# Configuration Manual

MSc Research Project
Cloud Computing


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# Configuration Manual

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## 1 Introduction

This document provides the steps to create and install the required softwares, tools and files to perform the research mentioned in research report with title “Enhancing Microservices Resilience: Chaos Engineering with Istio Service Mesh on Kubernetes”.

## 2 Deploying Kubernetes Cluster on Google Kubernetes Engine

To deploy a Kubernetes cluster on GKE, first we create a kubernetes cluster using the UI of Google Cloud as in figure 1 and 2. We will select the standard creation and provide the necessary details like cluster name, location, zone, type and memory Google Cloud (2023).

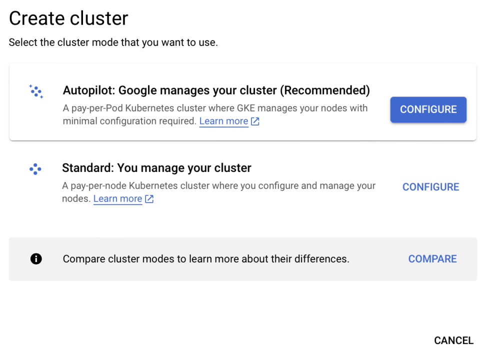



Figure 1: Cluster Modes

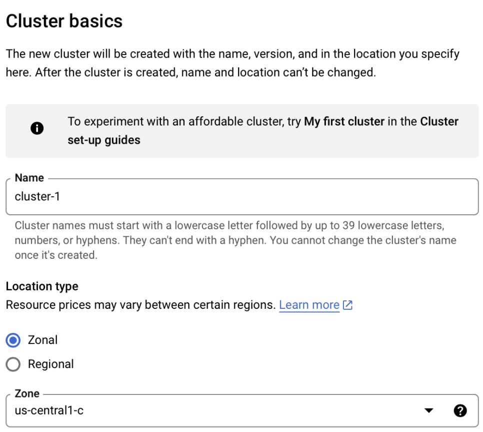
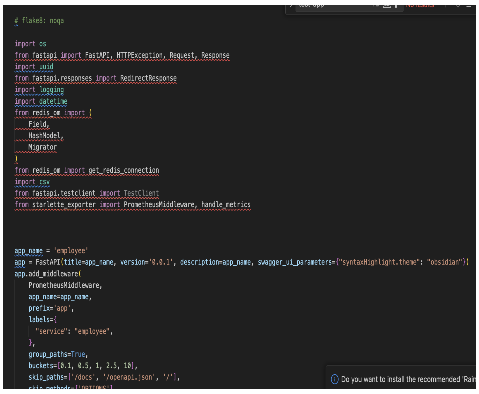



Figure 2: Cluster Configurations

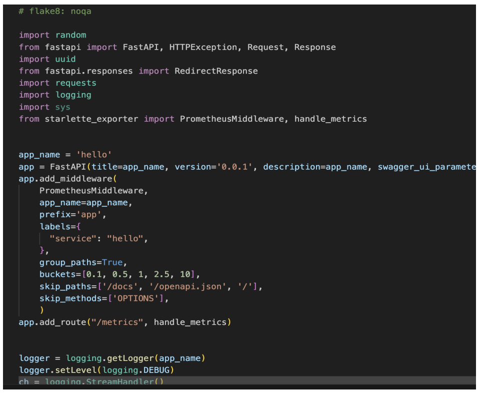
## 3 Microservices application creation and deployment

### 3.1 Building the Microservices

Two microservices named test-app-hello and test-app-employee are created using python FastAPI as in figure 3.



(a) test-app-employee main.py




(b) test-app-hello main.py

Figure 3: Application Code

## 3.2 Application UI

The application looks like as in figure 4.

