Configuration Manual

MSc Research Project
Cloud Computing

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Project Submission Sheet
School of Computing

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Configuration Manual

Anjali Sandeep Wagaskar
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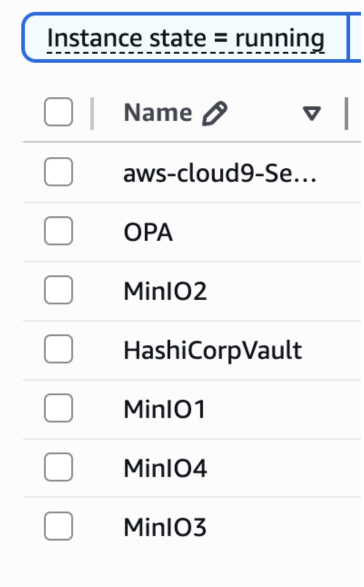
1 Prerequisites on EC2

EC2 instances running Ubuntu 20.04 or Amazon Linux 2 At least 4 vCPU, 8GB RAM recommended Security Groups configured to allow:

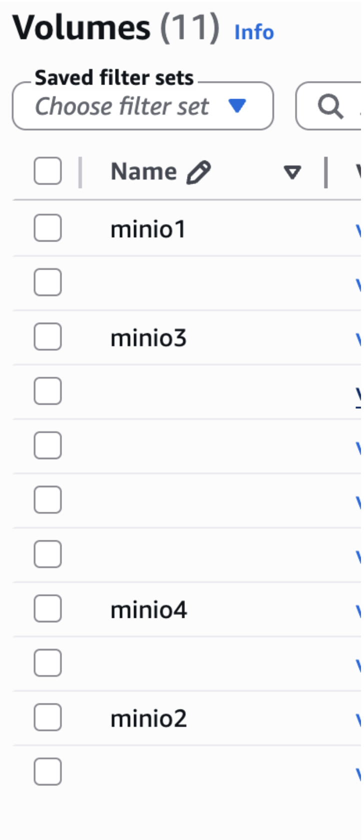
- SSH (port 22) from your IP
- Vault port (8200) between app and Vault instances
- OPA port (8181) open internally
- MinIO port (9000) open internally or externally based on use
- FastAPI port (8000) open to your client IP or public
- Attached EBS volumes or instance store for MinIO data



Instance state = running

□	Name
□	aws-cloud9-Se...
□	OPA
□	MinIO2
□	HashiCorpVault
□	MinIO1
□	MinIO4
□	MinIO3

Figure 1: configured ec2



□	Name
□	minio1
□	
□	minio3
□	
□	
□	
□	
□	minio4
□	
□	minio2
□	

Figure 2: set and attach EBS volume on all 4 instances

2 Environment Setup on EC2 Instances

2.1 Update and install dependencies

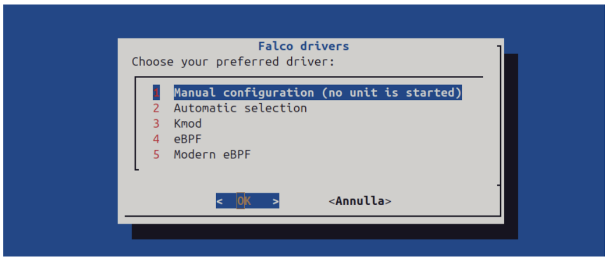
```
sudo apt update && sudo apt upgrade -y

sudo apt install -y wget curl unzip python3 python3-pip
```

2.2 Falco Installation and Configuration on EC2

set up according to installation guide of falco on there official site(Falco Security Project; 2025).

