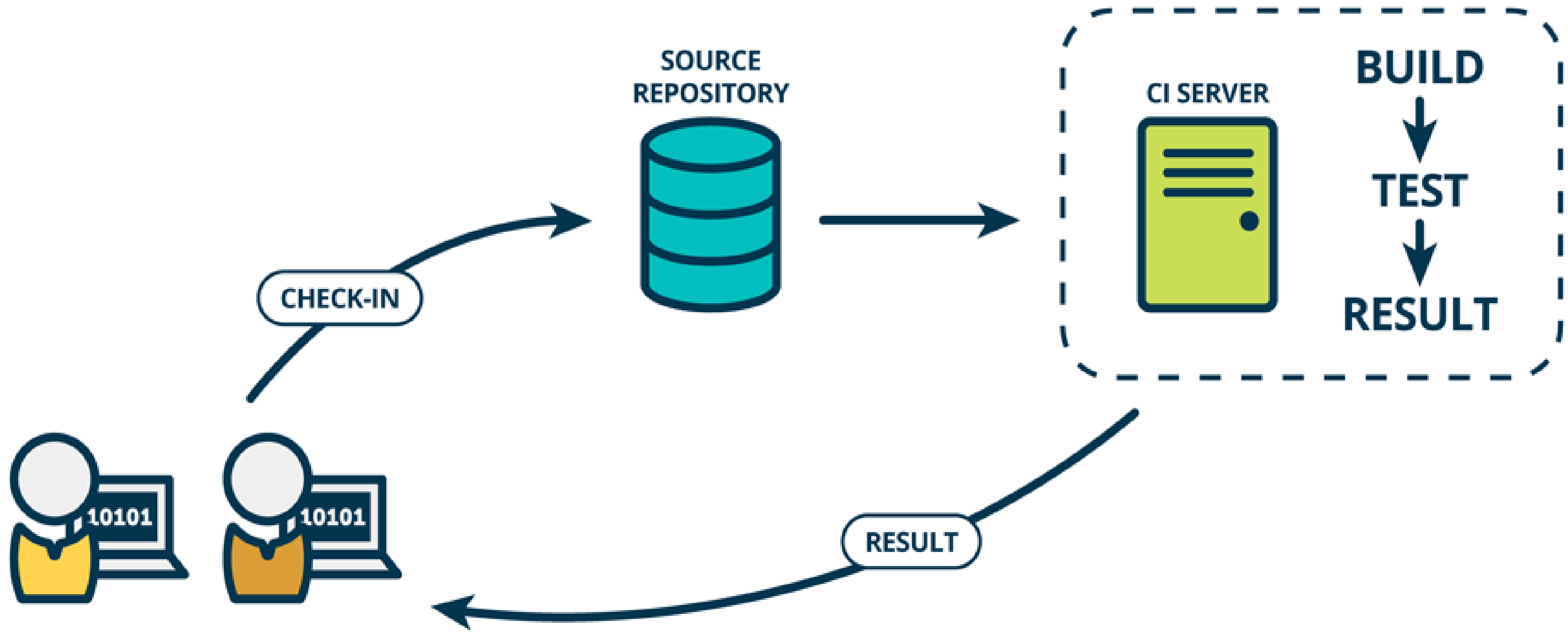
- Keep the build fast.
  - The whole point of Continuous Integration is to provide rapid feedback.
  - If the build is not fast, developers will commit less often and will be provided feedback on problems less often.