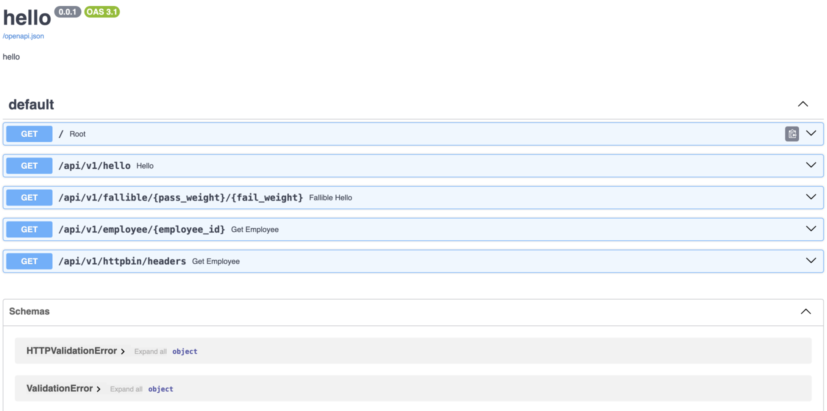



Figure 4: Application UI

## 3.3 REDIS Deployment

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name:  redis
  namespace: test-app
  labels:
    app:  redis
spec:
  selector:
    matchLabels:
      app: redis
```

```
  replicas: 1
  strategy:
    rollingUpdate:
      maxSurge: 25%
      maxUnavailable: 25%
    type: RollingUpdate
  template:
    metadata:
      labels:
        app:  redis
    spec:
      containers:
      - name: redis
        image: docker.io/redis/redis-stack-server:latest
        resources:
          limits:
            memory: 128Mi
          requests:
            memory: 128Mi
        livenessProbe:
          tcpSocket:
            port: 6379
          initialDelaySeconds: 3
          timeoutSeconds: 2
          successThreshold: 1
          failureThreshold: 3
          periodSeconds: 10
        readinessProbe:
          tcpSocket:
            port: 6379
          initialDelaySeconds: 3
          timeoutSeconds: 2
          successThreshold: 1
          failureThreshold: 3
          periodSeconds: 10
        ports:
        - containerPort: 6379
          name:  redis
      restartPolicy: Always
```

## 3.4 Deploying the application

Docker image is created for the microservices and pushed to docker as in figure 6. The same image name is used in YAML file for the deployment. The microservice will be deployed by running below command.

```yaml
apiVersion: v1
kind: Service
metadata:
  name: test-app-hello-int
  labels:
    app: test-app-hello
spec:
  type: ClusterIP
  selector:
    app: test-app-hello
  ports:
    - name: http
      port: 80
      targetPort: 8000
---
apiVersion: v1
kind: Service
metadata:
  name: test-app-hello
spec:
  type: LoadBalancer
  selector:
    app: test-app-hello
  ports:
    - name: http
      port: 80
      targetPort: 8000
```

Figure 5: Exposing test-app-hello

```
#kubectl apply -f test-app-hello.yaml
```

```
shubham4294singh@cloudshell:~$ kubectl get pods --all-namespaces -o=jsonpath='{range .items[*]}{.spec.containers[*].image}{"\n"}{end}' | sort | uniq
docker.io/hihellobolke/test-app-employee:2 docker.io/istio/proxyv2:1.20.0
docker.io/hihellobolke/test-app-hello:2 docker.io/istio/proxyv2:1.20.0
```

Figure 6: Docker Image

For exposing the application to outside world a service of type load balancer named test-app-hello-ext is created and exposed to outer world on IP-34.134.225.91 as in figure 5.

```
#kubectl apply -f test-app-hello-ext.yaml
```

Once this is done our both microservices are up and running having 1 pod each. But as we will be injecting failures in later stage we need more number of pods. For this edit the deployment yaml file and changed the replica count to 5 for both the microservices.

# 4 Installation and Configuration of Locust on AWS

Locust is installed on AWS EC2 instance, so first create an EC2 instance by logging into AWS account and the configurations of instance is visible in figure 7 Amazon Web Services (2023).

Now connect to created EC2 instance from the local command prompt using SSH.

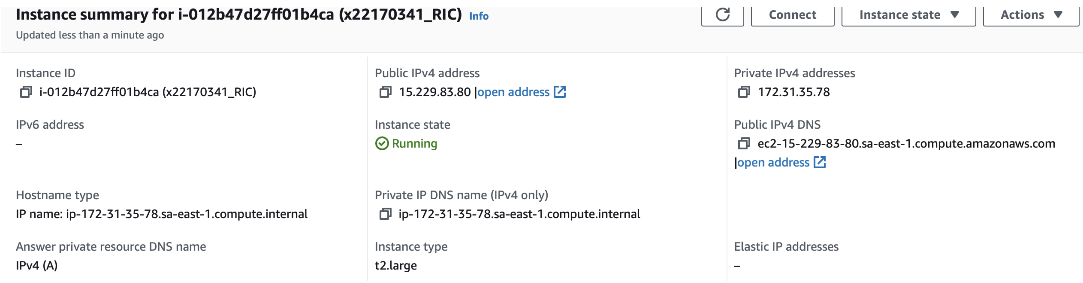



Figure 7: AWS Instance