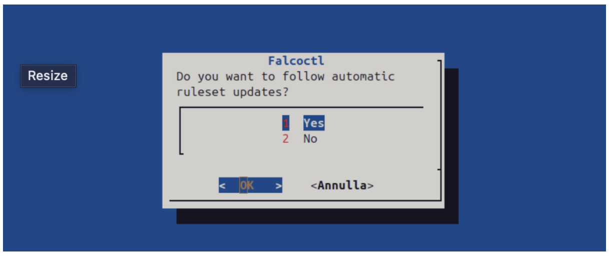
2.2.1 Set up the package repository

```
curl -fsSL https://falco.org/repo/falcosecurity-packages.asc | \
sudo gpg --dearmor -o /usr/share/keyrings/falco-archive-keyring.gpg
sudo bash -c 'cat << EOF > /etc/apt/sources.list.d/falcosecurity.list
deb [signed-by=/usr/share/keyrings/falco-archive-keyring.gpg] https://download.falco.
EOF'
sudo apt-get update -y
```



```
Falco drivers
Choose your preferred driver:

1  Manual configuration (no unit is started)
2  Automatic selection
3  Kmod
4  eBPF
5  Modern eBPF

<  OK  >          <Annulla>
```

Figure 3: Choose the Modern eBPF option



```
Falcoctl
Do you want to follow automatic
ruleset updates?

1  Yes
2  No

<  OK  >     <Annulla>
```

Figure 4: Choose YES

2.2.2 Install dialog

```
sudo apt-get install -y dialog
```

2.2.3 Install Falco

```
sudo apt-get install -y falco
```

Then select "Modern eBPF" option on the prompt,doyou want to follow autometic rules select "yes", and this enable the usage of the modern eBPF-based driver34.

make sure now if the falco server is running :

```
sudo systemctl status falco-modern-bpf.service
```

once everything is set configure falco rules in 5

```
/etc/falco/falco_rules.local.yaml
```

add this:

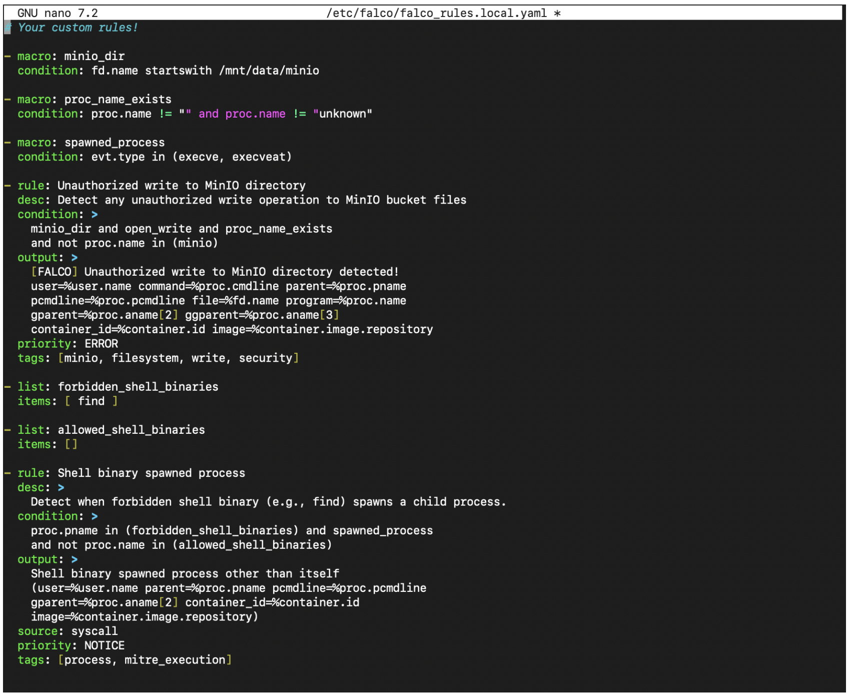
```
 macro: minio_dir
condition: fd.name startswith /mnt/data/minio
```

- `macro: proc_name_exists`
  `condition: proc.name != "" and proc.name != "unknown"`