Practices of Continuous Integration

- Test in a clone of the production environment.
  - Testing in a different environment introduces risk when the system is deployed in production.

production environment = laptop/tab/desktop

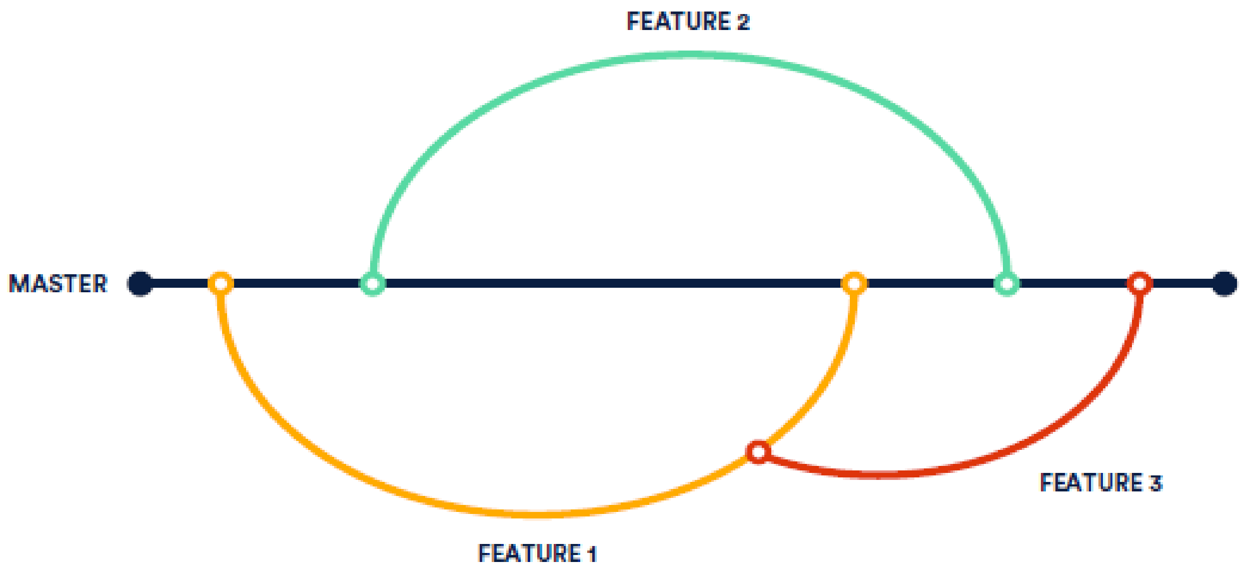
Continuous Integration cycle



Source: https://www.mindtheproduct.com/

Continuous Integration tools

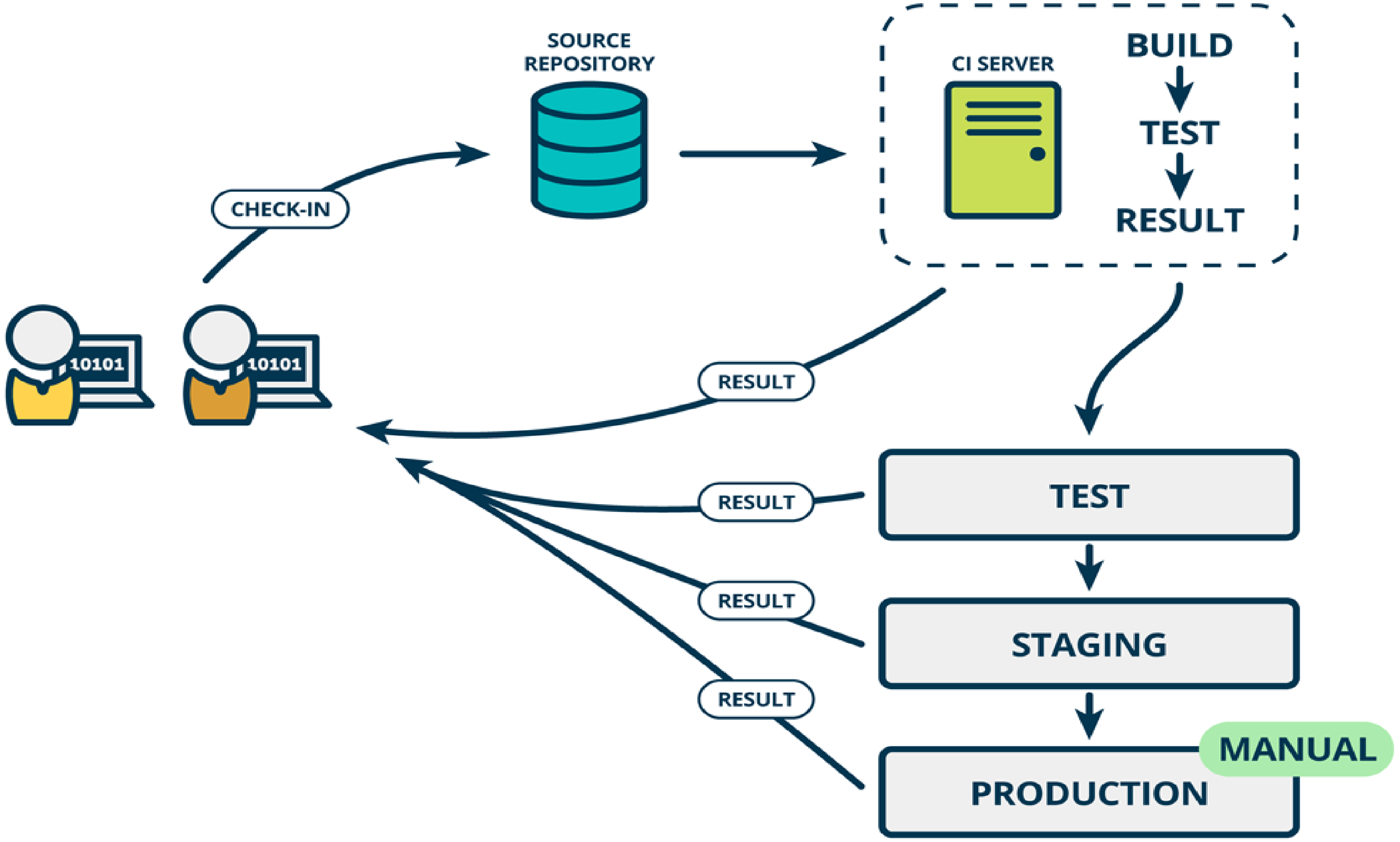
- CI tools: Jenkins, Travis CI, Bamboo, GitLab CI, etc.
- Demo CI using Bamboo: https://youtu.be/GIfYP4HmZ_4



Continuous Delivery

- Continuous Delivery is a further step beyond Continuous Integration:
  - Each time changes are pushed to the codebase, the new code is automatically built and tested on environments that are **very similar** to production (**staging environment**)
- The staging environment addresses **non-functional** requirements such as security, load-balancing, redundancy, and scalability. These may not be covered in the development environments
- Question: why is it useful to plan for a staging environment?

