Week 10 DevOps

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Overview

- DevOps
- Fabric
- AWS Lambda

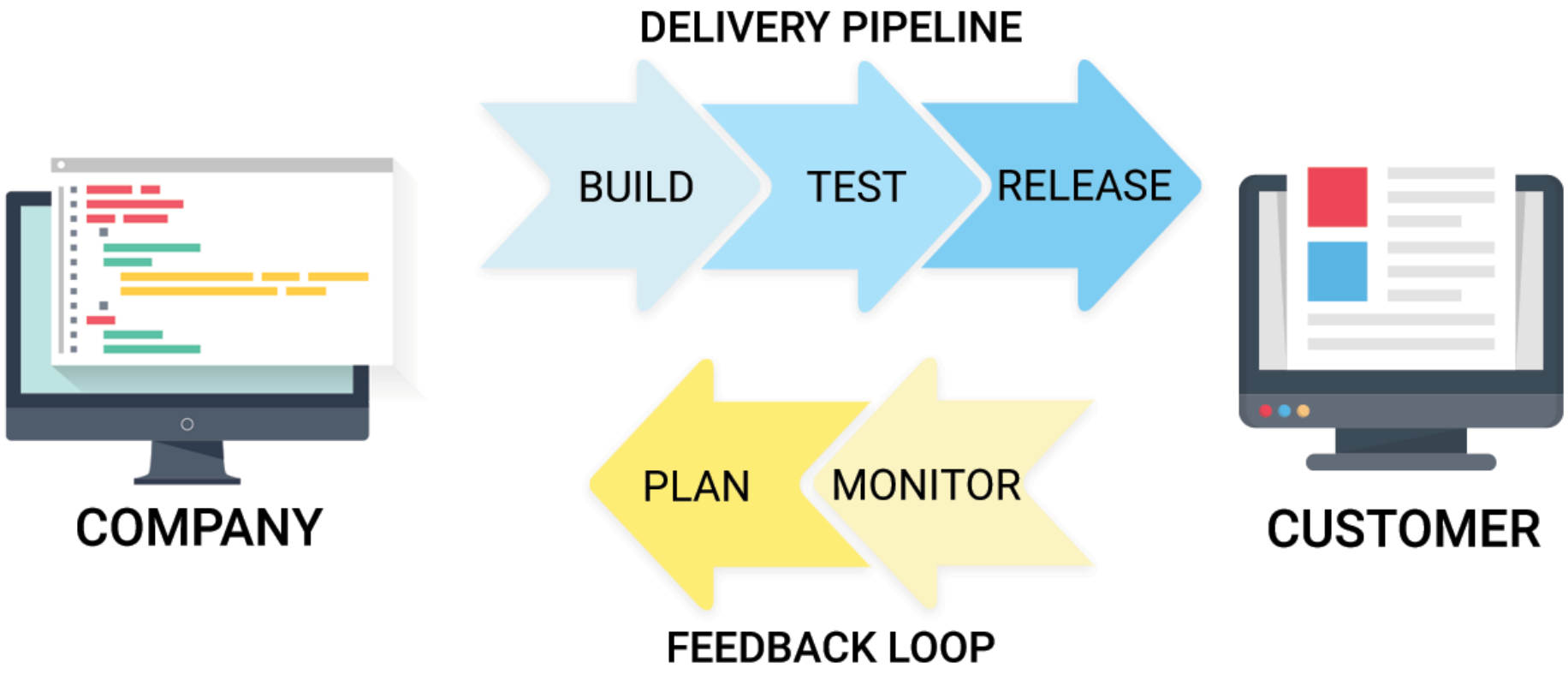
What is DevOps?

- It is a combination of cultural philosophies, practices and tools created to facilitate organizations in delivering services/applications much faster than they can through traditional software development.

What Is DevOps?

https://www.spiceworks.com/tech/devops/articles/what-is-devops/

HOW DEVOPS WORKS



https://www.spiceworks.com/tech/devops/articles/what-is-devops/

DevOps best practices

- Microservice
- Monitoring and Logging
- Continuous Integration
- Continuous Delivery
- Continuous Deployment

DevOps best practices

- Microservice
  - A design approach to build a single application as a set of small services. Each service runs in its own process and communicates with other services through network.
  - Applications are broken into many individual microservices with each microservice scoped to a single purpose or function
  - **Makes the application flexible and enable frequent and small updates.**
  - Example: AWS Lambda.

DevOps best practices

- Monitoring and Logging
  - Organizations monitor metrics and logs to see how application and infrastructure performance impacts the experience of their product's end user.
  - Tracks the performance of applications and infrastructure and detects real-time problems.
  - Example: AWS CloudWatch.

DevOps best practices

- Continuous Integration
- Continuous Delivery
- Continuous Deployment

The software/application release process:

- **Source Control:**
  - Developers use a VCS (Version Control System) to manage and track changes to a code repository.
- Run Build and Unit Tests:
- Deploy to Test Environment:
- Deploy to Production Environment:

The software/application release process:

- Source Control:
- **Run Build and Unit Tests:**
  - Build refers to automatically compiling the code, resolving dependencies, and generating executables for the application.
  - Automated unit tests are executed to ensure that individual components of the application function correctly.
  - Failures in build and unit tests alert the developers.
- Deploy to Test Environment:
- Deploy to Production Environment:

The software/application release process:

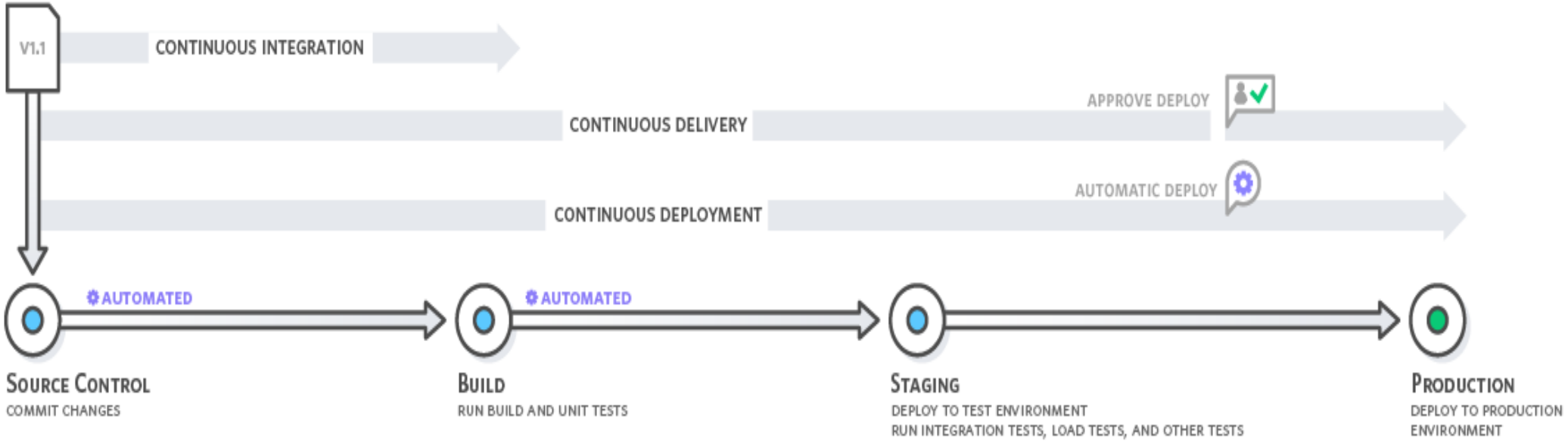
- Source Control:
- Run Build and Unit Tests:
- **Deploy to Test Environment:**
  - Automated deployment to the test environment.
  - Test Environment: a dedicated test environment mirrors the production environment but is isolated for testing purposes.
  - Test includes functional testing, integration testing, workload testing, etc.
- Deploy to Production Environment:

The software/application release process:

- Source Control:
- Run Build and Unit Tests:
- Deploy to Test Environment:
- **Deploy to Production Environment:**
  - The application is deployed to the production environment for serving real users.

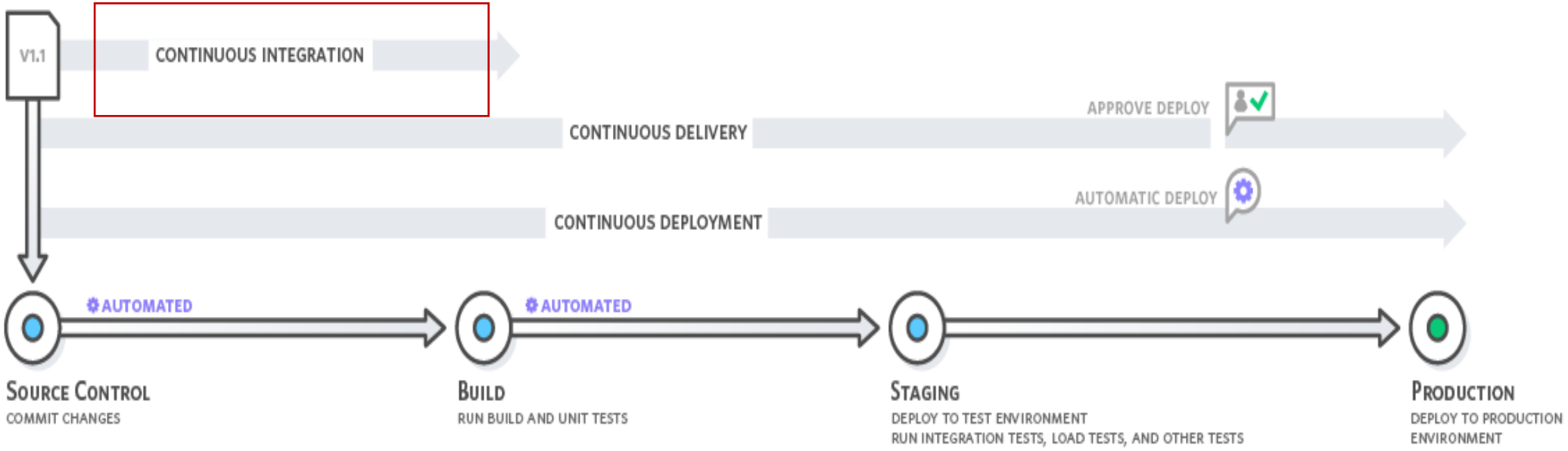
The software/application release process:

- Source Control:
- Run Build and Unit Tests:
- Deploy to Test Environment:
- **Deploy to Production Environment:**



DevOps best practices

- Continuous Integration
  - Every time developers merge their code changes into a central repository, automated builds and tests start: Whenever a change is committed, the automated build and test will be triggered.