```
#ssh −i "ric −2.pem" ubuntu@ec2−15−229−83−80.sa−east −1.
    compute.
amazonaws.com
```

Now first install the python on EC2 instance and after that set up a Python virtual environment using Python 3.10.

```
#sudo  apt install python3 − installing python
```

```
 #sudo apt update //Update the package lists to get the
 latest available versions
 #sudo apt install python3.10−venv //Install Python 3.10
     venv package
# python3.10 −m venv .venv //Create a virtual environment
     named .venv
 using Python 3.10
```

Now activate the virtual environment using the below command.

```
#source .venv/bin/activate  //Activate the virtual
    environment
```

After running these commands in order, a virtual environment called.venv will be created, activated for usage, and the Python 3.10 venv package will be installed. Any installation or execution of Python-related software will be contained within the virtual environment when it has been activated.

Now install locust using command

```
#pip3 install −r requirements.txt
```

pip reads the requirements.txt file, locates each package mentioned along with its version, and installs them into your Python environment.

Once the installation is complete verify the installation by running the below command as in figure 8.


Figure 8: Locust

# 5 Installation & Configuration of Chaos Engineering

In the GKE cluster create a directory called chaos and inside it write a bash script to inject the failure in the system as in figure 9.

In a Kubernetes cluster, the script restarts a selected number of pods from the test-app-employee deployment. After retrieving a list of ready pods, it chooses a certain number at random and restarts them at a set period of time. The absence of pods is logged for a restart if none of the pods satisfy the requirements.

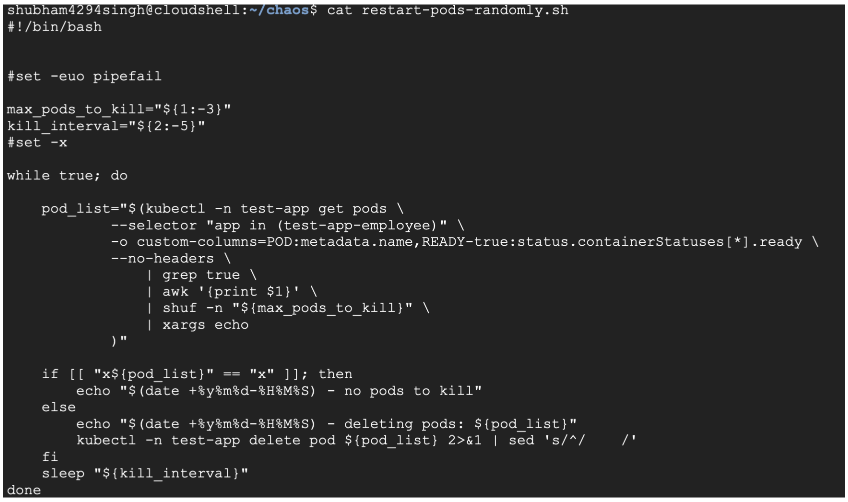



Figure 9: Chaos Engineering Bash Script

# 6 Installation & Configuration of Service Mesh Istio

To install Istio first create a separate namespace called istio-system. Now install Istio and create an ingress gateway and a service called VirtualService as in figure 10 and 11. Istio Documentation (2023).

```
#istioctl install --set values.pilot.env.
    PILOT_ENABLE_STATUS=true --set values.pilot.env.
    PILOT_ENABLE_CONFIG_DISTRIBUTION_TRACKING=true --set
values.global.istiod.enableAnalysis=true
```

Now istio-ingressgateway will be exposed on an external IP at 35.202.105.8. Create Istiod service as type of ClusterIP as in figure 12.