- `macro: spawned_process`
  `condition: evt.type in (execve, execveat)`

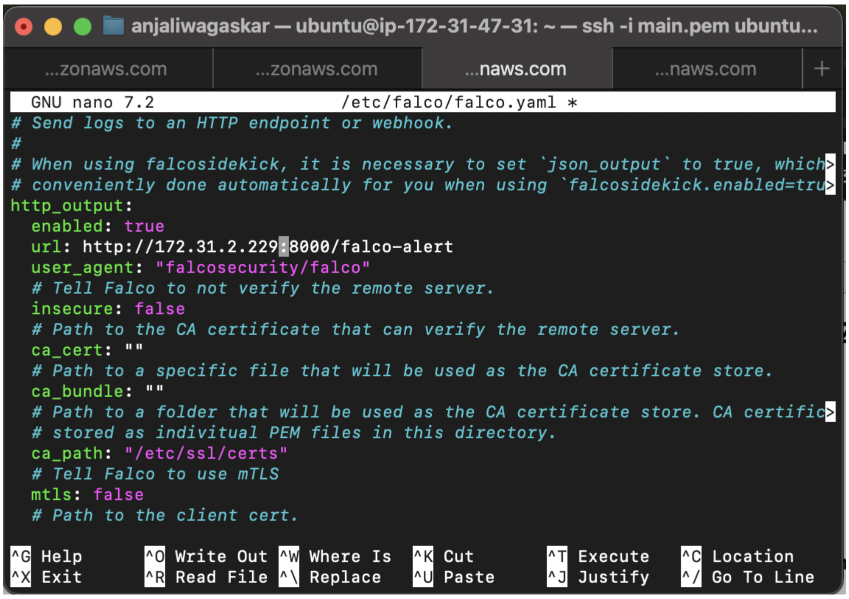
- `rule: Unauthorized write to MinIO directory`
  `desc: Detect any unauthorized write operation to MinIO bucket files`
  `condition: >`

```
    minio_dir and open_write and proc_name_exists
    and not proc.name in (minio)
  output: >
    [FALCO] Unauthorized write to MinIO directory detected!
    user=%user.name command=%proc.cmdline parent=%proc.pname
    pcmdline=%proc.pcmdline file=%fd.name program=%proc.name
    gparent=%proc.aname[2] ggparent=%proc.aname[3]
    container_id=%container.id image=%container.image.repository
  priority: ERROR
  tags: [minio, filesystem, write, security]

- list: forbidden_shell_binaries
  items: [ find ]

- list: allowed_shell_binaries
  items: []

- rule: Shell binary spawned process
  desc: >
    Detect when forbidden shell binary (e.g., find) spawns a child process.
  condition: >
    proc.pname in (forbidden_shell_binaries) and spawned_process
    and not proc.name in (allowed_shell_binaries)
  output: >
    Shell binary spawned process other than itself
    (user=%user.name parent=%proc.pname pcmdline=%proc.pcmdline
    gparent=%proc.aname[2] container_id=%container.id
    image=%container.image.repository)
  source: syscall
  priority: NOTICE
  tags: [process, mitre_execution]
```



```
GNU nano 7.2                    /etc/falco/falco_rules.local.yaml *
# Your custom rules!

- macro: minio_dir
  condition: fd.name startswith /mnt/data/minio

- macro: proc_name_exists
  condition: proc.name != "" and proc.name != "unknown"

- macro: spawned_process
  condition: evt.type in (execve, execveat)

- rule: Unauthorized write to MinIO directory
  desc: Detect any unauthorized write operation to MinIO bucket files
  condition: >
    minio_dir and open_write and proc_name_exists
    and not proc.name in (minio)
  output: >
    [FALCO] Unauthorized write to MinIO directory detected!
    user=%user.name command=%proc.cmdline parent=%proc.pname
    pcmdline=%proc.pcmdline file=%fd.name program=%proc.name
    gparent=%proc.aname[2] ggparent=%proc.aname[3]
    container_id=%container.id image=%container.image.repository
  priority: ERROR
  tags: [minio, filesystem, write, security]

- list: forbidden_shell_binaries
  items: [ find ]

- list: allowed_shell_binaries
  items: []

- rule: Shell binary spawned process
  desc: >
    Detect when forbidden shell binary (e.g., find) spawns a child process.
  condition: >
    proc.pname in (forbidden_shell_binaries) and spawned_process
    and not proc.name in (allowed_shell_binaries)
  output: >
    Shell binary spawned process other than itself
    (user=%user.name parent=%proc.pname pcmdline=%proc.pcmdline
    gparent=%proc.aname[2] container_id=%container.id
    image=%container.image.repository)
  source: syscall
  priority: NOTICE
  tags: [process, mitre_execution]
```