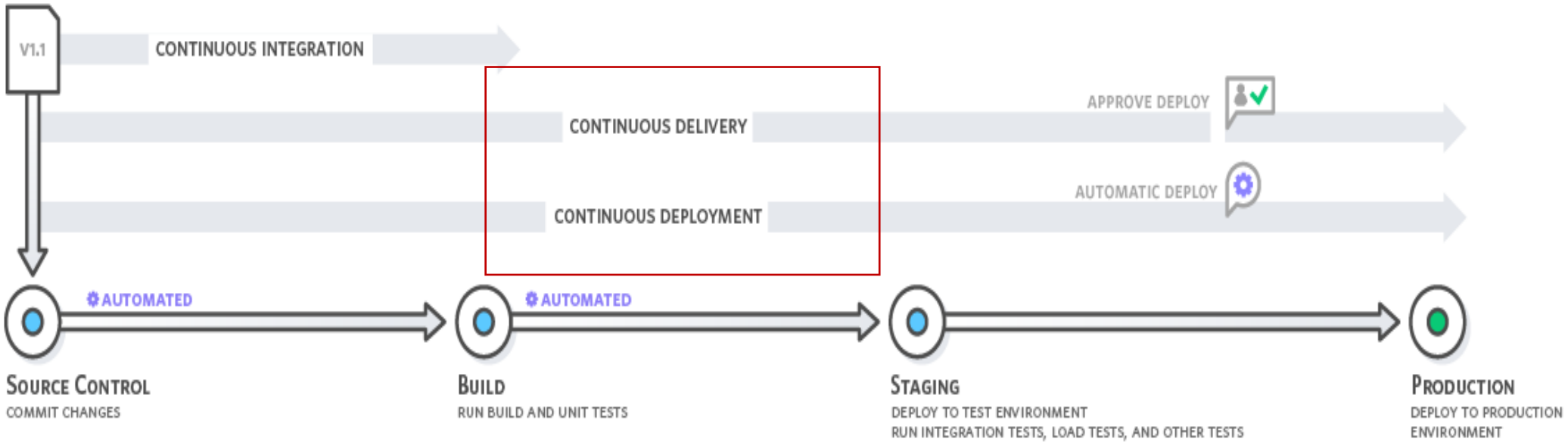


  - **Benefits:** Improve Developer Productivity, Find and Address Bugs Quicker, Deliver Updates Faster

https://aws.amazon.com/devops/continuous-integration/

DevOps best practices

- Continuous Delivery and Continuous Deployment:
  - Expand upon continuous integration by deploying all code changes to a testing environment and/or a production environment after the build stage.



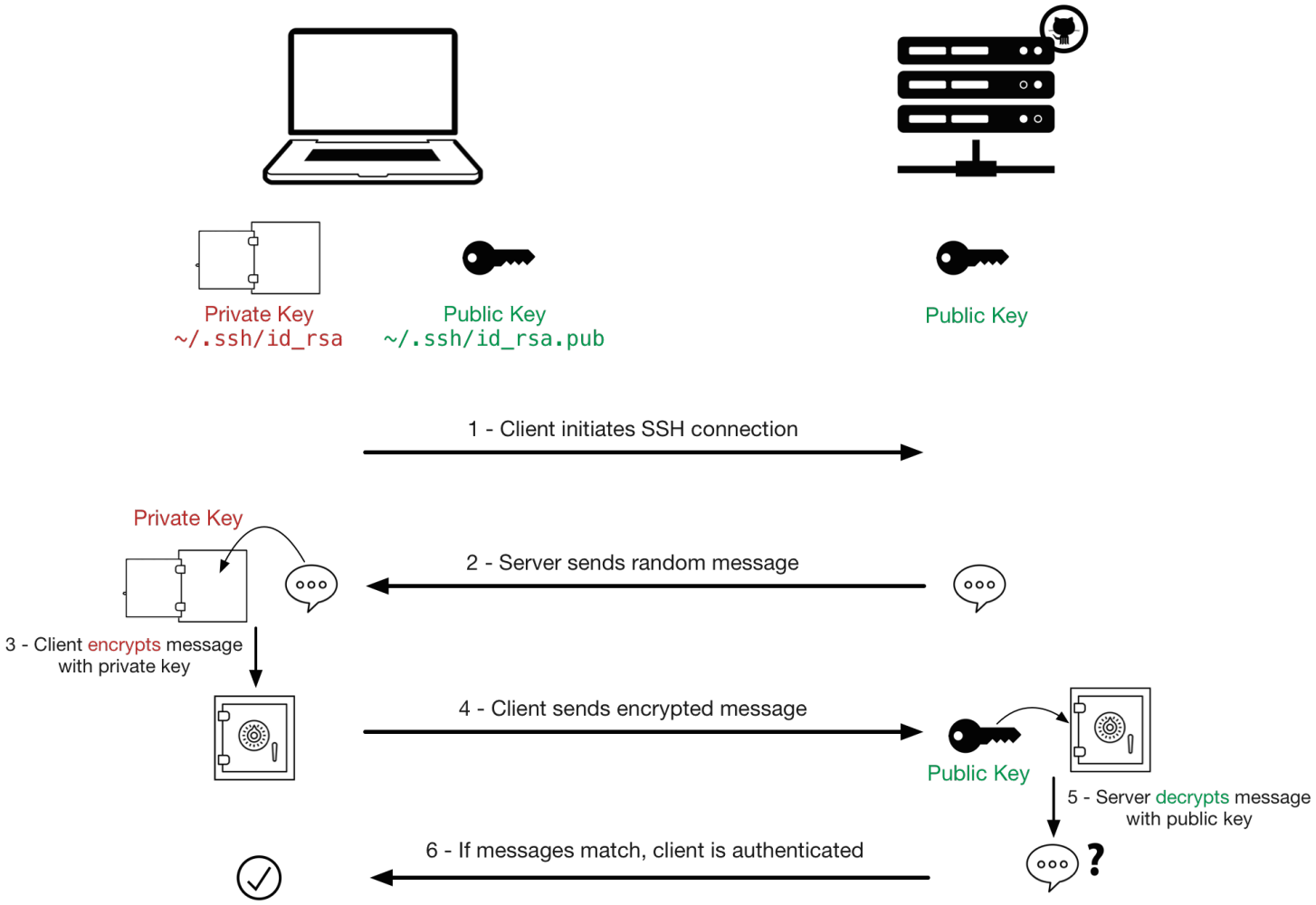
- Benefits: Continuous Integration + Automate the Software Release Process

https://aws.amazon.com/devops/continuous-integration/

Fabric: automate tasks in DevOps

- Fabric is a high level Python library designed to execute shell commands remotely over SSH, yielding useful Python objects in return.
- OpenSSH: a widely used version of the SSH protocol, available on Mac, Linux/Unix and Windows.
- Question: how is OpenSSH used for user/client authentication?

User/Client Authentication in SSH



https://sebastien.saunier.me/blog/2015/05/10/github-public-key-authentication.html

Add the public key to GitHub

1. Check for existing OpenSSH keys:

   ls ~/.ssh

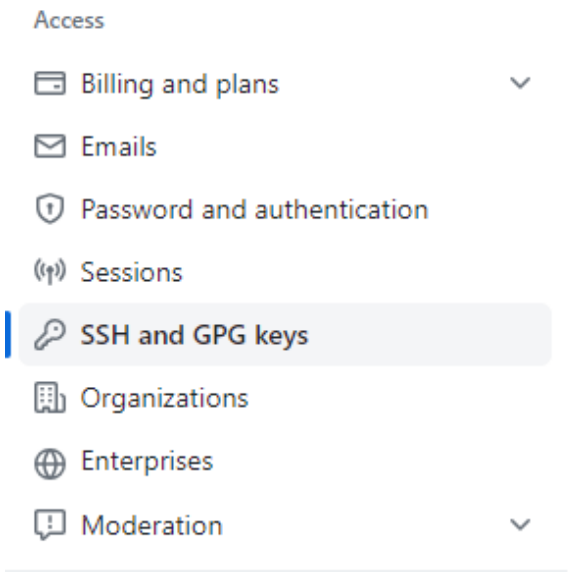
2. Generate OpenSSH keys if no key pairs exist:

   ssh-keygen -t rsa -b 4096 -C email@example.com

   private key: id_rsa

   public key: id_rsa.pub

3. Add the Public Key to GitHub:



How to configure OpenSSH to support Fabric

- Install fabric using: pip install fabric
- Create a config file in ~/.ssh

config

```
Host myFabric
Hostname 3.26.156.206
User ec2-user
UserKnownHostsFile /dev/null
StrictHostKeyChecking no
PasswordAuthentication no
IdentityFile ~/.ssh/myFabricKey.pem
```

