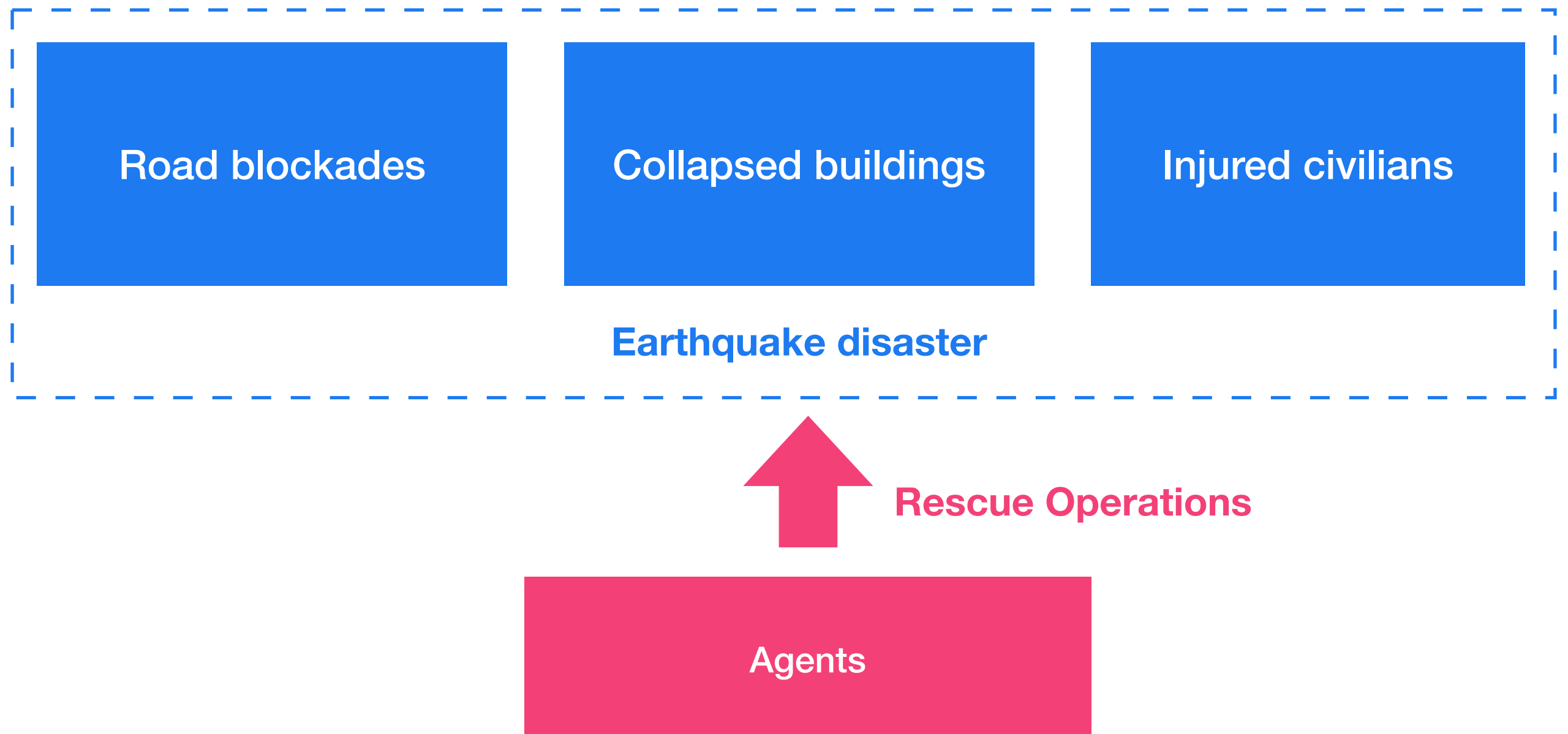# A Comprehensive Simulation Management Platform for RRS on Public Cloud
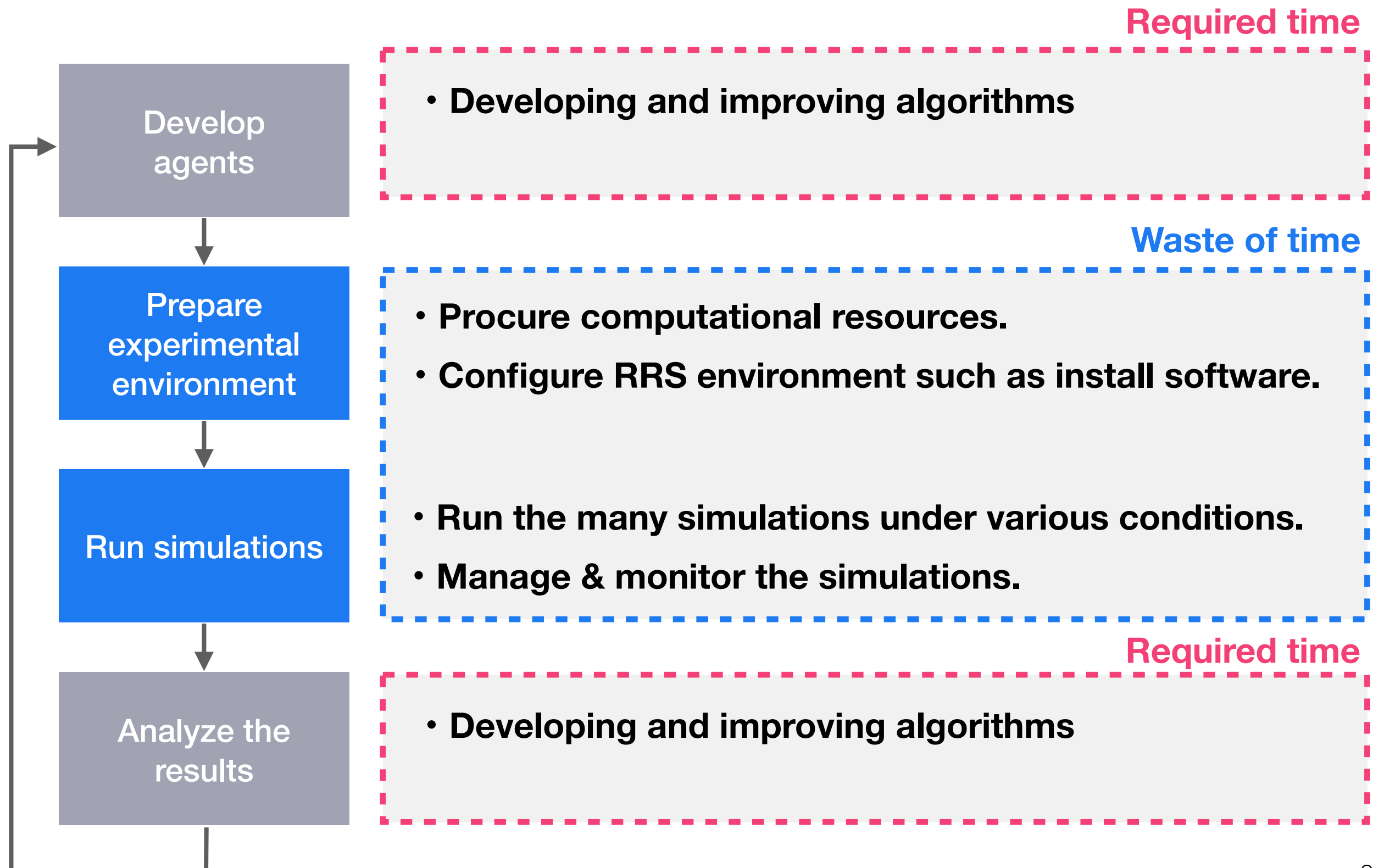
Akira Hasegawa, Yuki Miyamoto, Haruki Uehara, Takeshi Uchitane, Kazunori Iwata, Nobuhiro Ito