Figure 5: setting up rules



```
GNU nano 7.2                    /etc/falco/falco.yaml *
# Send logs to an HTTP endpoint or webhook.
#
# When using falcosidekick, it is necessary to set `json_output` to true, which>
# conveniently done automatically for you when using `falcosidekick.enabled=tru>
http_output:
  enabled: true
  url: http://172.31.2.229:8000/falco-alert
  user_agent: "falcosecurity/falco"
  # Tell Falco to not verify the remote server.
  insecure: false
  # Path to the CA certificate that can verify the remote server.
  ca_cert: ""
  # Path to a specific file that will be used as the CA certificate store.
  ca_bundle: ""
  # Path to a folder that will be used as the CA certificate store. CA certific>
  # stored as indivitual PEM files in this directory.
  ca_path: "/etc/ssl/certs"
  # Tell Falco to use mTLS
  mtls: false
  # Path to the client cert.
```

Figure 6: providing url where you want to print alert

then restart falco

```
sudo systemctl restart falco
```

3 HashiCorp Vault Installation and Setup on EC2

install vault according to the hashicorp vault installation guide(HashiCorp; 2025)
Download Vault binary

```
wget https://releases.hashicorp.com/vault/1.12.0/vault_1.12.0_linux_amd64.zip
unzip vault_1.12.0_linux_amd64.zip
sudo mv vault /usr/local/bin/
```

Configure Vault server Example for dev mode

```
vault server -dev -dev-root-token-id="root" -dev-listen-address="0.0.0.0:8200" &
```

For production, create a config file /etc/vault/config.hcl:

```
storage "file" {
  path = "/mnt/data/vault"
}

listener "tcp" {
  address = "0.0.0.0:8200"
  tls_disable = 1
}

ui = true
```

then start server in production

```
vault server -config=/etc/vault/config.hcl &
```

Export environment variable on app

```
export VAULT_ADDR='http://<Vault-EC2-IP>:8200'
VAULT_TOKEN='<hvs.currently runing server token>'
vault operator init
vault operator unseal <unseal_key>
vault policy write new-policy ./policy.hcl
vault token create -policy="new-policy"
```

Run OPA server with policy loaded:

```
opa run --server --addr 0.0.0.0:8181 policy.rego
```

4 Open Policy Agent (OPA) Setup on EC2

use user guide to install OPA(Lee; 2022). Download and install OPA binary:

```
wget https://openpolicyagent.org/downloads/latest/opa_linux_amd64
chmod +x opa_linux_amd64
sudo mv opa_linux_amd64 /usr/local/bin/opa
```

Place your policy.rego on the EC2 instance (e.g., /home/ubuntu/policy.rego)

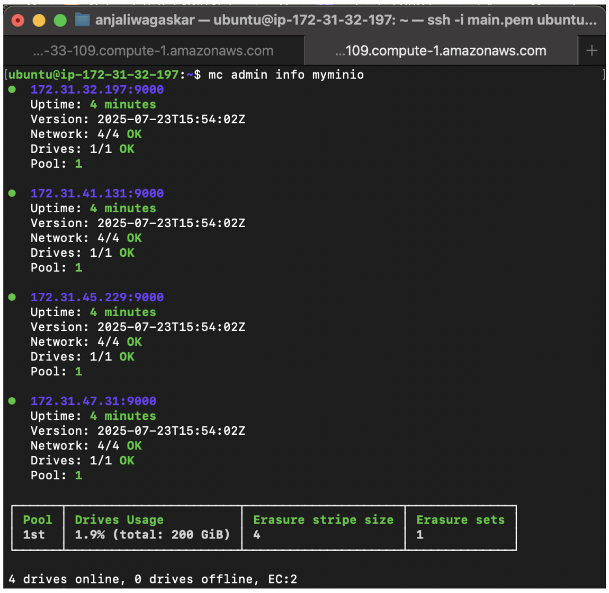
```
package main

default allow := false
```

```
roles := {
 "manager": {"allowed_endpoints": [
                {"path": "/v1/secret/myapp", "actions": ["read", "create", "updat
                {"path": "api/login/token", "actions": ["read"]},
        ]},
 "employee": {"allowed_endpoints": [
                {"path": "/v1/secret/myapp", "actions": ["read", "create"]},
                {"path": "api/login/token", "actions": ["read"]},
        ]},
 "admin": {"allowed_endpoints": []},
}

allow if {
 is_admin
}
    has_path_perms if {
 ae := roles[input.roles[_]].allowed_endpoints[_]
 not endswith(ae.path, "*")
 input.path == ae.path
 input.action in ae.actions
}

has_path_perms if {
 ae := roles[input.roles[_]].allowed_endpoints[_]
 endswith(ae.path, "*")
 startswith(input.path, trim_suffix(ae.path, "*"))
 input.action in ae.actions
}
```