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IdentityFile ~/.ssh/myFabricKey.pem
```

Question: Some settings in the configuration above will make the SSH connection NOT secure? What are they? Justify your answer.

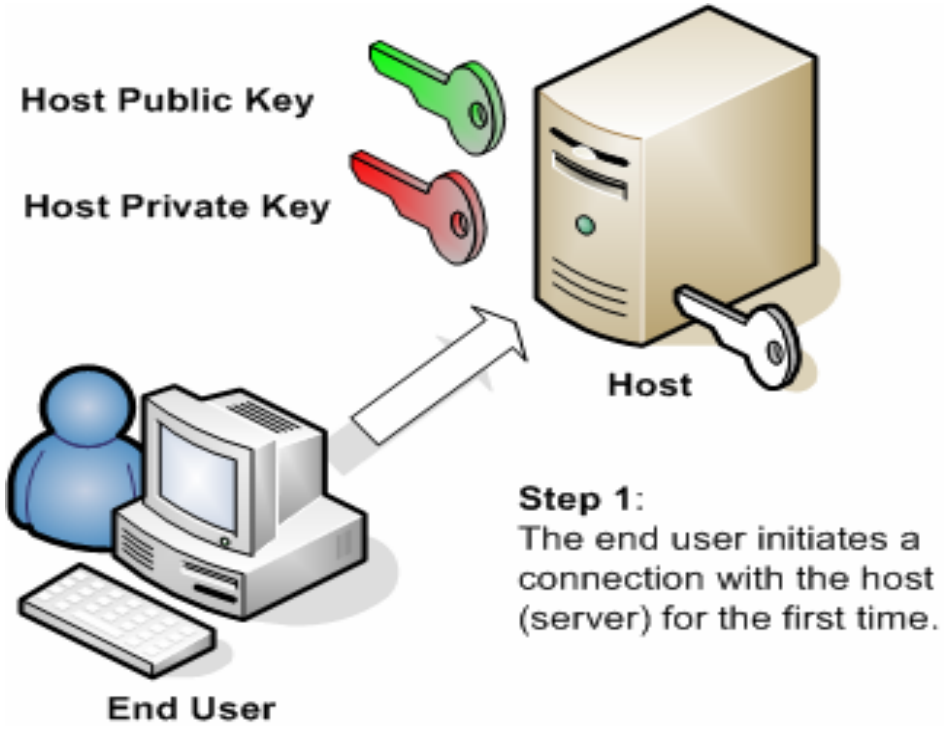
Both “UserKnownHostsFile /dev/null” and “StrictHostKeyChecking yes” have disabled host key checking, making the connection unsecure to the client.

To explain why, we need to be aware of “server/host authentication”.

Server/Host Authentication in SSH

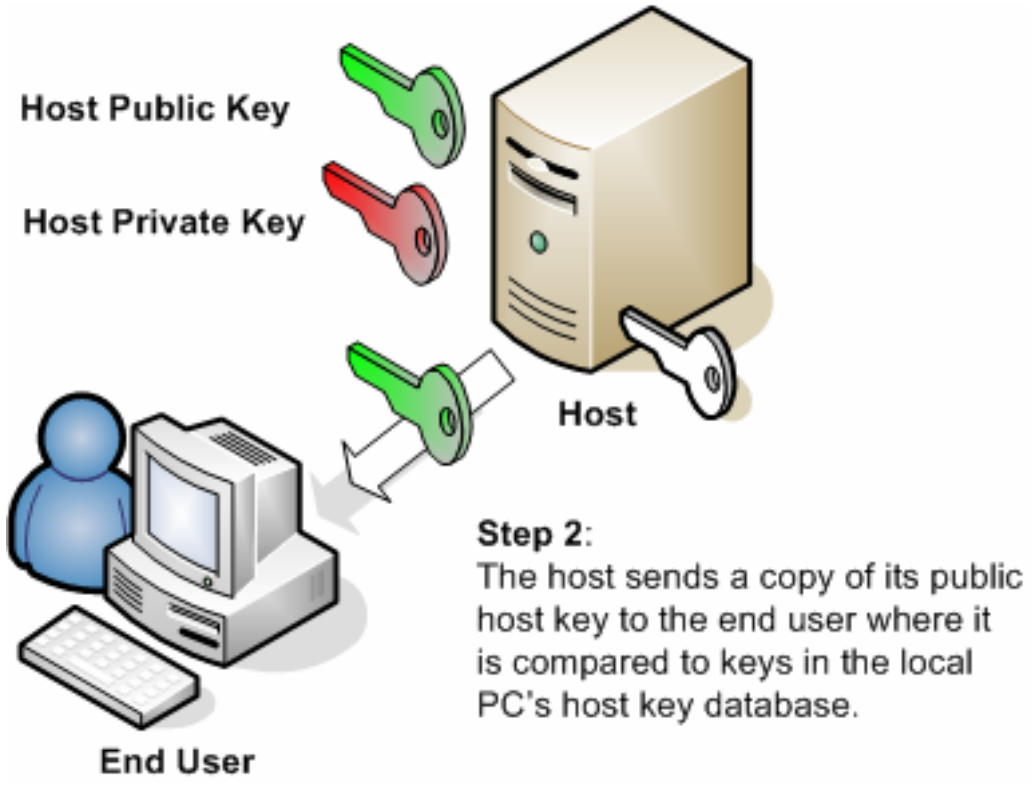
Key pair: host key is a key pair. Public host key is stored on and distributed to different clients, and private key is stored on the host/server.

Key Exchange: when a client attempts to connect to a server for the first time



Server/Host Authentication in SSH

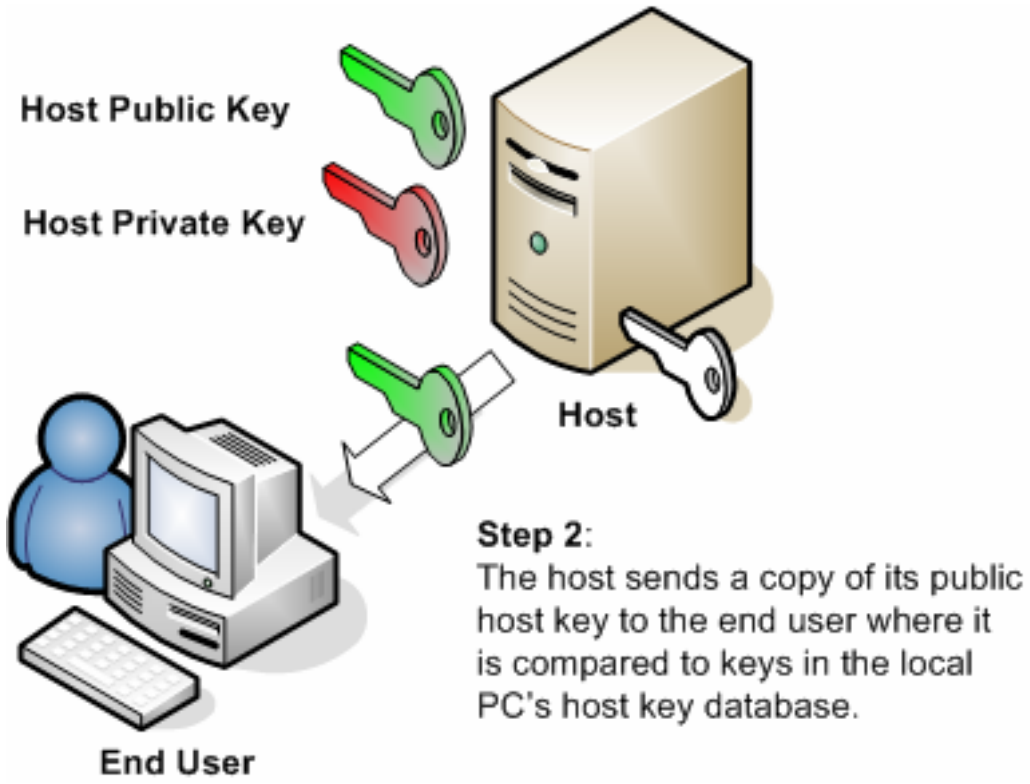
Key Exchange: when a client attempts to connect to a server for the first time, the server presents its host public key to the client.



Server/Host Authentication in SSH

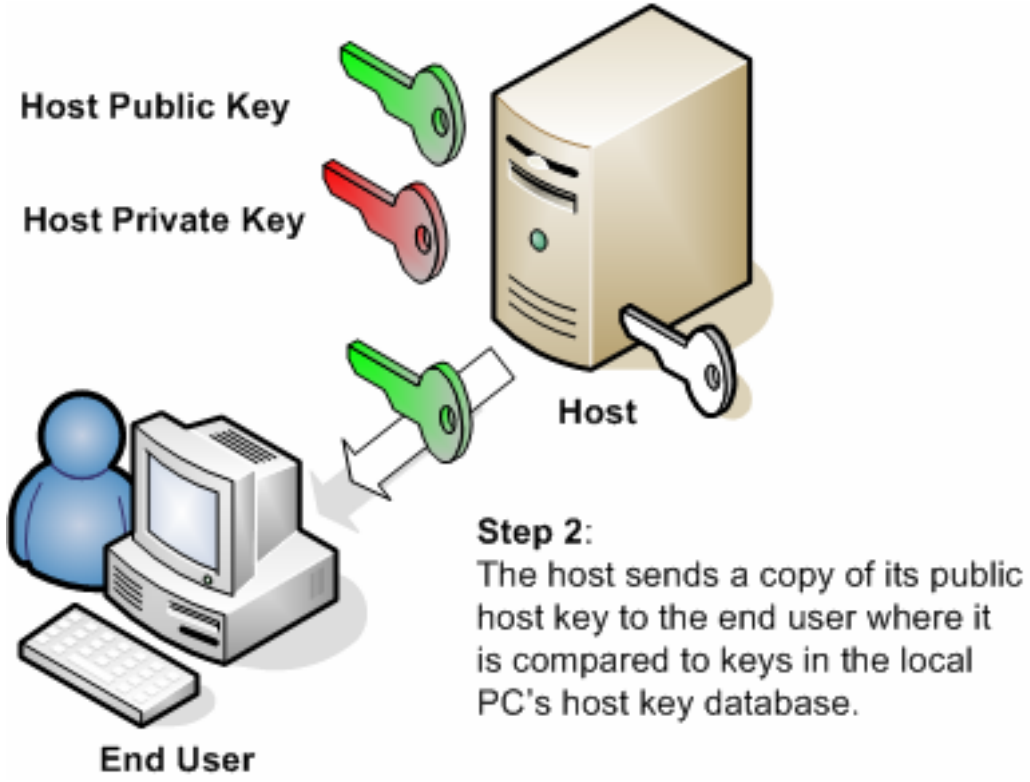
The host-key database is called *known_hosts* in Linux and contains *known host keys*.

```
cits1003@cits1003-virtualbox:~$ ls -al ~/.ssh/known_hosts
-rw------- 1 cits1003 cits1003 1342 Sep 28 22:48 /home/cits1003/.ssh
/known_hosts
cits1003@cits1003-virtualbox:~$
```



Server/Host Authentication in SSH

Host Key Checking: The client checks the server's host key against a copy stored in its "known_hosts" file. If the check succeeds, the server is authenticated.



Enable Server/Host Authentication in SSH

config

```
Host myFabric
Hostname 3.26.156.206
User ec2-user
UserKnownHostsFile /dev/null
StrictHostKeyChecking no
PasswordAuthentication no
IdentityFile ~/.ssh/myFabricKey.pem
```

↓

config

```
Host myFabric
Hostname 3.26.156.206
User ec2-user
StrictHostKeyChecking yes
PasswordAuthentication no
IdentityFile ~/.ssh/myFabricKey.pem
```

Fabric: common functions

```
from fabric import Connection
c = Connection('myFabric')
```

- upload a local file to the remote server
  - c.put(localfile, remotefilepath)
- run a remote command
  - c.run(command, otherargs)
- run a remote command with sudo
  - c.sudo(command, otherargs)

Fabric: common functions

```
from fabric import Connection
c = Connection('myFabric')
```

- upload a local file to the remote server
  - c.put(localfile, remotefilepath)
- run a remote command
  - c.run(command, otherargs)
- run a remote command with sudo
  - c.sudo(command, otherargs)

Question: what are the differences between `'sudo'` and `'su'`?

Question: what are the differences between 'sudo' and 'su'?

- sudo (Superuser Do): allows a user to execute specific commands that require superuser privileges.

```
File  Actions  Edit  View  Help
cits1003@cits1003-virtualbox:~$ vim /etc/sudoers
cits1003@cits1003-virtualbox:~$ sudo vim /etc/sudoers
[sudo] password for cits1003:
```

- su (Switch User): allows a user to switch to another user account by entering that account's password.