```yaml
apiVersion: networking.istio.io/v1alpha3
kind: VirtualService
metadata:
  name: test-app-hello
spec:
  hosts:
  - "*"
  gateways:
  - test-app-hello-gateway
  http:
  - match:
    - uri:
        prefix: /
    route:
    - destination:
        host: test-app-hello.test-app.svc.cluster.local
        port:
          number: 80
    retries:
      attempts: 3
      perTryTimeout: 2s
      retryOn: gateway-error,connect-failure,refused-stream,500,501,502,503
```

Figure 10: Virtual Services

```yaml
apiVersion: networking.istio.io/v1alpha3
kind: Gateway
metadata:
  name: test-app-hello-gateway
spec:
  selector:
    istio: ingressgateway
  servers:
  - port:
      number: 8080
      name: http
      protocol: HTTP
    hosts:
    - "*"
```

Figure 11: Ingress Gateway

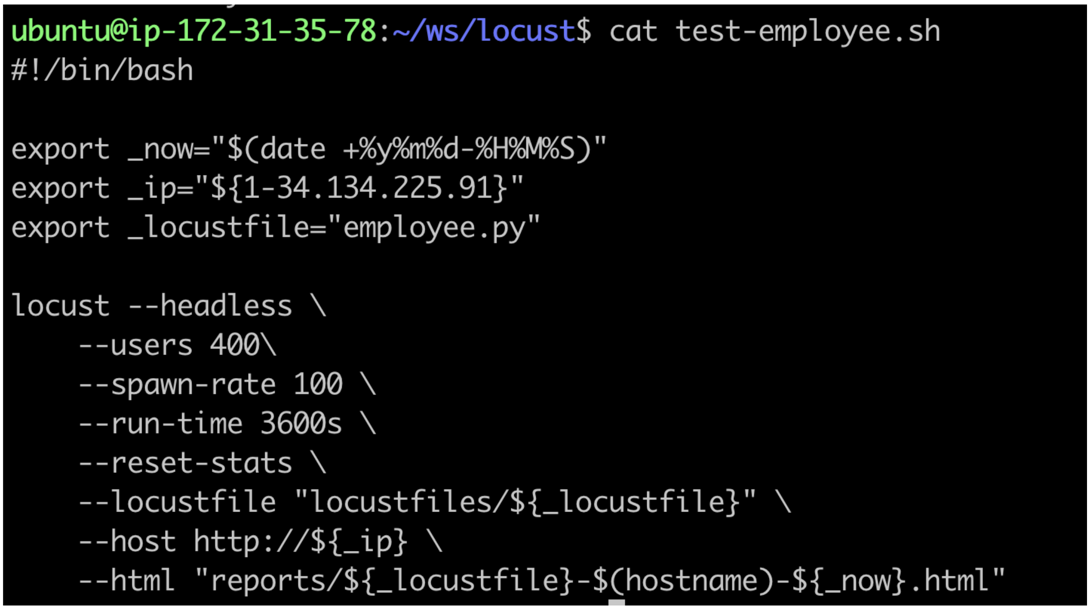
```
shubham4294singh@cloudshell:~/test-app-employee/k8s$ kubectl get services -n istio-system
NAME                   TYPE           CLUSTER-IP     EXTERNAL-IP     PORT(S)                                      AGE
istio-ingressgateway   LoadBalancer   10.100.8.232   35.202.105.82   15021:32478/TCP,80:31924/TCP,443:32653/TCP   11d
istiod                 ClusterIP      10.100.9.173   <none>          15010/TCP,15012/TCP,443/TCP,15014/TCP        11d
```

Figure 12: istio-system Services

# 7 Simulating Load on Microservice

To start load testing and hitting the microservice with large user requests a bash script is written as in figure 13.

Now to run this bash script first make sure the virtual environemnt is activated. After that navigate to path having the bash script. We can run it using **./test-employee.sh**

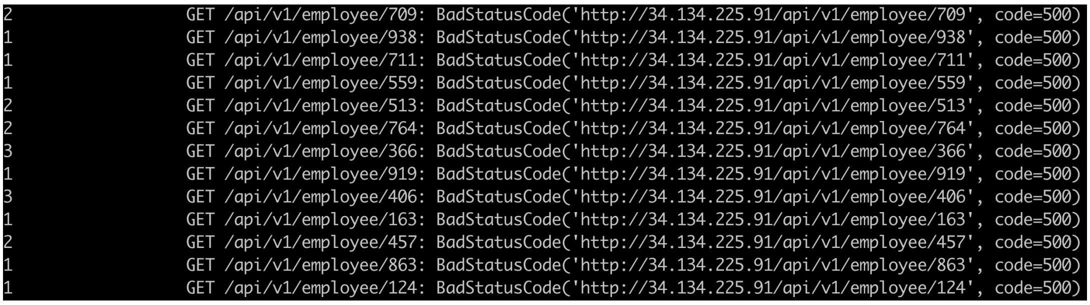