5 MinIO Installation and Setup on EC2

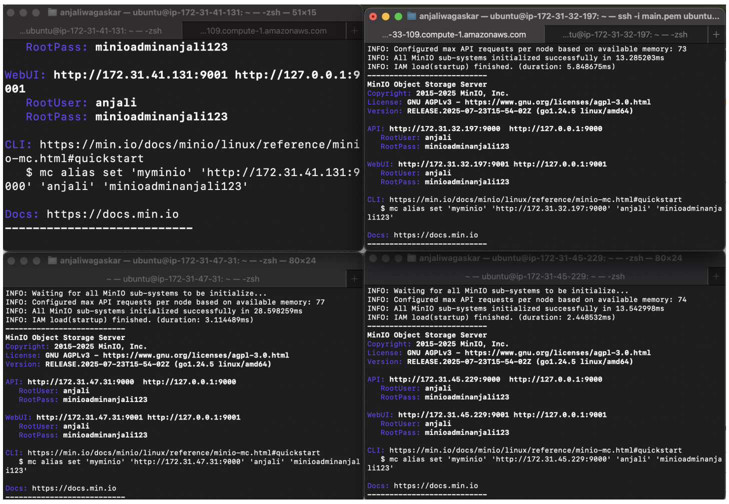
install MinIO from there official installation set up in distributed manner(Hernandez; 2022). system: ubantu 20.04 run every command on all the systems : Note: 10.0.0.1 should be the private IP of every system

```
sudo apt update && sudo apt upgrade -y

sudo apt install wget unzip -y

sudo useradd -r minio-user -s /sbin/nologin

sudo mkdir -p /mnt/data/minio
sudo chown -R minio-user:minio-user /mnt/data/minio

wget https://dl.min.io/server/minio/release/linux-amd64/minio
chmod +x minio
sudo mv minio /usr/local/bin/
sudo bash -c 'cat > /etc/systemd/system/minio.service <<EOF

[Unit]
Description=MinIO
After=network.target

[Service]
User=minio-user
Group=minio-user
Environment="MINIO_ACCESS_KEY=admin"
Environment="MINIO_SECRET_KEY=password123"
ExecStart=/usr/local/bin/minio server \\
 http://10.0.0.1/mnt/data/minio \\
 http://10.0.0.2/mnt/data/minio \\
 http://10.0.0.3/mnt/data/minio \\
 http://10.0.0.4/mnt/data/minio
Restart=always
LimitNOFILE=65536

[Install]
WantedBy=multi-user.target
EOF'

sudo systemctl daemon-reload
sudo systemctl enable minio
sudo systemctl start minio
```