```
File  Actions  Edit  View  Help
cits1003@cits1003-virtualbox:~$ su
Password:
root@cits1003-virtualbox:/home/cits1003# exit
exit
cits1003@cits1003-virtualbox:~$ su root
Password:
root@cits1003-virtualbox:/home/cits1003# exit
exit
cits1003@cits1003-virtualbox:~$
```

fabfile.py: a Python script that is a collection of tasks and functions

fabfile.py

```python
from fabric import task


@task
def fileOps(c):
    if c.run('test -f ~/myFabricFile', warn=True).failed:
        c.put('myFabricFile.tgz', '/home/ec2-user')
        c.run('tar -C ~/ -xf /home/ec2-user/myFabricFile.tgz')

@task
def sudoOps(c):
    c.sudo('cat /etc/passwd')

```

@task is a decorator from the Fabric library.

Question: what does the code snippet above primarily do?

fabfile.py

```python
from fabric import task


@task
def fileOps(c):
    if c.run('test -f ~/myFabricFile', warn=True).failed:
        c.put('myFabricFile.tgz', '/home/ec2-user')
        c.run('tar -C ~/ -xf /home/ec2-user/myFabricFile.tgz')

@task
def sudoOps(c):
    c.sudo('cat /etc/passwd')

```

@task is a decorator from the Fabric library.

Question: what does the code snippet above primarily do?

A task named fileOps is defined. It first checks if a file named myFabricFile exists in the home directory of the remote host. If the check does not exist, the warn=True argument prevents the check from aborting, and instead will return a warning. Besides, the task uploads a file named myFabricFile.tgz to the remote host's directory of '/home/ec2-user'. Then, it extracts the contents of myFabricFile.tgz into the remote host's home directory.

The other task named sudoOps is defined: This task executes the 'cat /etc/passwd command' with elevated privileges.

Execute fabfile.py

fabfile.py

```python
from fabric import task


@task
def fileOps(c):
    if c.run('test -f ~/myFabricFile', warn=True).failed:
        c.put('myFabricFile.tgz', '/home/ec2-user')
        c.run('tar -C ~/ -xf /home/ec2-user/myFabricFile.tgz')

@task
def sudoOps(c):
    c.sudo('cat /etc/passwd')

```

Navigate to the directory where the fabfile.py resides:

```
cits1003@cits1003-virtualbox:~$ ls -al fabfile.py
-rw-rw-r-- 1 cits1003 cits1003 231 Sep 28 23:23 fabfile.py
cits1003@cits1003-virtualbox:~$ fab -l
Available tasks:

  fileOps
  sudoOps
```

```
cits1003@cits1003-virtualbox:~$ fab -H ec2-user@52.62.6.162 -i ~/.ssh/myFa
bricKey.pem sudoOps
```

AWS Lambda: automate tasks in DevOps

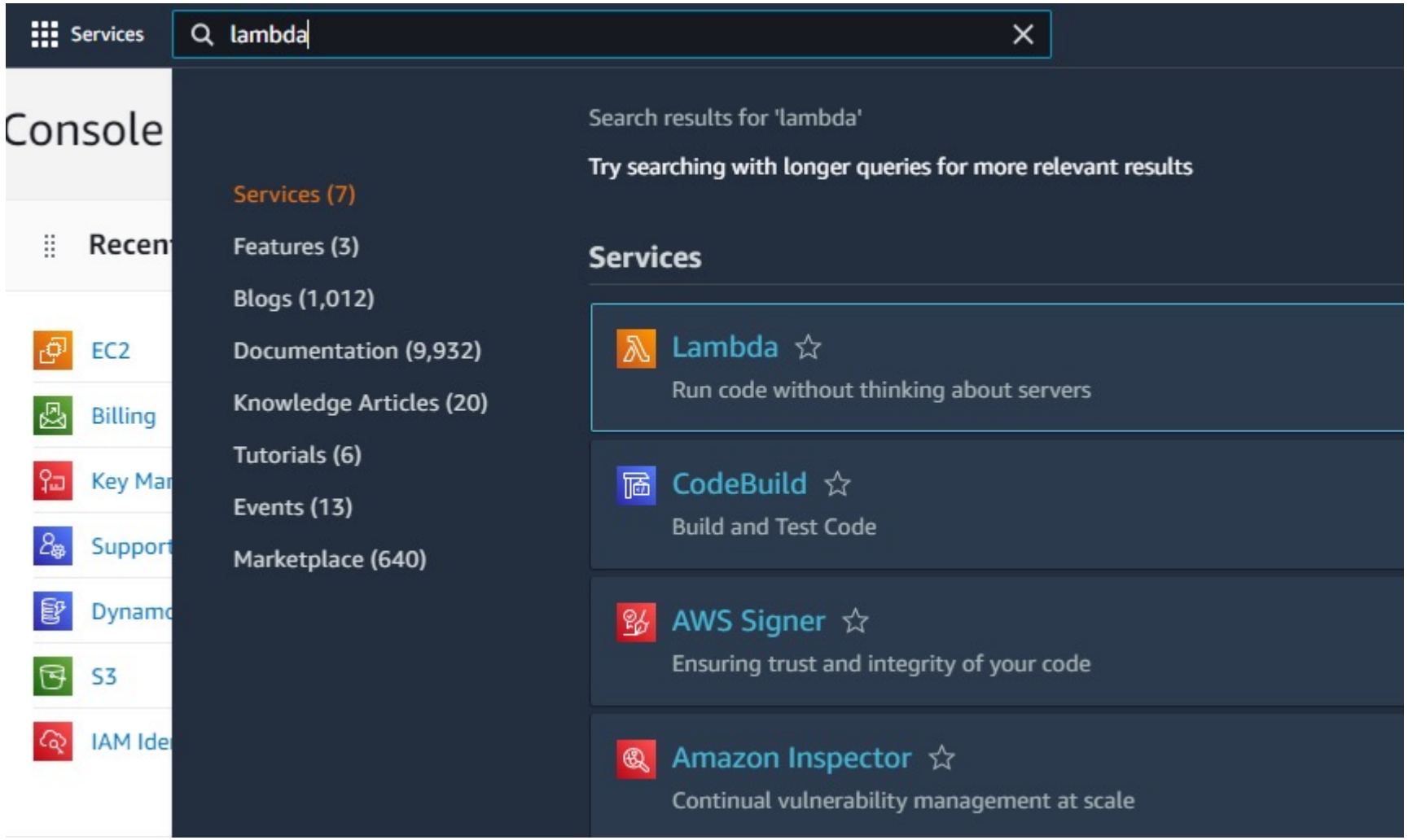
- Lambda is a compute service that lets us run code without provisioning or managing servers. With Lambda, all we need to do is **supply our code in one of the language runtimes that Lambda supports**.
- Lambda runs our code automatically on a high-availability compute infrastructure and performs all of the administration of the compute resources, including server and operating system maintenance, capacity provisioning and automatic scaling, and logging.

AWS Lambda: automate tasks in DevOps

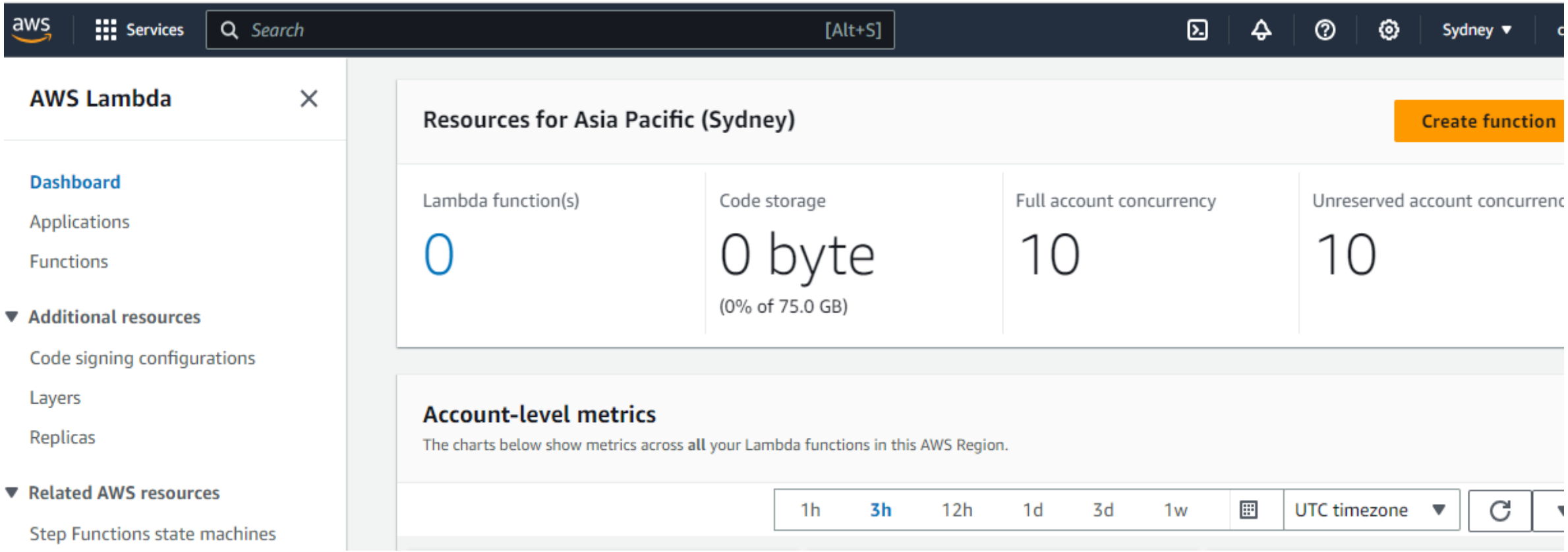
Examples:

- A toy lambda function
- A combination of lambda function and S3

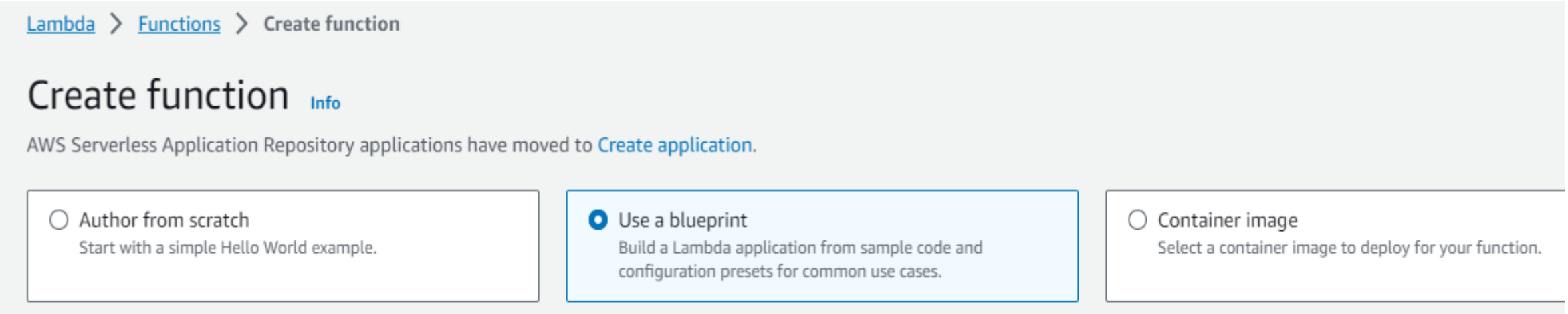
Step1: open the AWS Lambda Console



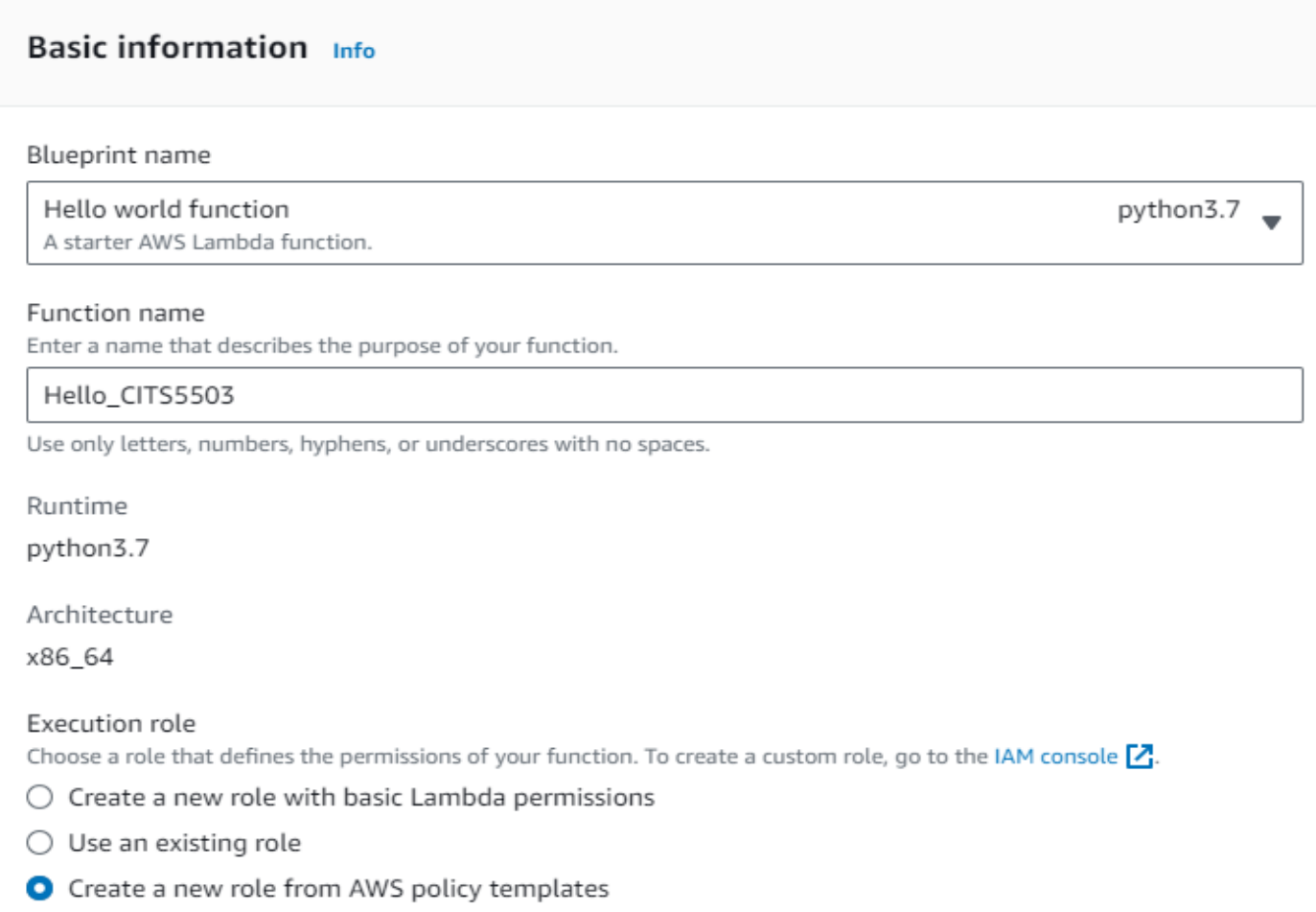
Step1: open the AWS Lambda Console



Step2: select a Lambda blueprint and configure it



Step3: basic information configuration



- Execution role: an IAM role that grants a Lambda function permission to access AWS services and resources

Step3: basic information configuration

Lambda function code

Code is preconfigured by the chosen blueprint. You can configure it after you create the function. Learn more about deploying Lambda functions.

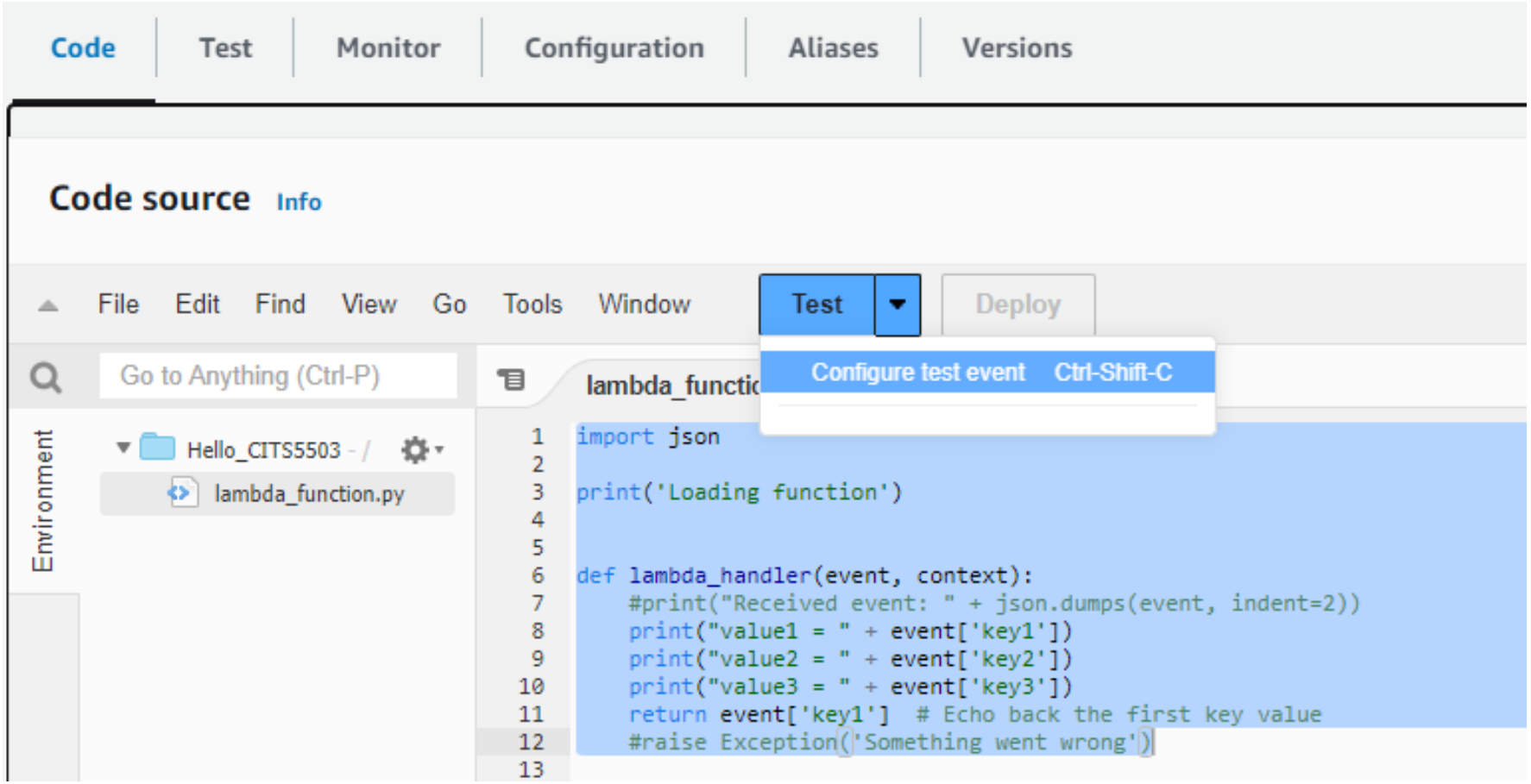
```
import json