Continuous Delivery cycle

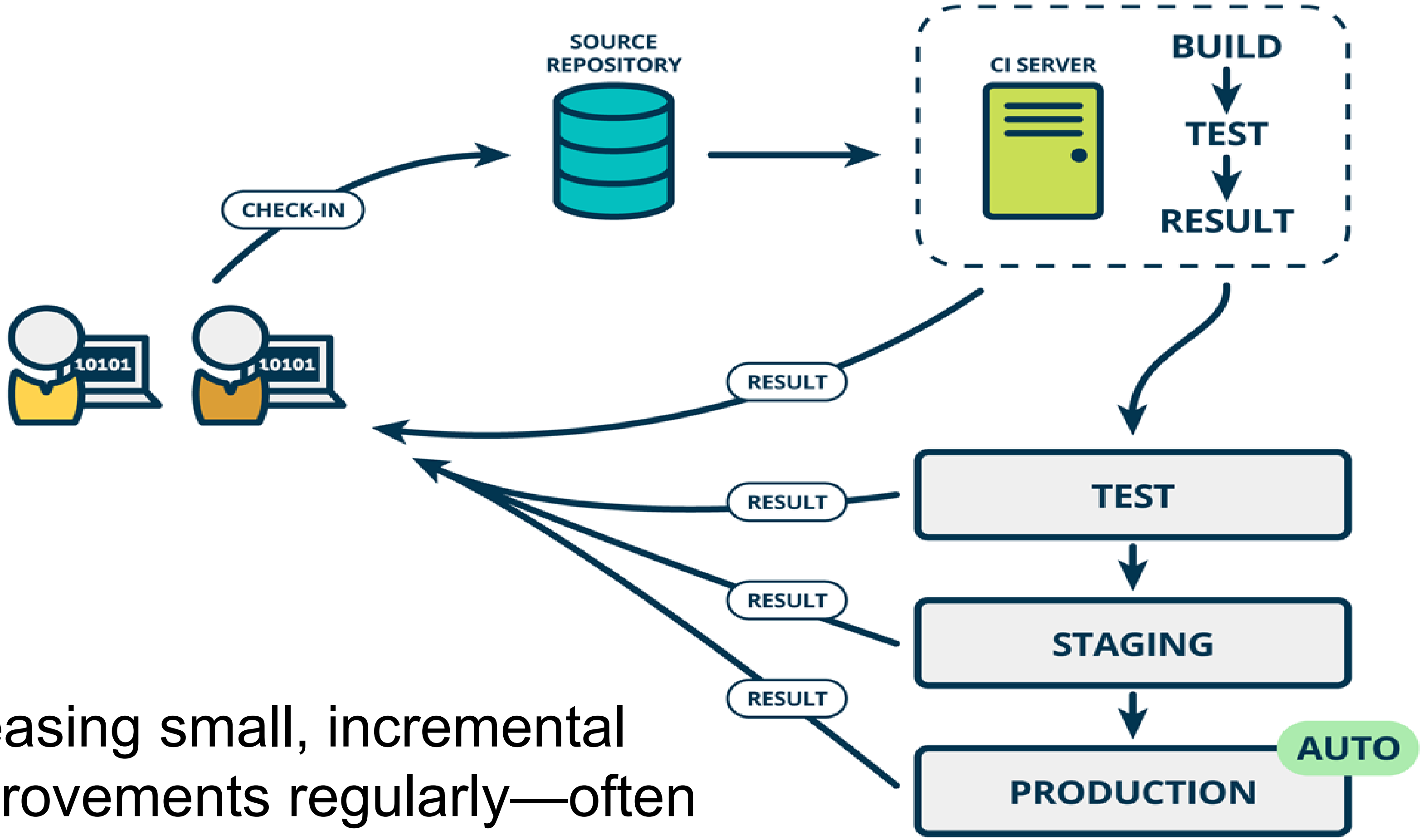


Continuous Deployment

- In Continuous Delivery, the deployment of the software application to a production environment is still done manually.

- Continuous Deployment is an additional step beyond Continuous Delivery:
  - The software application is deployed automatically.
  - Every time code changes are pushed to the codebase, it will be automatically built and tested – and if the tests are successfully, it will automatically go to production.

Continuous Deployment cycle



releasing small, incremental improvements regularly—often even several times per day.

Continuous Deployment (CD)

- Continuous Deployment demo:
  - Bamboo demo: https://youtu.be/rG-XxVYNS4c
  - GitHub and Azure demo: https://youtu.be/3WDe3l1M-3U