What is RoboCup Rescue Simulation (RRS) in 2021
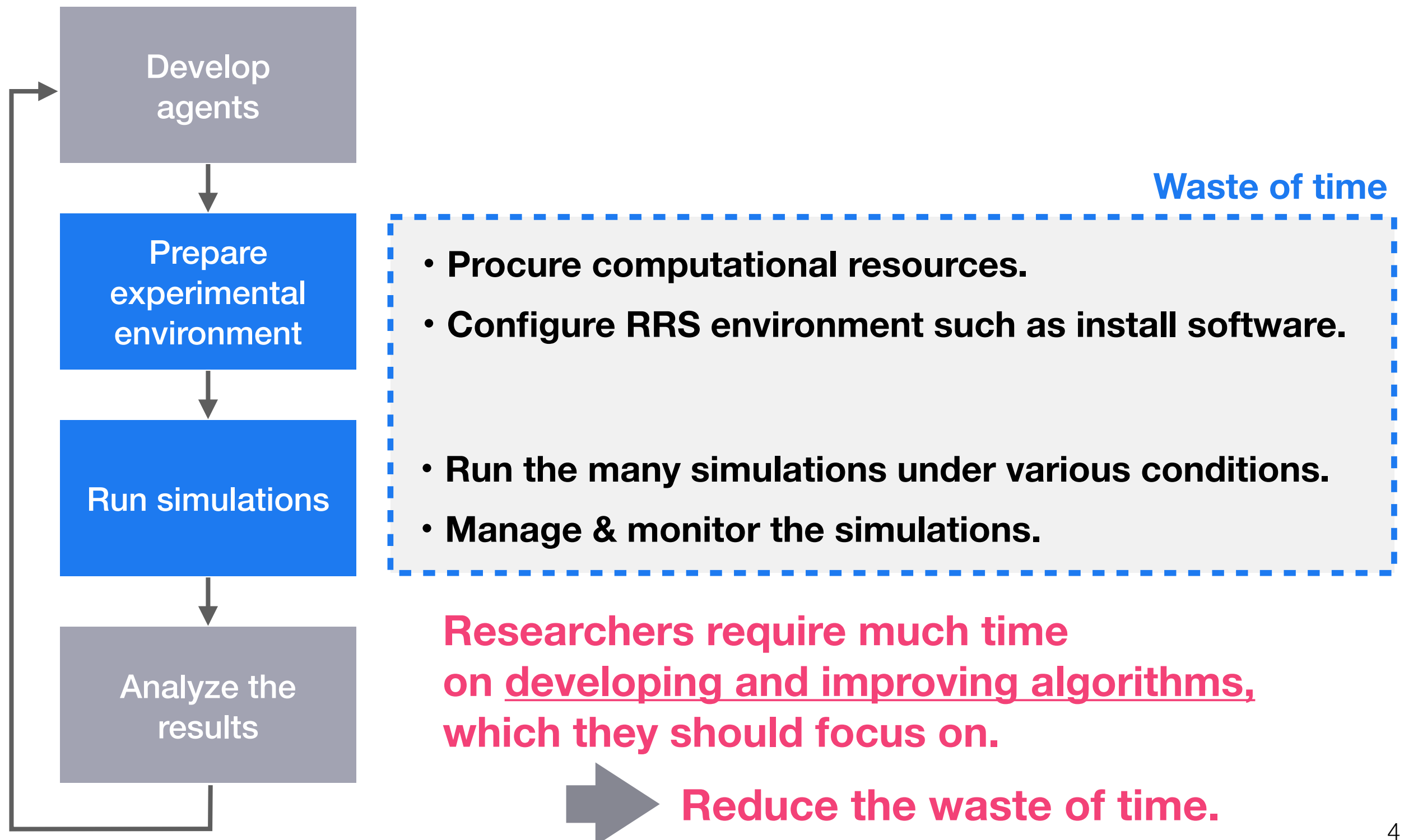
RRS simulates disaster situations and rescue operations by the multiple agents.