print('Loading function')


def lambda_handler(event, context):
    #print("Received event: " + json.dumps(event, indent=2))
    print("value1 = " + event['key1'])
    print("value2 = " + event['key2'])
    print("value3 = " + event['key3'])
    return event['key1']  # Echo back the first key value
    #raise Exception('Something went wrong')

```

Step4: invoke Lambda function and verify results



Step4: invoke Lambda function and verify results

Configure test event

A test event is a JSON object that mocks the structure of requests emitted by AWS services to invoke a Lambda function. Use it to see the function's invocation result.

To invoke your function without saving an event, configure the JSON event, then choose Test.

Test event action

- (selected) Create new event
- Edit saved event

Event name

HelloCITS5503Event

Maximum of 25 characters consisting of letters, numbers, dots, hyphens and underscores.

Event sharing settings

- (selected) Private
  This event is only available in the Lambda console and to the event creator. You can configure a total of 10. Learn more
- Shareable
  This event is available to IAM users within the same account who have permissions to access and use shareable events. Learn more

Step4: invoke Lambda function and verify results

Template - *optional*

hello-world

Event JSON

Format JSON

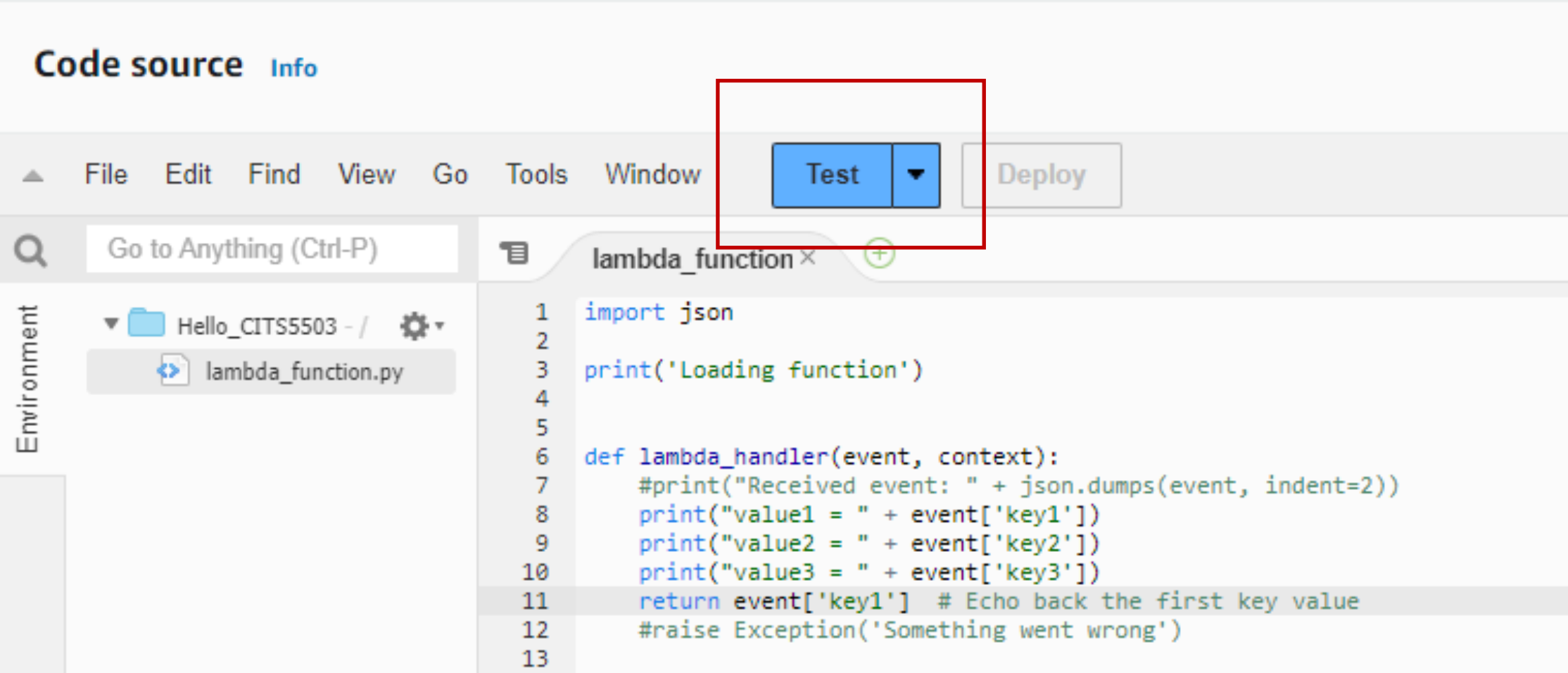
```
1 {
2   "key1": "value1",
3   "key2": "value2",
4   "key3": "value3"
5 }
```

Event JSON

Format JSON

