Meethack Torino

CI/CD Security Risks & CI/CD Goat

A new attack surface

- CI/CD environments, processes and systems are the beating heart of any modern software organization.
- They deliver code from an engineer’s workstation to production.
- However, they have also reshaped the *attack surface* with a multitude of new avenues and opportunities for attackers.
- Adversaries are shifting their attention to CI/CD, realizing CI/CD services provide an efficient path to reaching an organization's crown jewels.

https://owasp.org/www-project-top-10-ci-cd-security-risks/

Top 10 CI/CD Security Risks

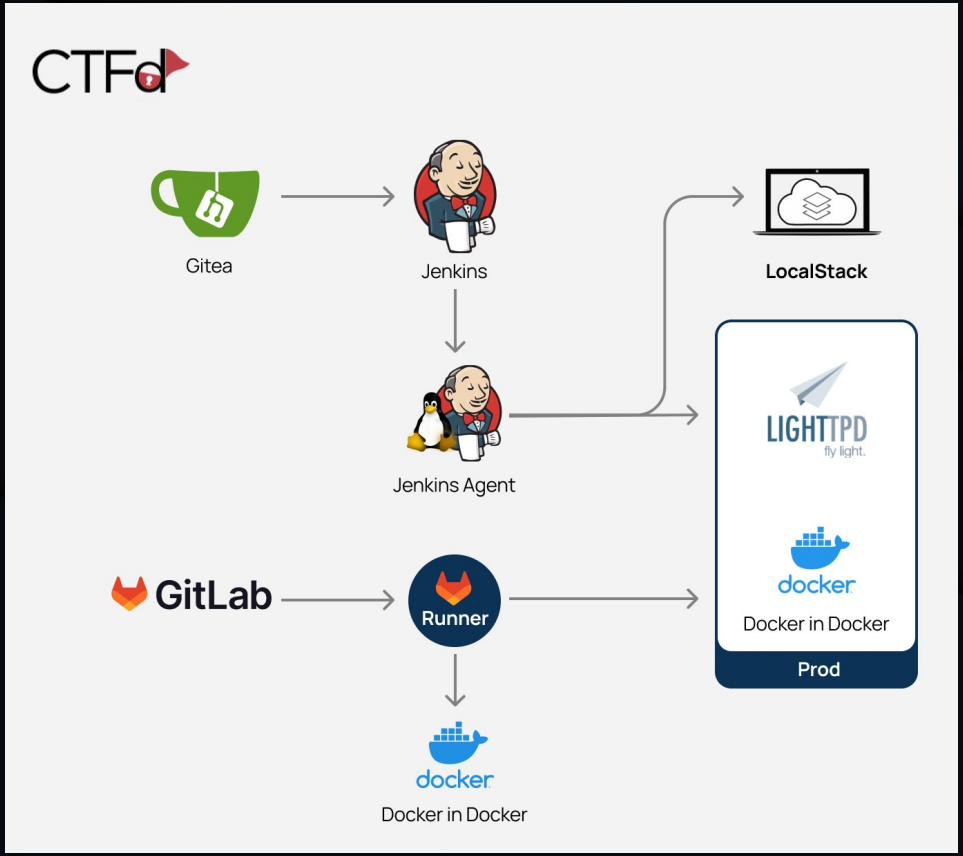
Proposed by ***Cider Security*** (acquired by *Palo Alto Networks*).

Still an OWASP ***"Lab Project"***.

1. Insufficient Flow Control Mechanisms
2. Inadequate Identity and Access Management
3. Dependency Chain Abuse
4. Poisoned Pipeline Execution (PPE)
    - Direct (D-PPE)
    - Indirect (I-PPE)
    - Public (3PE)
5. Insufficient PBAC (Pipeline-Based Access Controls)
6. Insufficient Credential Hygiene
7. Insecure System Configuration
8. Ungoverned Usage of 3rd Party Services
9. Improper Artifact Integrity Validation
10. Insufficient Logging and Visibility

https://owasp.org/www-project-top-10-ci-cd-security-risks/

CI/CD Goat: our playground



- Things to keep in mind:
  - Builds will start on Jenkins, usually after a *Pull Request* (*PR*).
  - PRs can be created between *main* branch and a newly created branch on Gitea.
  - Jenkins will mask plain text secrets leaked in console output. This will happen in every challenge!
  - Each challenge stands on its own. Do not use access gained in one challenge to solve another challenge.
  - Don't be afraid to look at hints.
  - There is no need to exploit CVEs.

https://github.com/cider-security-research/cicd-goat

Just a couple of prerequisites...