Infrastructure as Code

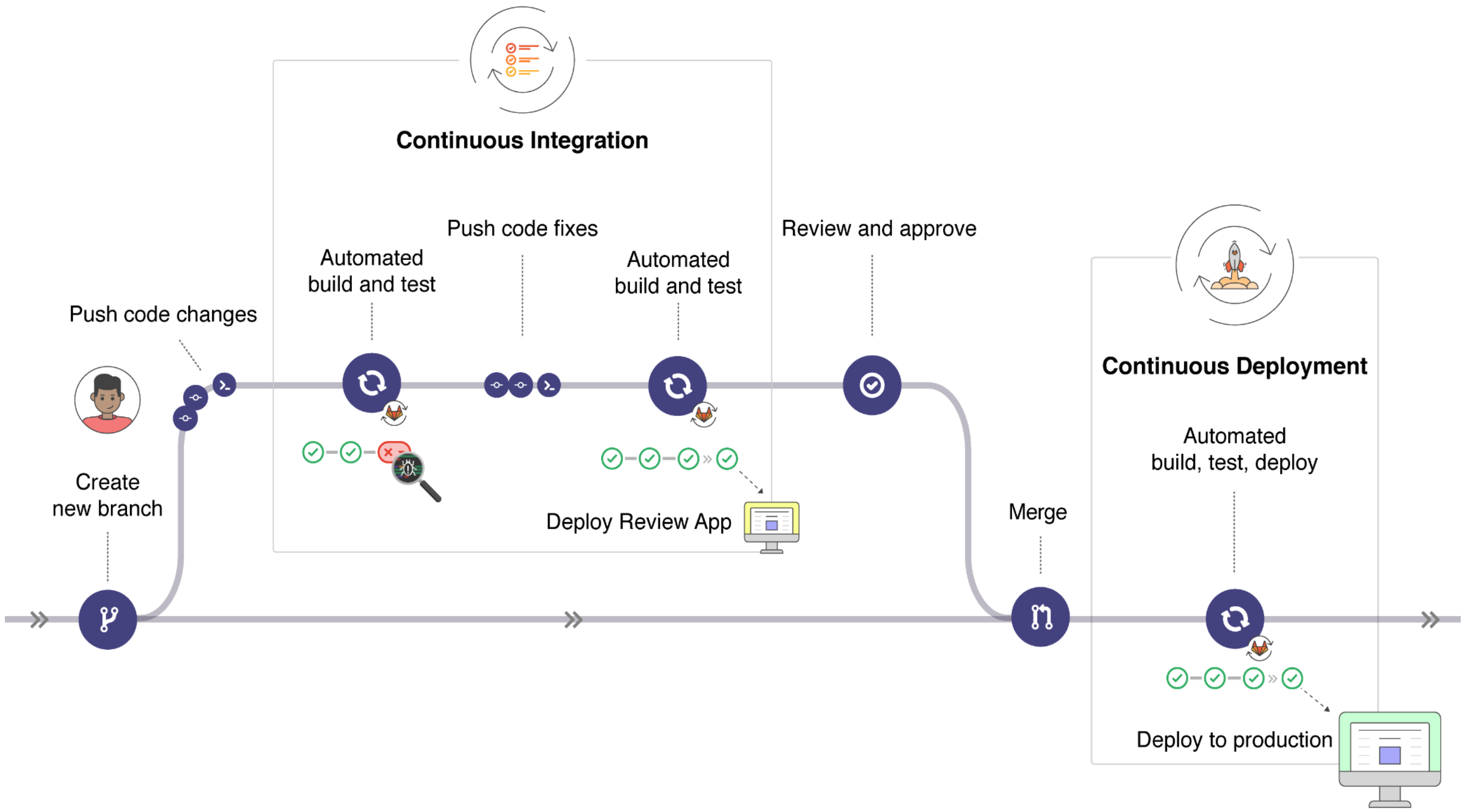
- What is IT infrastructure?
  - Physical machines, devices, OS, databases, and any other systems that are used to run a software application.
- Infrastructure as Code: the whole IT infrastructure can be treated as if they are software.
  - The whole IT environment can be setup, configured and changed automatically through writing code.
- Infrastructure as code is the prerequisite for common CI/CD practices

Infrastructure as Code (cont.)

- IaC model generates the same environment every time it is applied.
  - Infrastructure as Code enables software teams to test applications in production-like environments early in the development cycle