```
ubuntu@ip-172-31-35-78:~/ws/locust$ cat test-employee.sh
#!/bin/bash

export _now="$(date +%y%m%d-%H%M%S)"
export _ip="${1-34.134.225.91}"
export _locustfile="employee.py"

locust --headless \
    --users 400\
    --spawn-rate 100 \
    --run-time 3600s \
    --reset-stats \
    --locustfile "locustfiles/${_locustfile}" \
    --host http://${_ip} \
    --html "reports/${_locustfile}-$(hostname)-${_now}.html"
```

Figure 13: Bash Script-Load Testing



```
2          GET /api/v1/employee/709: BadStatusCode('http://34.134.225.91/api/v1/employee/709', code=500)
1          GET /api/v1/employee/938: BadStatusCode('http://34.134.225.91/api/v1/employee/938', code=500)
1          GET /api/v1/employee/711: BadStatusCode('http://34.134.225.91/api/v1/employee/711', code=500)
1          GET /api/v1/employee/559: BadStatusCode('http://34.134.225.91/api/v1/employee/559', code=500)
2          GET /api/v1/employee/513: BadStatusCode('http://34.134.225.91/api/v1/employee/513', code=500)
2          GET /api/v1/employee/764: BadStatusCode('http://34.134.225.91/api/v1/employee/764', code=500)
3          GET /api/v1/employee/366: BadStatusCode('http://34.134.225.91/api/v1/employee/366', code=500)
1          GET /api/v1/employee/919: BadStatusCode('http://34.134.225.91/api/v1/employee/919', code=500)
3          GET /api/v1/employee/406: BadStatusCode('http://34.134.225.91/api/v1/employee/406', code=500)
1          GET /api/v1/employee/163: BadStatusCode('http://34.134.225.91/api/v1/employee/163', code=500)
2          GET /api/v1/employee/457: BadStatusCode('http://34.134.225.91/api/v1/employee/457', code=500)
1          GET /api/v1/employee/863: BadStatusCode('http://34.134.225.91/api/v1/employee/863', code=500)