```
1 {
2   "key1": "Hello, CITS5503",
3   "key2": "value2",
4   "key3": "value3"
5 }
```

Step4: invoke Lambda function and verify results



Step4: invoke Lambda function and verify results

Tools Window Test Deploy

lambda_function × Execution result: ×

Execution results Status: Succeeded Max memory used: 36 MB Time: 1.59 ms

Test Event Name

```
HelloCITS5503Event
```

Response

```
"Hello, CITS5503"
```

Function Logs

```
START RequestId: 50ef06f1-609e-4c3f-a100-1cc95fa7159d Version: $LATEST
value1 = Hello, CITS5503
value2 = value2
value3 = value3
END RequestId: 50ef06f1-609e-4c3f-a100-1cc95fa7159d
REPORT RequestId: 50ef06f1-609e-4c3f-a100-1cc95fa7159d  Duration: 1.59 ms   Billed Duration: 2 ms   Memory
```

Request ID

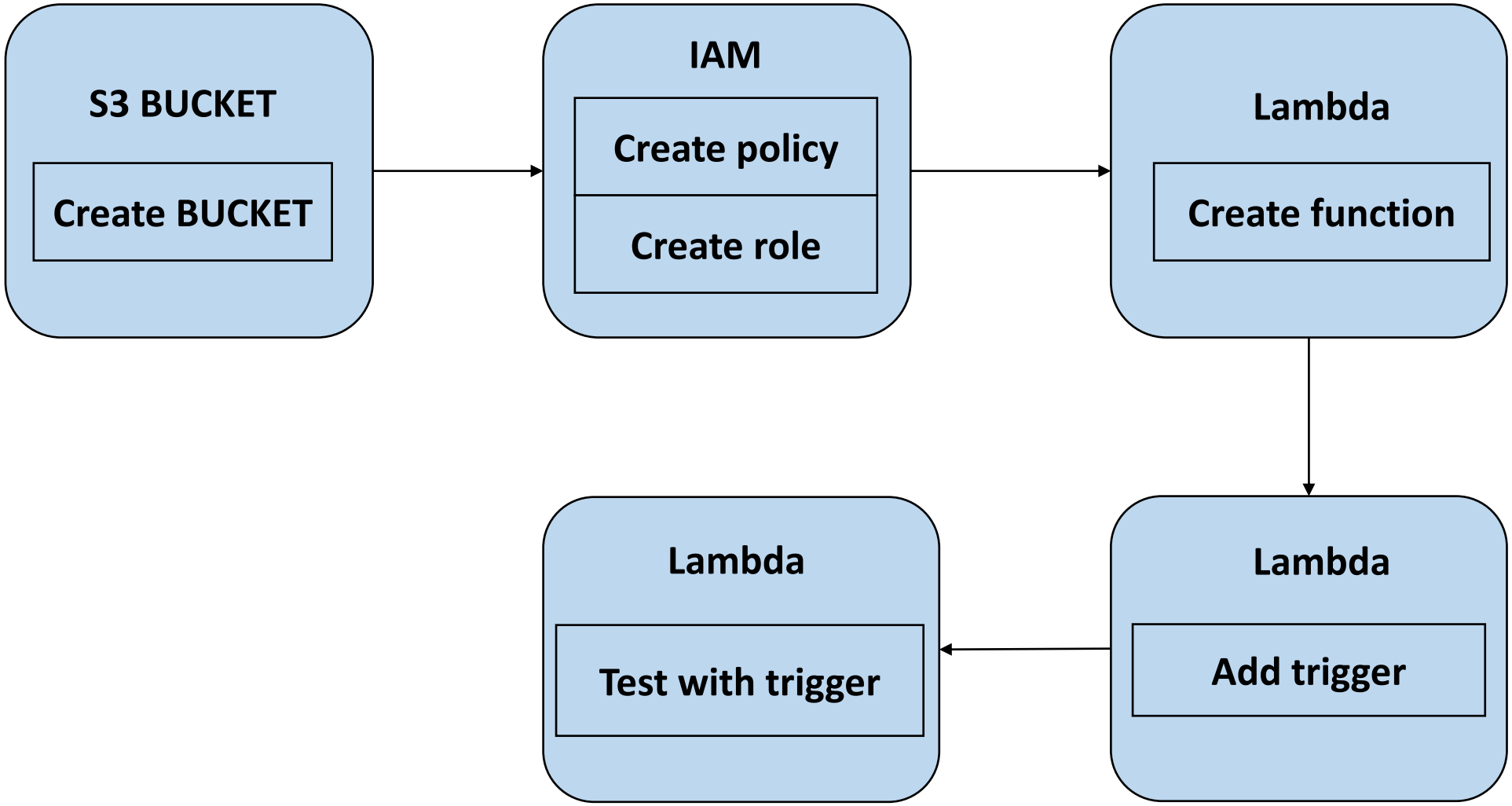
```
50ef06f1-609e-4c3f-a100-1cc95fa7159d
```

AWS Lambda: automate tasks in DevOps

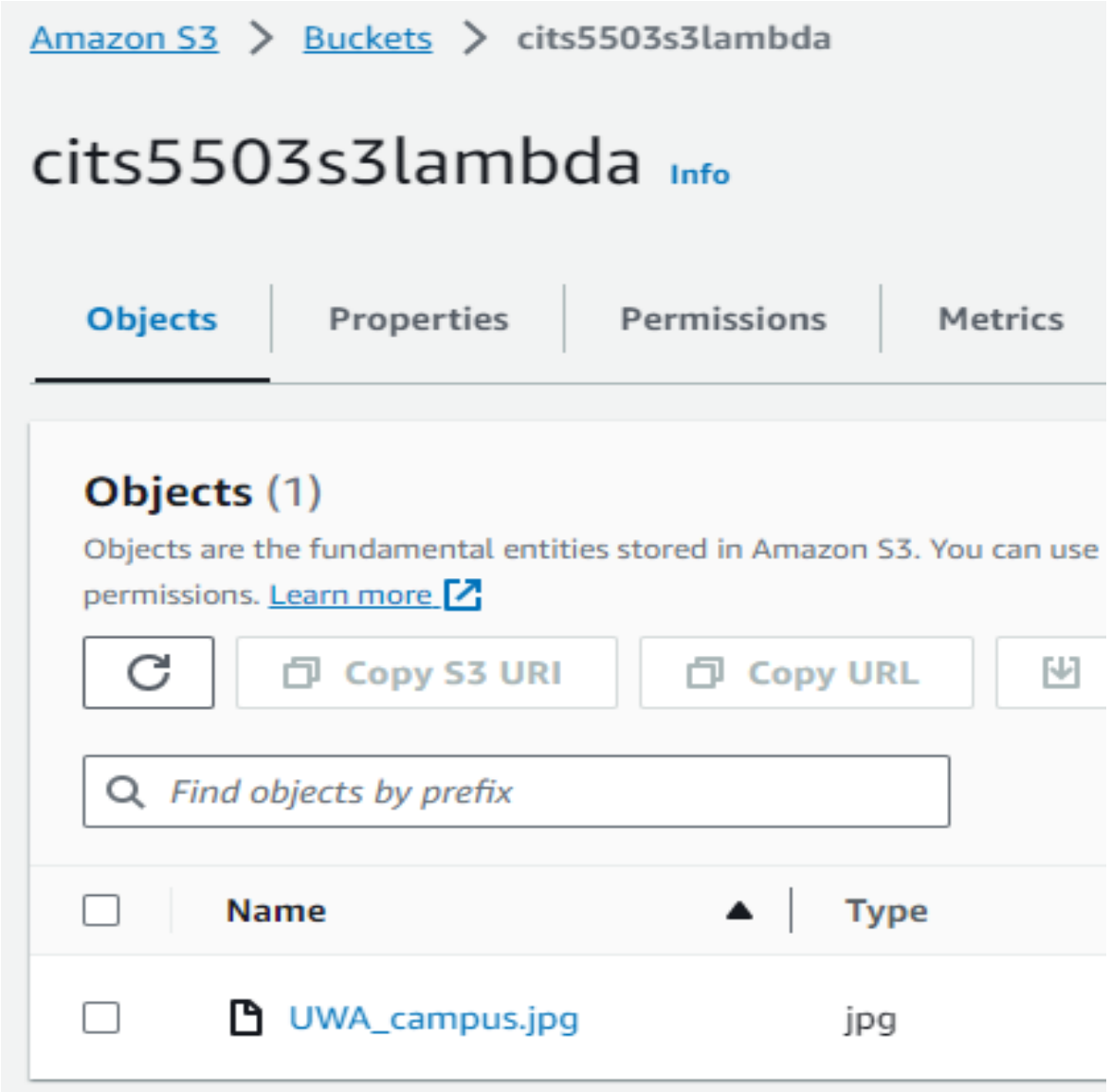
Example:

- A toy Lambda function
- A combination of lambda and S3

Combine Lambda with S3



Step1: create an Amazon S3 bucket and upload the test object



Step2: create a permissions policy

Policy name	Type	Used as
s3_trigger_lambda_cits5503	Customer managed	Permissions policy (1)

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "logs:PutLogEvents",
                "logs:CreateLogGroup",
                "logs:CreateLogStream"
            ],
            "Resource": "arn:aws:logs:*:*:*"
        },
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObject"
            ],
            "Resource": "arn:aws:s3:::*/*"
        }
    ]
}
```