- IaC demo: https://youtu.be/k6_ZTIxI4xk

CI/CD with GitLab



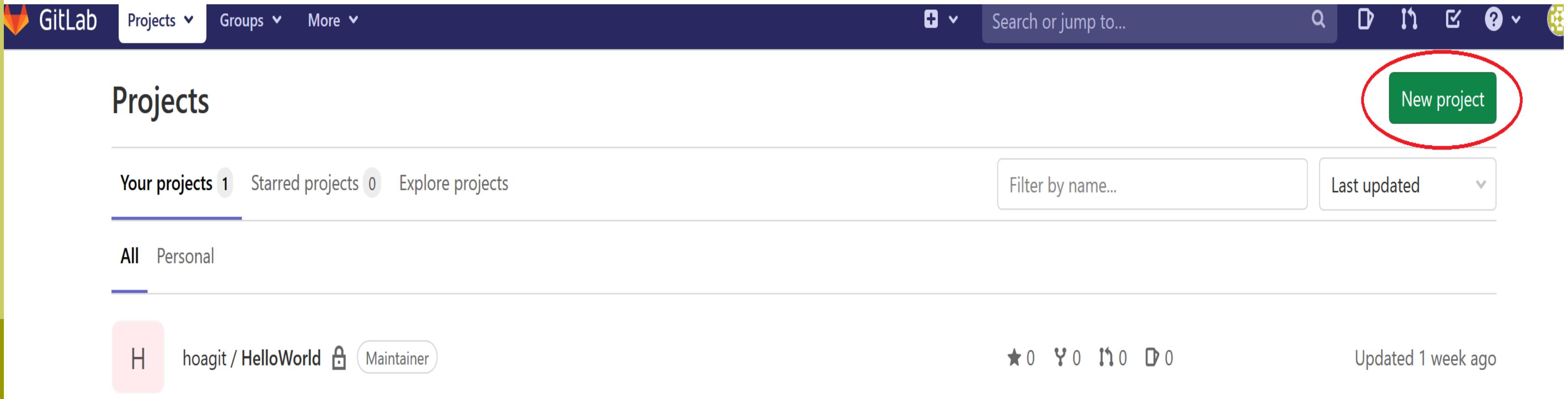
CI/CD with GitLab (cont.)

- Create an account on GitLab
- Setup a project on GitLab
- Install Git on your computer:
  - https://desktop.github.com/ or
  - https://git-scm.com/downloads

See a demo at:
https://documents.uow.edu.au/~hoa/teaching/SIM/CI-CD.mp4

CI/CD with GitLab (cont.)