Road blockades	Collapsed buildings	Injured civilians

Earthquake disaster

Rescue Operations

Agents

A general flow of study on RRS

Develop agents

- **Developing and improving algorithms**

Prepare experimental environment

- **Procure computational resources.**
- **Configure RRS environment such as install software.**

Run simulations

- **Run the many simulations under various conditions.**
- **Manage & monitor the simulations.**

Analyze the results

- **Developing and improving algorithms**

A general flow of study on RRS

```
┌──────────────┐
│   Develop    │
│   agents     │
└──────┬───────┘
       │
       ▼
┌──────────────┐
│   Prepare    │
│ experimental │
│ environment  │
└──────┬───────┘
       │
       ▼
┌──────────────┐
│              │
│ Run simulations │
│              │
└──────┬───────┘
       │
       ▼
┌──────────────┐
│ Analyze the  │
│   results    │
└──────────────┘
```

Waste of time

- **Procure computational resources.**

- **Configure RRS environment such as install software.**

- **Run the many simulations under various conditions.**

- **Manage & monitor the simulations.**

**Researchers require much time
on developing and improving algorithms,
which they should focus on.**

➡ Reduce the waste of time.

4

Key points for reducing waste of time

① Easy preparation to use

- Researchers become able to use the RRS without professional knowledge and complicated configuration.

② Flexible computing resources

- Researchers become able to use any scale of computing resources when they want it.

- Researchers do not need a large initial cost for large-scale simulations.

③ Automatic executions of various simulations

- Researchers become able to manage and monitor the simulations easily.

Our Approach

Key points for this study

① **Without complex preparation to use**

② **Flexible computing resources**

③ **Automatic executions of various simulations**

We **realized a new management platform** by which the waste of time is reduced through the following four steps on public cloud.

A **Virtualizing RRS Environment**

B **Design of the simulations scheme**

C **Design of the batch jobs**

D **Automating configuration**

Summary of each step

A: Virtualizing RRS Environment

- We virtualize RRS Environment by OS-level virtualization.
- It allows researchers to do just the same step for the setup, even if operating systems and/or computers are different.

B: Design of the simulations scheme

- We design a scheme with AWS ECS and S3.
- It allows researchers to procure computational resources flexibly.