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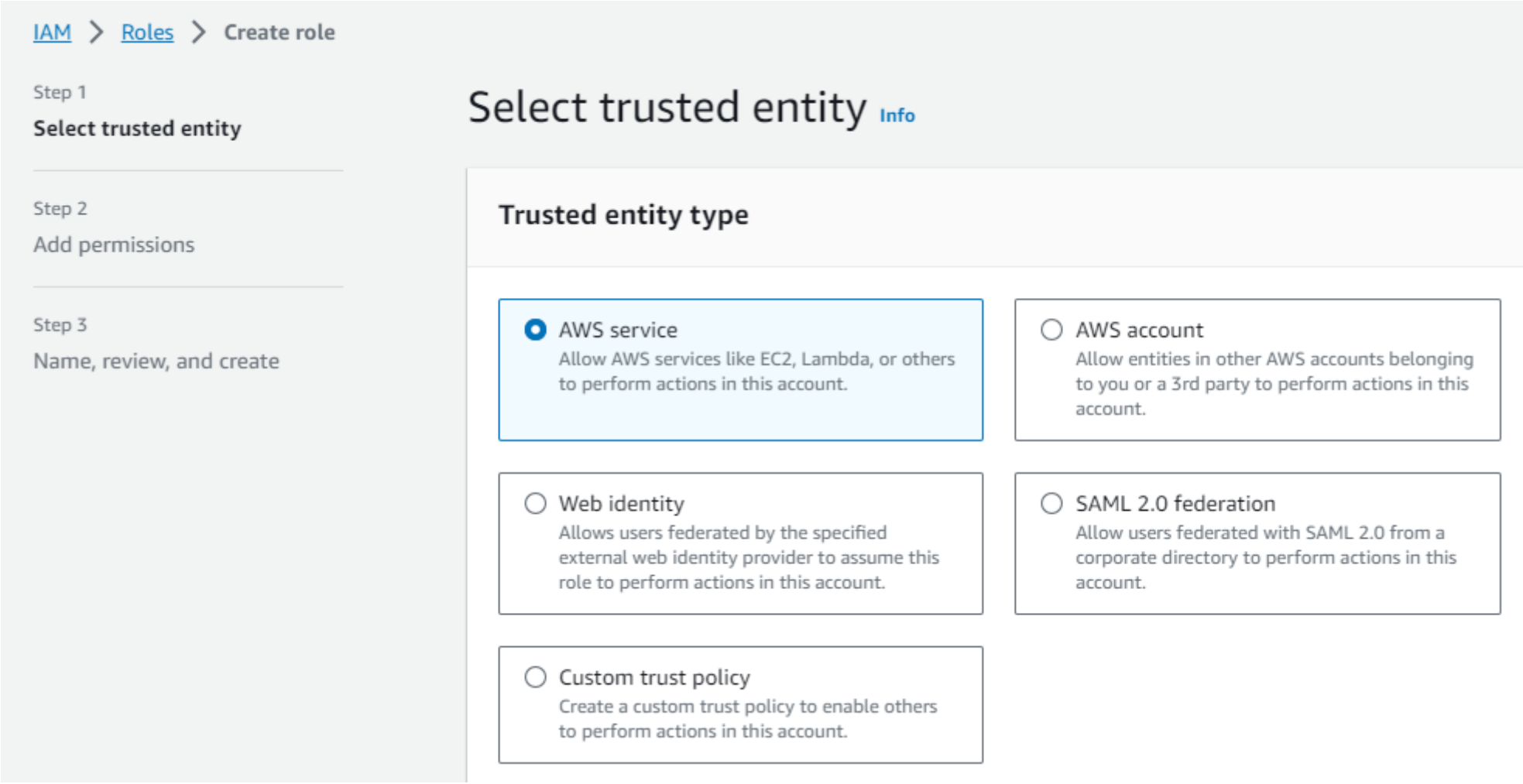
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObject"
            ],
            "Resource": "arn:aws:s3:::*/*"
        }
    ]
}
```

A log stream is a sequence of log events that share the same source. Each separate source of logs in cloudwatch logs makes up a separate log stream.

A log group is a group of log streams that share the same monitoring settings.

This permissions policy allows read actions against s3 buckets and write actions against cloudwatch logs.

Step3: create an execution role



Step3: create an execution role

Use case

Allow an AWS service like EC2, Lambda, or others to perform actions in this account.

Service or use case

Lambda

Choose a use case for the specified service.

Use case

- Lambda
  Allows Lambda functions to call AWS services on your behalf.

Add permissions Info

Permissions policies (1/893) Info

Choose one or more policies to attach to your new role.

Filter by Type

s3_tri

All types

1 match

	Policy name	Type	Description
☑	s3_trigger_lambda_cits5503	Customer managed	-

Step3: create an execution role

Role details

Role name

Enter a meaningful name to identify this role.

role_s3_trigger_lambda_cits5503

Maximum 64 characters. Use alphanumeric and '+=,.@-_' characters.

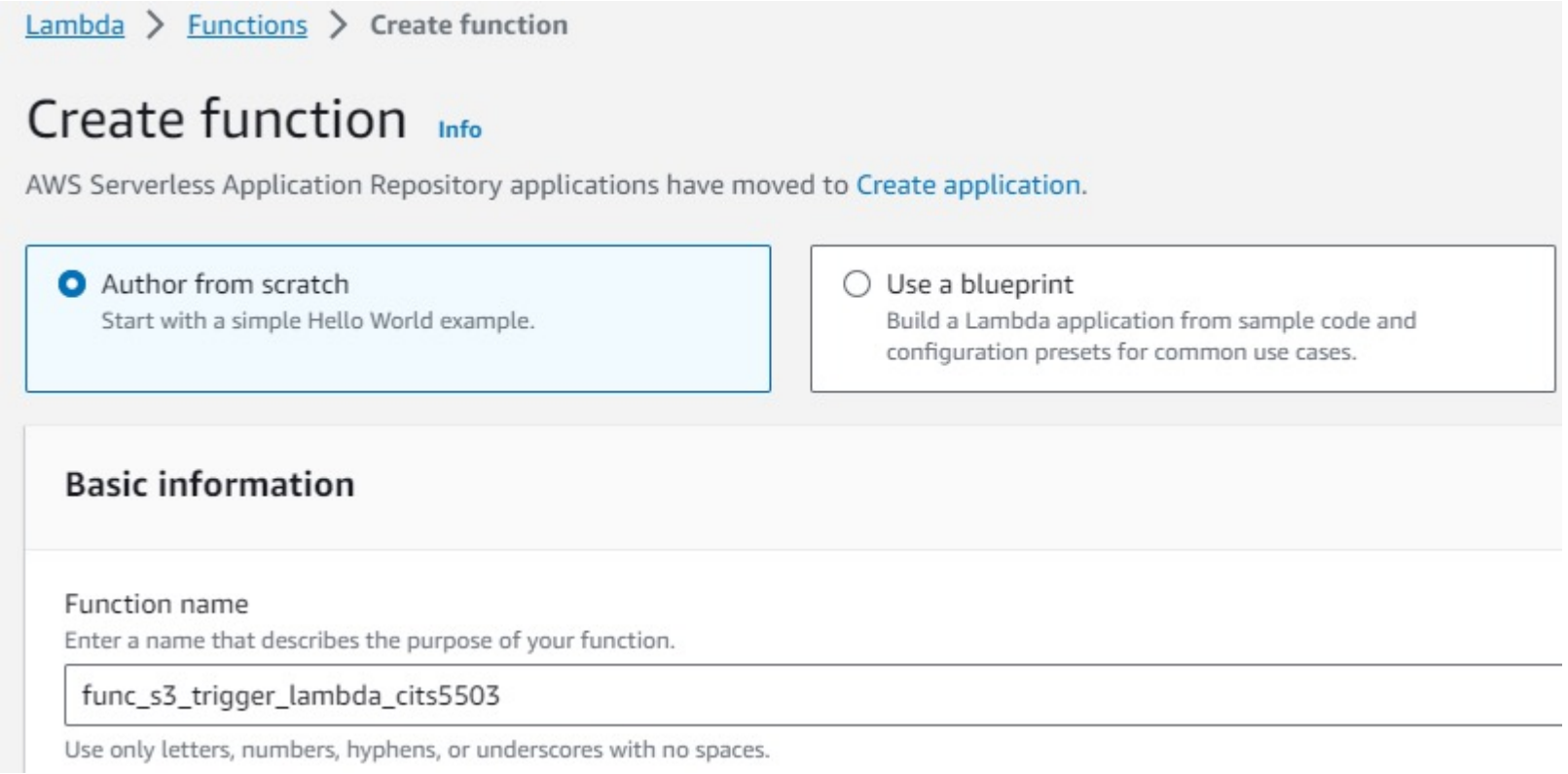
Description

Add a short explanation for this role.

Allows Lambda functions to call AWS services on your behalf.

Maximum 1000 characters. Use alphanumeric and '+=,.@-_' characters.

Step4: create the lambda function



Step4: create the lambda function

Runtime Info

Choose the language to use to write your function. Note that the console code editor supports only Node.js, Python, and Ruby.

Python 3.10

Architecture Info

Choose the instruction set architecture you want for your function code.

- (●) x86_64
- ( ) arm64

Permissions Info

By default, Lambda will create an execution role with permissions to upload logs to Amazon CloudWatch Logs. You can customize this default role later when adding triggers.

▼ **Change default execution role**

Execution role

Choose a role that defines the permissions of your function. To create a custom role, go to the IAM console.

- ( ) Create a new role with basic Lambda permissions
- (●) Use an existing role
- ( ) Create a new role from AWS policy templates

Existing role

Choose an existing role that you've created to be used with this Lambda function. The role must have permission to upload logs to Amazon CloudWatch Logs.

role_s3_trigger_lambda_cits5503

Step4: create the lambda function

Tools Window Test Deploy Changes not deployed

lambda_function

```python
import json
import urllib.parse
import boto3

print('Loading function')

s3 = boto3.client('s3')


def lambda_handler(event, context):
    #print("Received event: " + json.dumps(event, indent=2))

    # Get the object from the event and show its content type
    bucket = event['Records'][0]['s3']['bucket']['name']
    key = urllib.parse.unquote_plus(event['Records'][0]['s3']['object']['key'], encoding='utf-8')
    try:
        response = s3.get_object(Bucket=bucket, Key=key)
        print("CONTENT TYPE: " + response['ContentType'])
        return response['ContentType']
    except Exception as e:
        print(e)
        print('Error getting object {} from bucket {}. Make sure they exist and your bucket is in the same region as this function.'.format(key, bucket))
        raise e
```

Step4: create the lambda function

```
13
14      bucket = event['Records'][0]['s3']['bucket']['name']
15
```

1. event['Records']: contains an array of records. Each record corresponds to a specific event that triggered the lambda function.
2. event['Records'][0]: retrieves the first record in this array.
3. event['Records'][0]['s3']: contains information specific to an S3 event in the record.
4. event['Records'][0]['s3']['bucket']: contains information about the S3 bucket where the S3 event occurred.
5. event['Records'][0]['s3']['bucket']['name’]: retrieves the name field from the bucket.

Step4: create the lambda function

```
key = urllib.parse.unquote_plus(event['Records'][0]['s3']['object']['key'], encoding='utf-8')
```

1. event['Records'][0]['s3']['object']['key']: retrieves the S3 object key from the S3 object, encoded by utf-8.
2. urllib.parse.unquote_plus(): a function call that decodes an encoded URL string.
3. encoding='utf-8: specifies the character encoding to be used when decoding the object key.