1          GET /api/v1/employee/124: BadStatusCode('http://34.134.225.91/api/v1/employee/124', code=500)
```

Figure 14: Locust Execution

## Locust Test Report

During: 26/11/2023, 19:28:38 - 26/11/2023, 19:38:36

Target Host: http://34.134.225.91

Script: employee.py

### Request Statistics

| Method | Name | # Requests | # Fails | Average (ms) | Min (ms) | Max (ms) | Average size (bytes) | RPS | Failures/s |
|---|---|---|---|---|---|---|---|---|---|
| GET | /api/v1/employee/1 | 65 | 0 | 225 | 146 | 4392 | 341 | 0.1 | 0.0 |
| GET | /api/v1/employee/10 | 50 | 0 | 179 | 146 | 442 | 345 | 0.1 | 0.0 |
| GET | /api/v1/employee/100 | 61 | 0 | 169 | 146 | 610 | 353 | 0.1 | 0.0 |
| GET | /api/v1/employee/101 | 54 | 0 | 164 | 145 | 421 | 359 | 0.1 | 0.0 |
| GET | /api/v1/employee/102 | 52 | 0 | 164 | 145 | 386 | 353 | 0.1 | 0.0 |
| GET | /api/v1/employee/103 | 67 | 0 | 260 | 147 | 3737 | 345 | 0.1 | 0.0 |
| GET | /api/v1/employee/104 | 67 | 0 | 205 | 145 | 2984 | 347 | 0.1 | 0.0 |

Figure 15: Locust Test Execution Result

The system searches the current directory for a file called test-employee.sh when you type ./test-employee.sh, then tries to launch it using the default shell interpreter Locust

Documentation (2023).

Once the test run completes will get the result in the form of a .html file as in figure 15 and 16.

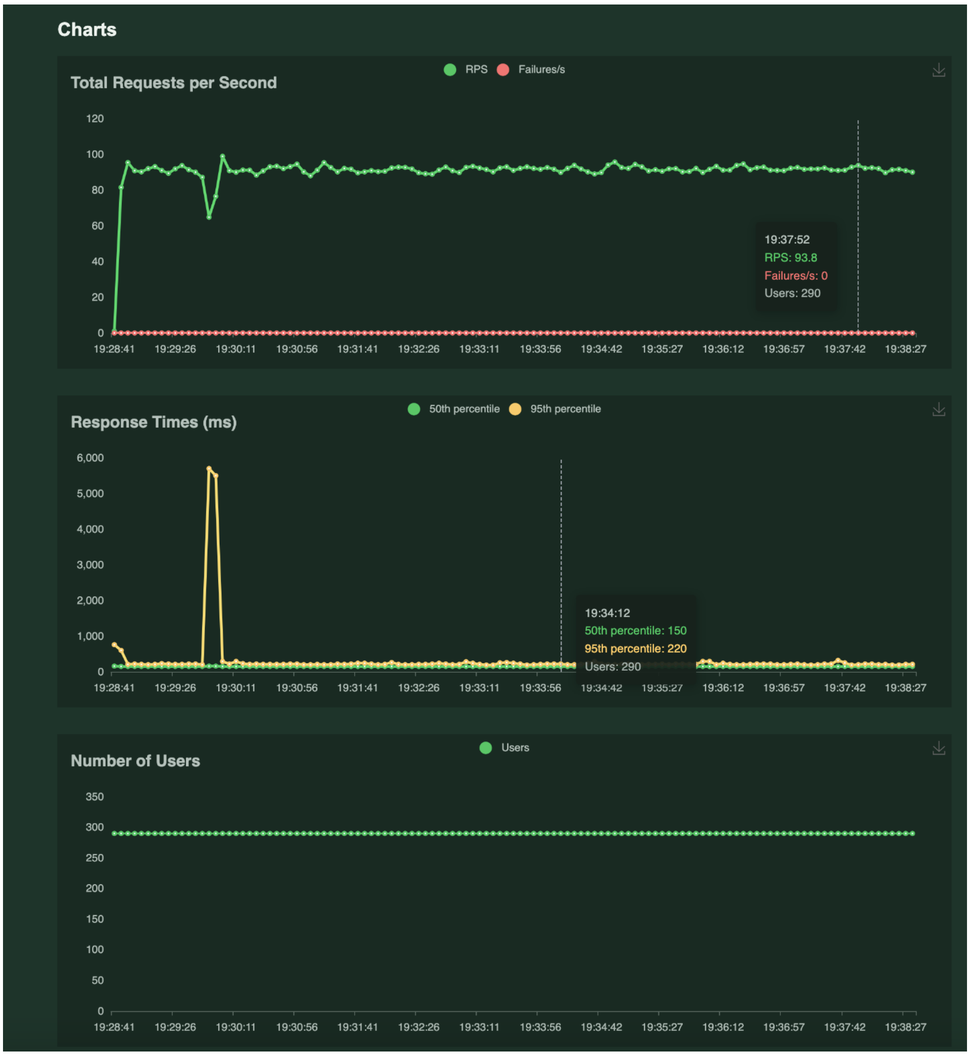



Figure 16: Locust Test Execution Result

# 8 Injecting the Failures

To inject the failure run the restart-pods-randomly.sh bash script.

Keep changing the max_pods_to_kill and kill_interval. Observe the behaviour of microservice everytime the numbers are changed as in figure 17.