anjaliwagaskar — ubuntu@ip-172-31-32-197: ~ — ssh -i main.pem ubuntu...
...-33-109.compute-1.amazonaws.com
...109.compute-1.amazonaws.com

```
ubuntu@ip-172-31-32-197:~$ mc admin info myminio
●  172.31.32.197:9000
   Uptime: 4 minutes
   Version: 2025-07-23T15:54:02Z
   Network: 4/4 OK
   Drives: 1/1 OK
   Pool: 1

●  172.31.41.131:9000
   Uptime: 4 minutes
   Version: 2025-07-23T15:54:02Z
   Network: 4/4 OK
   Drives: 1/1 OK
   Pool: 1

●  172.31.45.229:9000
   Uptime: 4 minutes
   Version: 2025-07-23T15:54:02Z
   Network: 4/4 OK
   Drives: 1/1 OK
   Pool: 1

●  172.31.47.31:9000
   Uptime: 4 minutes
   Version: 2025-07-23T15:54:02Z
   Network: 4/4 OK
   Drives: 1/1 OK
   Pool: 1

┌──────┬──────────────────────────┬──────────────────────┬───────────────┐
│ Pool │ Drives Usage             │ Erasure stripe size  │ Erasure sets  │
│ 1st  │ 1.9% (total: 200 GiB)    │ 4                    │ 1             │
└──────┴──────────────────────────┴──────────────────────┴───────────────┘

4 drives online, 0 drives offline, EC:2
```

Figure 7: distributed setup showing drivers running



anjaliwagaskar — ubuntu@ip-172-31-41-131: ~ — -zsh — 51×15
...ubuntu@ip-172-31-41-131: ~ — -zsh
...109.compute-1.amazonaws.com

```
   RootPass: minioadminanjali123

WebUI: http://172.31.41.131:9001 http://127.0.0.1:9
001
   RootUser: anjali
   RootPass: minioadminanjali123

CLI: https://min.io/docs/minio/linux/reference/mini
o-mc.html#quickstart
   $ mc alias set 'myminio' 'http://172.31.41.131:9
000' 'anjali' 'minioadminanjali123'

Docs: https://docs.min.io
---------------------------
```

anjaliwagaskar — ubuntu@ip-172-31-32-197: ~ — ssh -i main.pem ubuntu...
...-33-109.compute-1.amazonaws.com
...tu@ip-172-31-32-197: ~ — -zsh

```
INFO: Configured max API requests per node based on available memory: 73
INFO: All MinIO sub-systems initialized successfully in 13.285203ms
INFO: IAM load(startup) finished. (duration: 5.848675ms)
---------------------------
MinIO Object Storage Server
Copyright: 2015-2025 MinIO, Inc.
License: GNU AGPLv3 - https://www.gnu.org/licenses/agpl-3.0.html
Version: RELEASE.2025-07-23T15-54-02Z (go1.24.5 linux/amd64)

API: http://172.31.32.197:9000  http://127.0.0.1:9000
   RootUser: anjali
   RootPass: minioadminanjali123

WebUI: http://172.31.32.197:9001 http://127.0.0.1:9001
   RootUser: anjali
   RootPass: minioadminanjali123

CLI: https://min.io/docs/minio/linux/reference/minio-mc.html#quickstart
   $ mc alias set 'myminio' 'http://172.31.32.197:9000' 'anjali' 'minioadminanja
li123'

Docs: https://docs.min.io
---------------------------
```

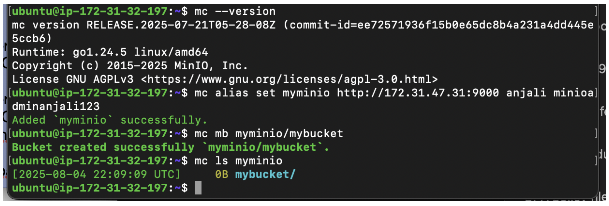
anjaliwagaskar — ubuntu@ip-172-31-47-31: ~ — -zsh — 80×24
~ — ubuntu@ip-172-31-47-31: ~ — -zsh

```
INFO: Waiting for all MinIO sub-systems to be initialize...
INFO: Configured max API requests per node based on available memory: 77
INFO: All MinIO sub-systems initialized successfully in 28.598259ms
INFO: IAM load(startup) finished. (duration: 3.114489ms)
---------------------------
MinIO Object Storage Server
Copyright: 2015-2025 MinIO, Inc.
License: GNU AGPLv3 - https://www.gnu.org/licenses/agpl-3.0.html
Version: RELEASE.2025-07-23T15-54-02Z (go1.24.5 linux/amd64)

API: http://172.31.47.31:9000  http://127.0.0.1:9000
   RootUser: anjali
   RootPass: minioadminanjali123

WebUI: http://172.31.47.31:9001 http://127.0.0.1:9001
   RootUser: anjali
   RootPass: minioadminanjali123

CLI: https://min.io/docs/minio/linux/reference/minio-mc.html#quickstart
   $ mc alias set 'myminio' 'http://172.31.47.31:9000' 'anjali' 'minioadminanjal
i123'

Docs: https://docs.min.io
---------------------------
```