```
print("key url: " + event['Records'][0]['s3']['object']['key'])
key = urllib.parse.unquote_plus(event['Records'][0]['s3']['object']['key'], encoding='utf-8')
print("decoded key url: " + key)
```

```
2023-10-02T14:53:09.908+08:00          key url: test.txt
2023-10-02T14:53:09.908+08:00          decoded key url: test.txt
```

Step4: create the lambda function

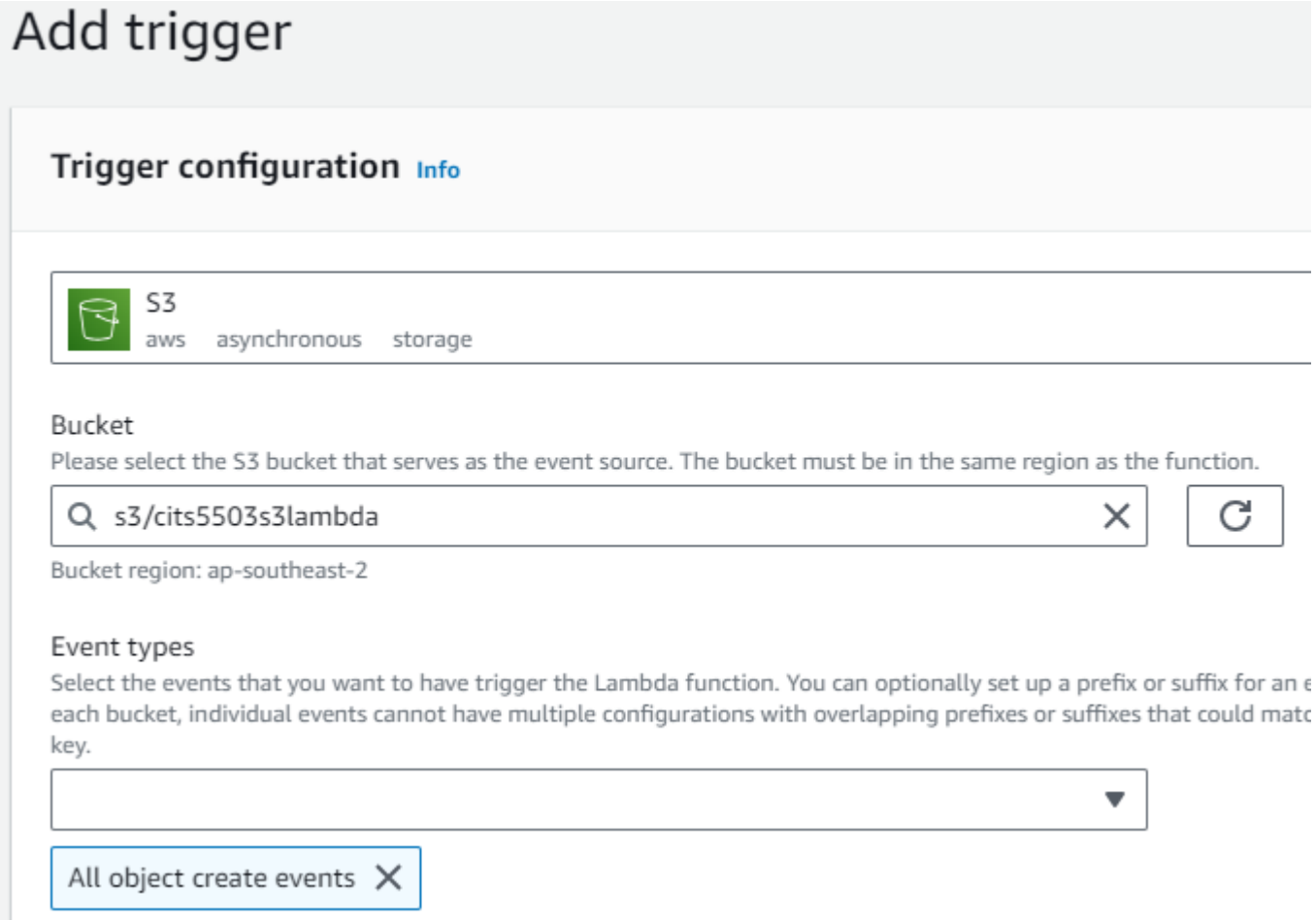
Tools Window Test Deploy Changes not deployed

lambda_function

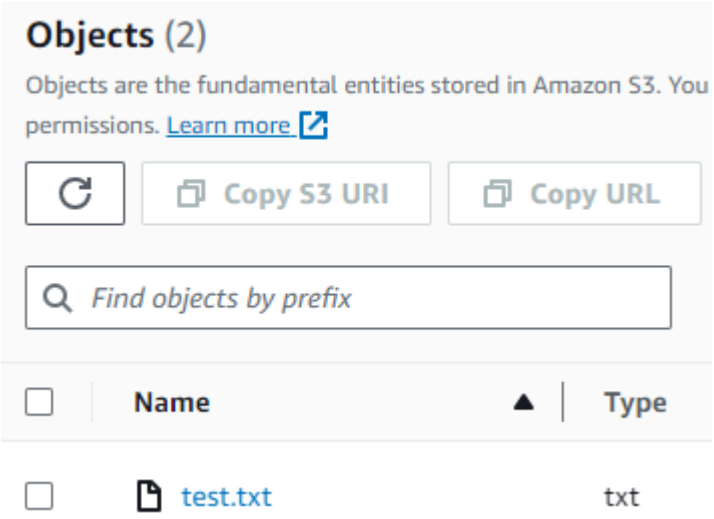
```python
import json
import urllib.parse
import boto3

print('Loading function')

s3 = boto3.client('s3')


def lambda_handler(event, context):
    #print("Received event: " + json.dumps(event, indent=2))

    # Get the object from the event and show its content type
    bucket = event['Records'][0]['s3']['bucket']['name']
    key = urllib.parse.unquote_plus(event['Records'][0]['s3']['object']['key'], encoding='utf-8')
    try:
        response = s3.get_object(Bucket=bucket, Key=key)
        print("CONTENT TYPE: " + response['ContentType'])
        return response['ContentType']
    except Exception as e:
        print(e)
        print('Error getting object {} from bucket {}. Make sure they exist and your bucket is in the same region as this function.'.format(key, bucket))
        raise e
```

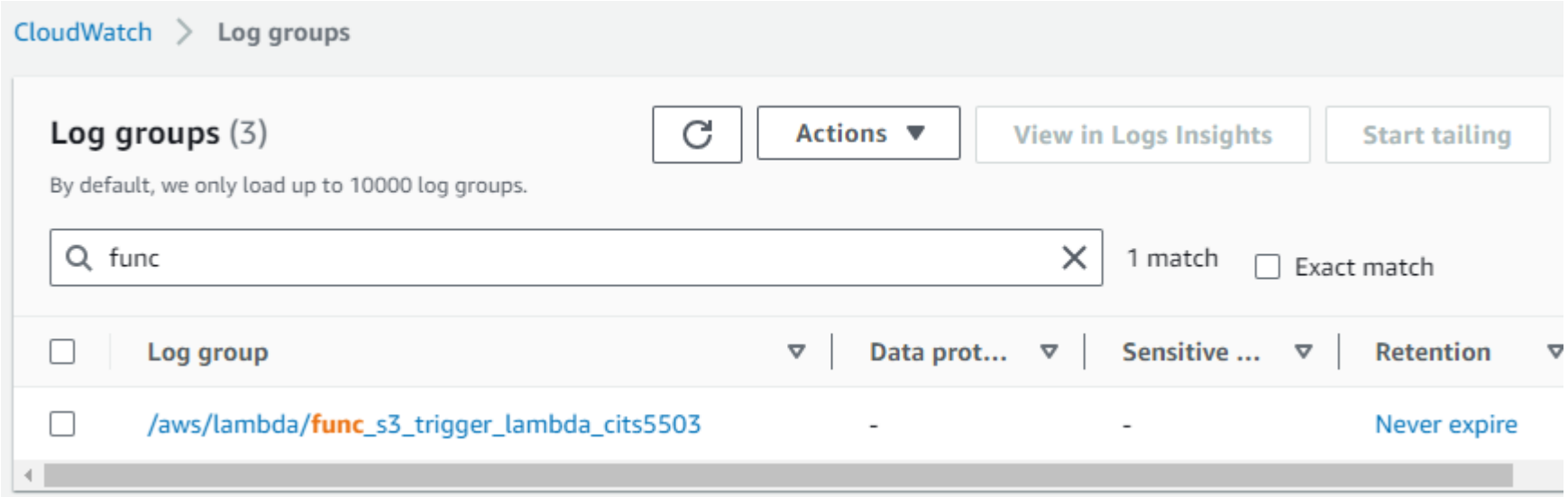
Step5: create the S3 trigger

Step5: create the S3 trigger



Step6: test the Lambda function with the S3 trigger





Step6: test the Lambda function with the S3 trigger

Log streams | Tags | Metric filters | Subscription filters

Log streams (1)

Filter log streams or try prefix search

Log stream
2023/10/02/[$LATEST]ddd91b5f8aff4e70bdea5942d6133198

Timestamp	Message
	No older events at this moment. *Retry*
2023-10-02T13:55:21.603+08:00	INIT_START Runtime Version: python:3.10.v13 Runtime Version ARN: arn:aws:lambda:ap-southeast-2::run…
2023-10-02T13:55:21.821+08:00	Loading function
2023-10-02T13:55:21.953+08:00	START RequestId: cff20359-347f-4f7e-9622-610032cb62b6 Version: $LATEST
2023-10-02T13:55:22.202+08:00	CONTENT TYPE: text/plain