```
#max pods to_kill="${1:-3)"
#kill interval="$(2:-5)"
```

```
shubham4294singh@cloudshell:~/chaos$ cat restart-pods-randomly.sh
#!/bin/bash


#set -euo pipefail

max_pods_to_kill="${1:-3}"
kill_interval="${2:-5}"
#set -x

while true; do

    pod_list="$(kubectl -n test-app get pods \
            --selector "app in (test-app-employee)" \
            -o custom-columns=POD:metadata.name,READY-true:status.containerStatuses[*].ready \
            --no-headers \
                | grep true \
                | awk '{print $1}' \
                | shuf -n "${max_pods_to_kill}" \
                | xargs echo
            )"

    if [[ "x${pod_list}" == "x" ]]; then
        echo "$(date +%y%m%d-%H%M%S) - no pods to kill"
    else
        echo "$(date +%y%m%d-%H%M%S) - deleting pods: ${pod_list}"
        kubectl -n test-app delete pod ${pod_list} 2>&1 | sed 's/^/    /'
    fi
    sleep "${kill_interval}"
done
```

Figure 17: Bash Script to Inject Pod Failure

```
shubham4294singh@cloudshell:~/chaos$ ./restart-pods-randomly.sh
231130-212628 - deleting pods: test-app-employee-5458b5f756-2vc8k test-app-employee-5458b5f756-fxwh6 test-app-employee-5458b5f756-gn87x
    pod "test-app-employee-5458b5f756-2vc8k" deleted
    pod "test-app-employee-5458b5f756-fxwh6" deleted
    pod "test-app-employee-5458b5f756-gn87x" deleted
231130-212641 - deleting pods: test-app-employee-5458b5f756-sw749 test-app-employee-5458b5f756-lkbg4 test-app-employee-5458b5f756-zh2hr
    pod "test-app-employee-5458b5f756-sw749" deleted
    pod "test-app-employee-5458b5f756-lkbg4" deleted
    pod "test-app-employee-5458b5f756-zh2hr" deleted
231130-212653 - deleting pods: test-app-employee-5458b5f756-8hlkx test-app-employee-5458b5f756-55nbf test-app-employee-5458b5f756-qz8g8
    pod "test-app-employee-5458b5f756-8hlkx" deleted
    pod "test-app-employee-5458b5f756-55nbf" deleted
    pod "test-app-employee-5458b5f756-qz8g8" deleted
```

Figure 18: Failure Creation

# 9 Running the Istio

To run the locust first we need to enable the istio injection. Open the all.yaml file and comment out the line mentioning istio-injection disabled as in figure 19.

After that delete the deployment for test-app-employee, test-app-hello, and Redis.

```
kubectl delete deployment  test-app-employee test-app-
   hello redis
```

```
#kubectl apply -k.
```

Execute the above command. The command **kubectl apply -k** will read the instructions included in the kustomization.yaml file and apply the appropriate resources to the Kubernetes cluster in accordance with the configurations specified in it.

```
apiVersion: kustomize.config.k8s.io/v1beta1
kind: Kustomization

namespace: test-app

resources:
```

```
– deployments/all.yaml
– ns/all.yaml
– servicemonitor/all.yaml
– svc/all.yaml
– istio/all.yaml
```

After the deployment are available the test can be run with Istio enabled.

```yaml
apiVersion: v1
kind: Namespace
metadata:
  labels:
    # istio-injection: enabled
    istio-injection: disabled
  name: test-app
spec: {}
~
```

Figure 19: Istio-Injection

## References


Amazon Web Services (2023). Amazon ec2 user guide for linux instances. Retrieved November 29, 2023.
**URL:** *https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/concepts.html*

Google Cloud (2023). Deploy an application to a cluster — kubernetes engine documentation. Retrieved November 29, 2023.
**URL:** *https://cloud.google.com/kubernetes-engine/docs/deploy-app-cluster*

Istio Documentation (2023). Installing istio — istio documentation. Retrieved November 29, 2023.
**URL:** *https://istio.io/latest/docs/setup/install/istioctl/*

Locust Documentation (2023). Writing a locustfile — locust documentation. Retrieved November 29, 2023.
**URL:** *https://docs.locust.io/en/stable/writing-a-locustfile.html*