`git` client 101

- Clone a repository (use Gitea credentials):
  - `git clone http://localhost:3000/Wonderland/<repository_name>.git`
- Checkout to a new branch:
  - `git checkout -b <branch_name>`
- Add and commit with message:
  - `git commit -am "Your message"`
- Push to the remote branch:
  - `git push -u origin <branch_name>`

An example of *Jenkinsfile*

```
pipeline {
    agent any
    environment {
        PROJECT = "src/urllib3"
    }

    stages {
        stage ('Install_Requirements') {
            steps {
                sh """
                    virtualenv venv
                    pip3 install -r requirements.txt || true
                """
            }
        }

        stage ('Lint') {
            steps {
                sh "pylint ${PROJECT} || true"
            }
        }

        stage ('Unit Tests') {
            steps {
                sh "pytest"
            }
        }

    }
    post {
        always {
            cleanWs()
        }
    }
}

```

- *Jenkins Pipeline* is a suite of plugins which supports implementing and integrating *continuous delivery pipelines* into Jenkins.
- A *continuous delivery (CD) pipeline* is an automated expression of your process for getting software from version control right through to your users and customers.
- The definition of a Jenkins Pipeline is written into a text file (called a *Jenkinsfile*) which in turn can be committed to a project's source control repository.
- This is the foundation of *"Pipeline-as-code"*; treating the CD pipeline as a part of the application to be versioned and reviewed like any other code.
- https://www.jenkins.io/doc/book/pipeline/

“[...] You take the red pill, you stay in Wonderland, and I show you how deep the rabbit hole goes.”

Challenge: *White Rabbit - 100*

- http://localhost:8000/challenges#White%20Rabbit-1
- Scenario:
  - Use your access to the *Wonderland/white-rabbit* repository to steal the *flag1* secret stored in the Jenkins credential store.
  - Secret is stored with the *Global* scope, which makes it accessible to any pipeline on the Jenkins instance.
  - *Jenkinsfile* is not protected.
  - https://www.jenkins.io/doc/book/pipeline/jenkinsfile/#handling-credentials
- Solution:
  - *Direct Poisoned Pipeline Execution (D-PPE)*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/white-rabbit.md

Challenge: *Mad Hatter - 100*

- http://localhost:8000/challenges#Mad%20Hatter-3
- Scenario:
  - Use your access to the *Wonderland/mad-hatter* repository to steal the *flag3* secret.
  - *Jenkinsfile* is protected: the pipeline is configured in a separate repository from where the application code is stored at. The attacker doesn't have permission to trigger a pipeline with a modified *Jenkinsfile*.
- Solution:
  - *Indirect Poisoned Pipeline Execution (I-PPE)*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/mad-hatter.md

Challenge: *Caterpillar - 200*

- http://localhost:8000/challenges#Caterpillar-2
- Scenario:
  - Use your access to the *Wonderland/caterpillar* repository to steal the *flag2* secret, which is stored in the Jenkins credential store.
  - *Jenkinsfile* is protected: the pipeline is configured in the same repository from where the application code is stored at, but the current user can't change it.
  - There are two jobs in Jenkins: *-prod* and *-test*.
  - *Think about this repository like an "open source" one… And escalate your privileges to control it.*
- Solution:
  - *Public Poisoned Pipeline Execution (3PE)*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/caterpillar.md
  - Considerations about the `when` condition in the *`deploy`* `stage` of the pipeline?
    - You can both: remove the condition for the attack and do it via PR or leave it and push directly on *main* branch instead.

Challenge: *Cheshire Cat - 200*

- http://localhost:8000/challenges#Cheshire%20Cat-5
- Scenario:
  - All jobs in your victim's Jenkins instance run on dedicated nodes. You want to execute code on the Jenkins Controller.
  - Use your access to the *Wonderland/cheshire-cat* repository to run code on the Controller and steal *~/flag5.txt* from its file system.
  - https://www.jenkins.io/doc/book/managing/nodes/#components-of-distributed-builds
  - https://www.jenkins.io/doc/book/pipeline/syntax/#agent
  - http://localhost:8080/computer/
- Solution:
  - *Direct Poisoned Pipeline Execution (D-PPE)*
  - *Insufficient PBAC (Pipeline-Based Access Controls)*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/cheshire-cat.md
    - Error in the solution: the file name is missing *.txt* extension.

Challenge: *Duchess - 100*

- http://localhost:8000/challenges#Duchess-4
- Scenario:
  - You've got access to the *Wonderland/duchess* repository, which heavily uses Python. There must be some PyPi token left somewhere. Can you find it?
  - The flag is the token.
- Solution:
  - *Insufficient Credential Hygiene*
  - **You could need external tools for this!**
    - `gitleaks detect -v --enable-rule="pypi-upload-token"`
    - `docker run -v <full_path_to_host_folder_to_scan>:/path zricethezav/gitleaks:latest detect --source="/path" -v --enable-rule="pypi-upload-token"`
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/duchess.md

Challenge: *Twiddledum - 200*

- http://localhost:8000/challenges#Twiddledum-6
- Scenario:
  - The flag is under `process.env.FLAG6`.
  - You can't interact with *Wonderland/Twiddledum repository.*
  - The *Wonderland/Twiddledum* repository is a JS app that uses *Wonderland/Twiddledee* as a dependency. View its *package.json* file.
  - Trying to add pre or post-install scripts with malicious code should fail, as the *Twiddledum* pipeline runs with the `--ignore-scripts` param.
    - https://docs.npmjs.com/cli/v9/using-npm/scripts
- Solution:
  - *Dependency Chain Abuse*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/twiddledum.md