anjaliwagaskar — ubuntu@ip-172-31-45-229: ~ — -zsh — 80×24
~ — ubuntu@ip-172-31-45-229: ~ — -zsh

```
INFO: Waiting for all MinIO sub-systems to be initialize...
INFO: Configured max API requests per node based on available memory: 74
INFO: All MinIO sub-systems initialized successfully in 13.542998ms
INFO: IAM load(startup) finished. (duration: 2.448532ms)
---------------------------
MinIO Object Storage Server
Copyright: 2015-2025 MinIO, Inc.
License: GNU AGPLv3 - https://www.gnu.org/licenses/agpl-3.0.html
Version: RELEASE.2025-07-23T15-54-02Z (go1.24.5 linux/amd64)

API: http://172.31.45.229:9000  http://127.0.0.1:9000
   RootUser: anjali
   RootPass: minioadminanjali123

WebUI: http://172.31.45.229:9001 http://127.0.0.1:9001
   RootUser: anjali
   RootPass: minioadminanjali123

CLI: https://min.io/docs/minio/linux/reference/minio-mc.html#quickstart
   $ mc alias set 'myminio' 'http://172.31.45.229:9000' 'anjali' 'minioadminanja
li123'

Docs: https://docs.min.io
---------------------------
```

Figure 8: distributed setup of minio



```
ubuntu@ip-172-31-32-197:~$ mc --version
mc version RELEASE.2025-07-21T05-28-08Z (commit-id=ee72571936f15b0e65dc8b4a231a4dd445e
5ccb6)
Runtime: go1.24.5 linux/amd64
Copyright (c) 2015-2025 MinIO, Inc.
License GNU AGPLv3 <https://www.gnu.org/licenses/agpl-3.0.html>
ubuntu@ip-172-31-32-197:~$ mc alias set myminio http://172.31.47.31:9000 anjali minioa
dminanjali123
Added `myminio` successfully.
ubuntu@ip-172-31-32-197:~$ mc mb myminio/mybucket
Bucket created successfully `myminio/mybucket`.
ubuntu@ip-172-31-32-197:~$ mc ls myminio
[2025-08-04 22:09:09 UTC]     0B mybucket/
ubuntu@ip-172-31-32-197:~$ 
```

Figure 9: checking if the files are stored and buckets are created

6 FastAPI Application Setup on EC2

create a cloud9 environment Instance type: t2.micro (1 GiB RAM + 1 vCPU)

```
python3 -m venv venv
source venv/bin/activate
pip install -r requirements.txt
uvicorn app:app --host 0.0.0.0 --reload
```

References

Falco Security Project (2025). Try falco on linux - quickstart guide. Accessed: 2025-08-10.
URL: *https://falco.org/docs/getting-started/falco-linux-quickstart/install-falco-1*

HashiCorp (2025). Install vault. Accessed: 2025-08-10.
URL: *https://developer.hashicorp.com/vault/install*

Hernandez, C. C. (2022). How to install minio in distributed mode on aws ec2. Accessed: 2025-08-11.
URL: *https://blog.min.io/install-minio-distributed-mode-aws-ec2/*

Lee, S. (2022). *Chap 2. OPA Installation and Usage*, OPA Guidebook. Accessed: 2025-08-11.
URL: *https://sangkeon.github.io/opaguide/chap2/installandusage.html*