- Create a new project on GitLab

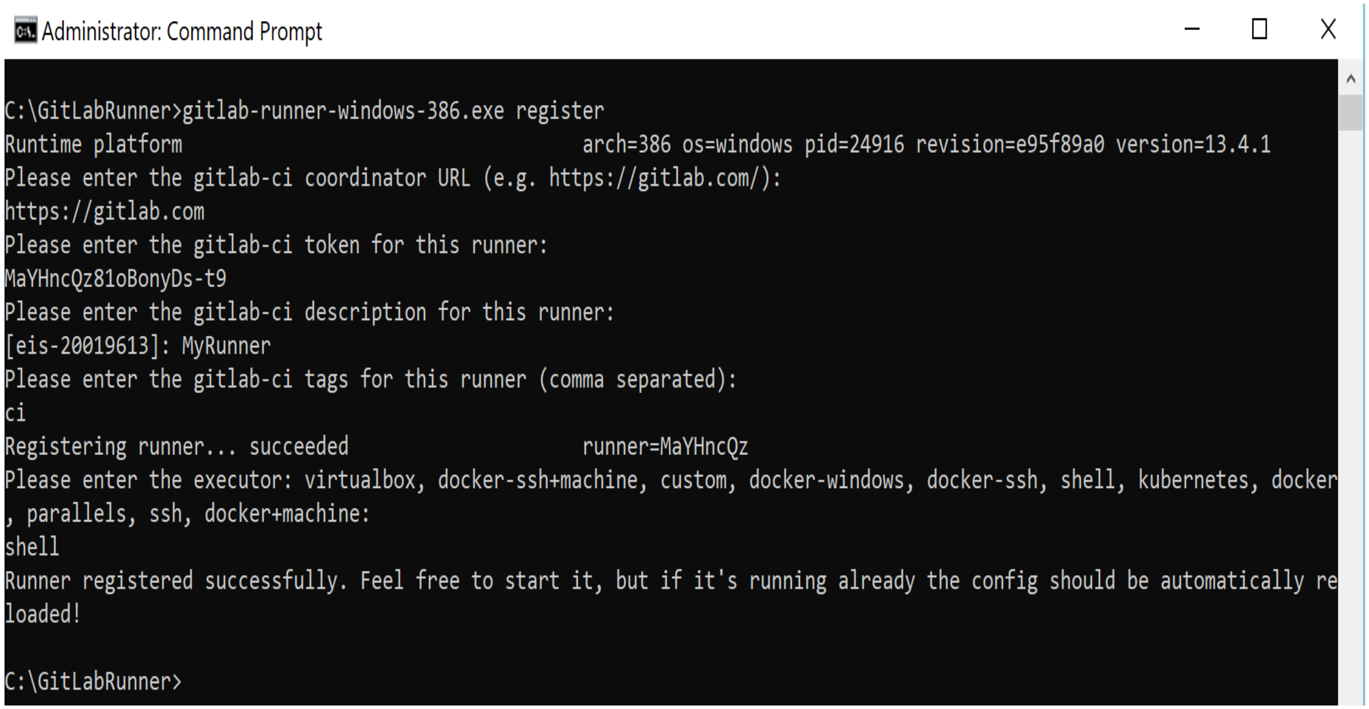


Projects

hoagit / HelloWorld Maintainer ★ 0 0 0 0 Updated 1 week ago

CI/CD with GitLab (cont.)

- Install GitLab Runner on your computer
  - https://docs.gitlab.com/runner/#install-gitlab-runner
- Register GitLab Runner with GitLab
  - https://docs.gitlab.com/runner/register/
- Start GitLab Runner