Challenge: *Dodo - 200*

- http://localhost:8000/challenges#Dodo-7
- Scenario:
  - Your mission is to make the *dodo* S3 bucket public-readable without getting caught.
    - The flag will be printed in the job's console output once you're done.
  - *Checkov* (https://github.com/bridgecrewio/checkov) validates that the S3 bucket created by the Terraform code is private, which stops you from making it public.
  - https://registry.terraform.io/providers/hashicorp/aws/latest/docs/resources/s3_bucket_acl
  - https://www.checkov.io/2.Basics/Hard%20and%20soft%20fail.html
- Solution:
  - *Insufficient Flow Control Mechanisms*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/dodo.md

Challenge: *Dormouse - 300*

- http://localhost:8000/challenges#Dormouse-9
- Scenario:
  - You can't interact with *Wonderland/dormouse* repository.
  - The *Jenkinsfile* uses a *reportcov.sh* script.
  - *Cov/reportcov* is a public repository of a 3rd party used by other CI pipelines.
    - It has its own Jenkins job, which you can't view, creating an artifact stored remotely, i.e. *reportcov.sh*.
    - All this can be viewed via the *Jenkinsfile*.
    - You can't interact with the repository.
- Solution:
  - *Ungoverned Usage of 3rd Party Services*
  - *Improper Artifact Integrity Validation*
  - **You could need external tools for this!**
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/dormouse.md
    - Error in the solution: the command to craft *reportcov.sh* is wrong, here the correct one → `echo 'echo "${FLAG}" | base64' > reportcov.sh`

Challenge: *Mock Turtle - 300*

- http://localhost:8000/challenges#Mock%20Turtle-10
- Scenario:
  - Can you push to the *main* branch of the *Wonderland/mock-turtle* repository? Do what's needed to steal the *flag10* secret stored in the Jenkins credential store.
  - The pipeline is used to automatically merge code into the *main* branch if it introduces just a version bump (stored in the *version* file).
- Solution:
  - *Insufficient Flow Control Mechanisms*
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/mock-turtle.md
    - **Pay attention to the `\n` in *version* file! Be sure to remove them!**

Challenge: *Hearts - 300*

- http://localhost:8000/challenges#Hearts-8
- Scenario:
  - You have to exfiltrate *agent* System credentials stored on Jenkins via a user that has privileged access to manage agents.
  - The users in the Jenkins instance are managed by Jenkins' own user database, which lacks basic security controls against various types of attacks, e.g., credentials bruteforce attempts.
  - http://localhost:8080/asynchPeople/
  - https://www.jenkins.io/blog/2022/12/27/run-jenkins-agent-as-a-service/ (Jenkins version is different)
    - http://localhost:8080/computer/
- Solution:
  - *Inadequate Identity and Access Management*
  - Let's skip the bruteforce part… If you need a password, it's "*rockme*".
  - **You could need external tools for this!** To do everything via containers, follow these steps:
    - Launch *SSH-MITM* with:
      - `docker network ls`
      - `docker run --network=<the_goat_network_name_retrieved_before> --name evil-jenkins-agent -it --rm positronsecurity/ssh-mitm`
    - Use `evil-jenkins-agent` as host and `2222` as port.
    - Check for incoming connections entering in the container:
      - `docker exec -it evil-jenkins-agent /bin/bash`
      - `ls /home/ssh-mitm/log/`
      - `cat /home/ssh-mitm/log/sftp_session_*.html`
        - This doesn't make any sense, but it works...
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/hearts.md

Challenge: *Gryphon - 500*

- http://localhost:8000/challenges#Gryphon-11
- Scenario:
  - You've compromised GitLab. The compromised user is the maintainer of *pygryphon/pygryphon* package.
  - You can click the "Explore projects" button to view public projects.
    - http://localhost:4000/explore
  - There are also public projects: *Wonderland/nest-of-gold* and *Wonderland/awesome-app* to which you have read-only access.
  - https://docs.gitlab.com/ee/ci/yaml/
  - https://packaging.python.org/en/latest/tutorials/packaging-projects/
    - https://packaging.python.org/en/latest/specifications/pypirc/
    - https://docs.gitlab.com/ee/user/packages/pypi_repository/#authenticate-with-a-personal-access-token
    - http://localhost:4000/-/profile/personal_access_tokens
- Solution:
  - *Dependency Chain Abuse*
  - *Insufficient Credential Hygiene*
  - **To test/monitor the scheduled executions, use the script in the next slide.**
  - https://github.com/cider-security-research/cicd-goat/blob/main/solutions/gryphon.md
    - `git clone http://localhost:4000/pygryphon/pygryphon.git`
    - Patch the source code and create `.pypirc` file.
    - `python3 -m build`
    - Remove existing packages under http://localhost:4000/pygryphon/pygryphon/-/packages
    - `python3 -m twine upload -r gitlab --config-file .pypirc --verbose dist/*`

Bugged challenge: it fails during the *test* stage! T_T

https://github.com/cider-security-research/cicd-goat/issues/71

Backup