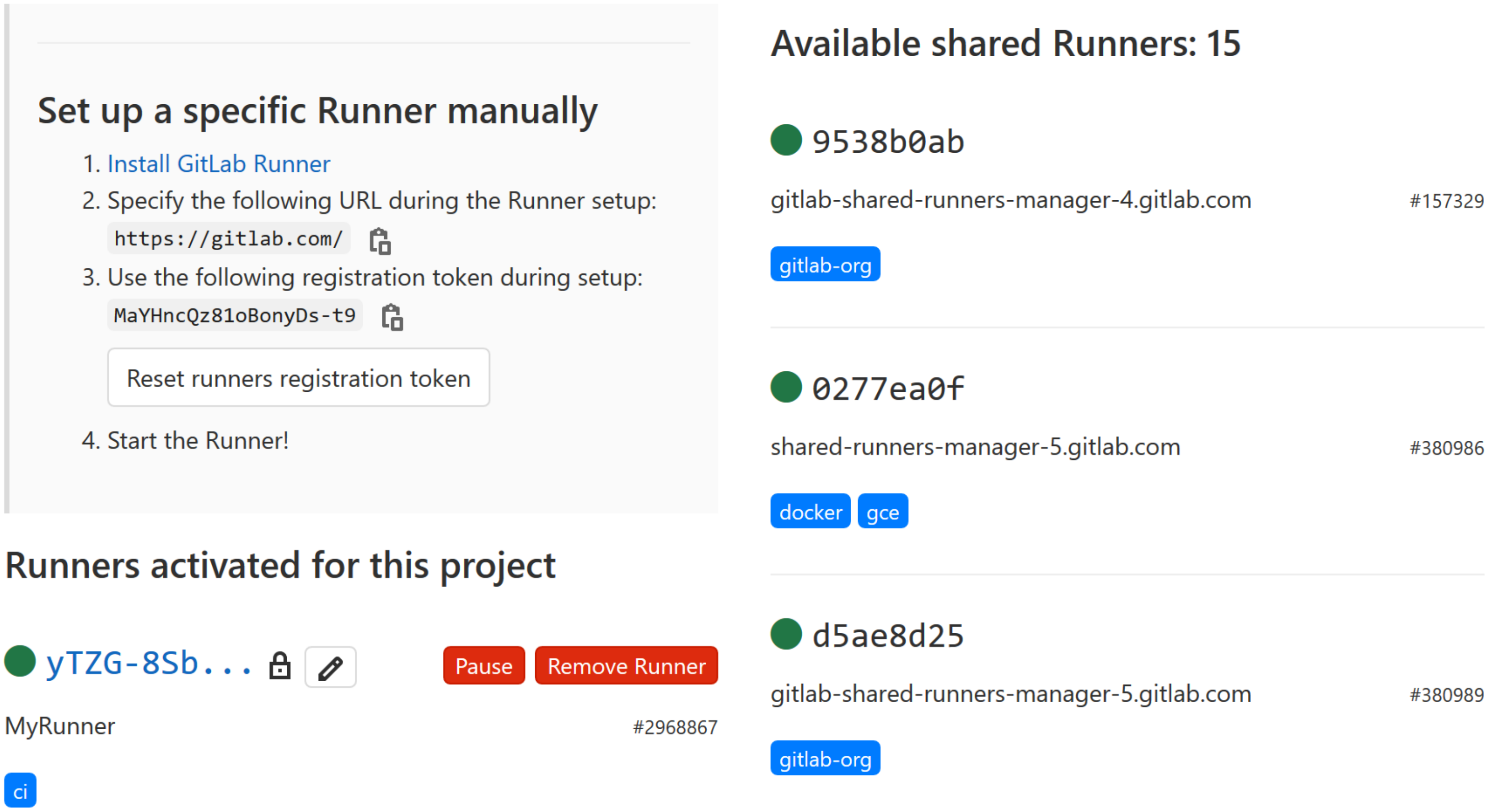


Administrator: Command Prompt

```
C:\GitLabRunner>gitlab-runner-windows-386.exe register
Runtime platform                                    arch=386 os=windows pid=24916 revision=e95f89a0 version=13.4.1
Please enter the gitlab-ci coordinator URL (e.g. https://gitlab.com/):
https://gitlab.com
Please enter the gitlab-ci token for this runner:
MaYHncQz81oBonyDs-t9
Please enter the gitlab-ci description for this runner:
[eis-20019613]: MyRunner
Please enter the gitlab-ci tags for this runner (comma separated):
ci
Registering runner... succeeded                     runner=MaYHncQz
Please enter the executor: virtualbox, docker-ssh+machine, custom, docker-windows, docker-ssh, shell, kubernetes, docker
, parallels, ssh, docker+machine:
shell
Runner registered successfully. Feel free to start it, but if it's running already the config should be automatically re
loaded!

C:\GitLabRunner>
```

CI/CD with GitLab (cont.)



Set up a specific Runner manually

1. Install GitLab Runner
2. Specify the following URL during the Runner setup:
   `https://gitlab.com/`
3. Use the following registration token during setup:
   `MaYHncQz81oBonyDs-t9`

4. Start the Runner!

Runners activated for this project

● yTZG-8Sb...

MyRunner #2968867

ci

Available shared Runners: 15

● 9538b0ab

gitlab-shared-runners-manager-4.gitlab.com #157329

gitlab-org

● 0277ea0f

shared-runners-manager-5.gitlab.com #380986

docker gce

● d5ae8d25

gitlab-shared-runners-manager-5.gitlab.com #380989

gitlab-org

CI/CD with GitLab (cont.)

- Create a CI/CD pipeline on GitLab
  - Create/add a file called ".gitlab-ci.yml" in the root folder of your project.
  - This YAML file defines the structure and order of the CI/CD pineline and decides:
    - What will be executed using GitLab Runner
    - What to do when some specific conditions are satisfied (e.g. when a process succeeds or fails).

  (See https://docs.gitlab.com/ee/ci/yaml/ for more details)

CI/CD with GitLab (cont.)

- Let’s watch a live demo of how to set up and run CI/CD with GitLab.

CI/CD with GitLab (cont.)

- GitLab CI/CD Examples for different types of applications written in different programing languages
  - https://docs.gitlab.com/ee/ci/examples/