C: Design of the batch jobs

- We design batch jobs with Amazon Batch.
- It allows researchers to manage and monitor the simulations easily.

D: Automating configuration

- We automate configure with AWS CloudFormation.
- It allows researchers to configure the platform with just a few clicks on the AWS console.

The Architecture of the proposal platform
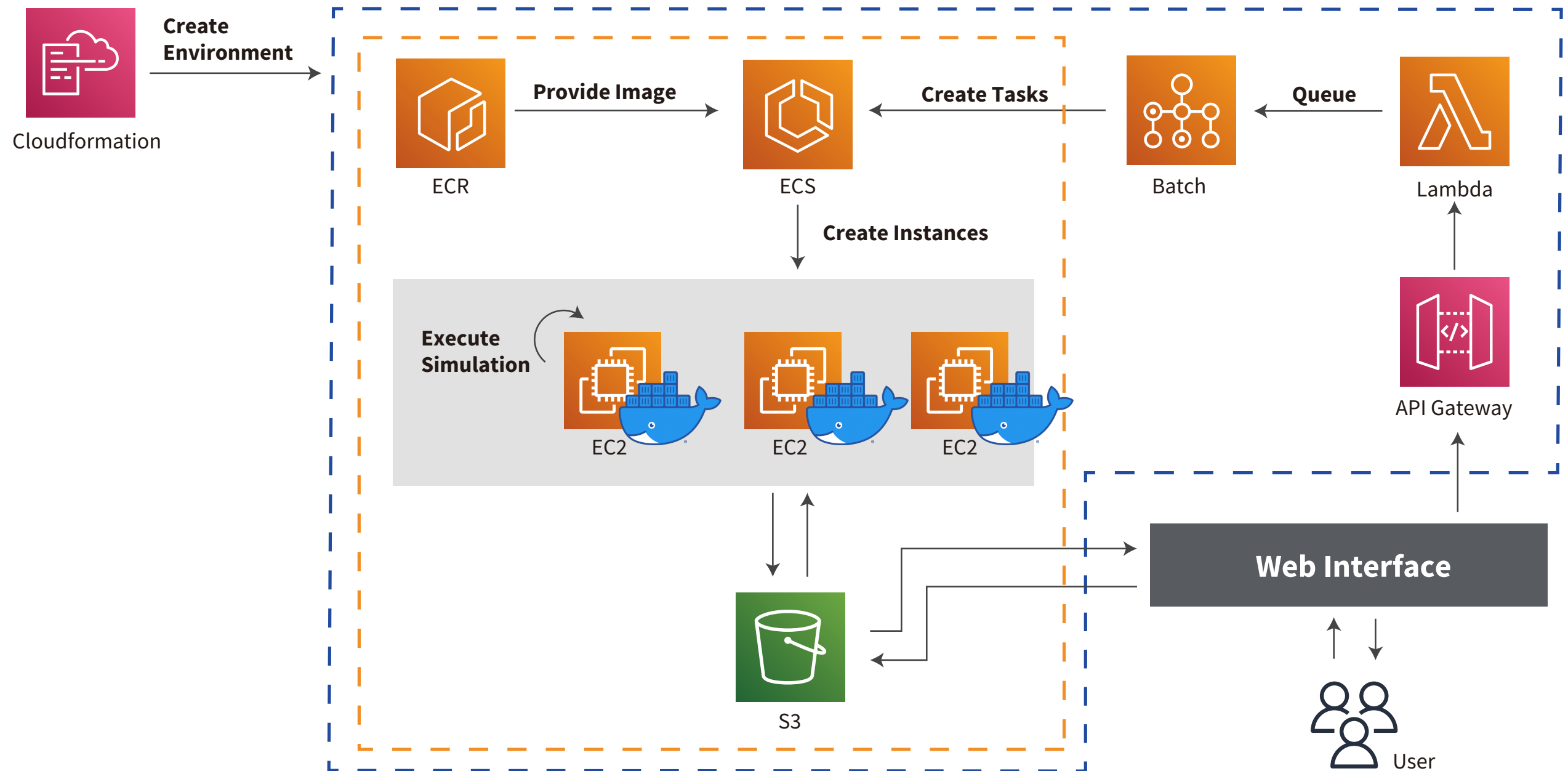
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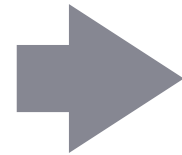
Key points for this study

① **Without complex preparation to use**

B: Design of the simulations scheme

C: Design of the batch jobs

D: Automating configuration

Virtualize RRS Environment

OS-level virtualization: Isolates processes and file systems as containers, and the containers share the host's kernel.

Docker (One of the implements of OS-level virtualization)

- Uses a template (*Docker Image)* with instructions for creating a Docker container.
- Manages computer resources of each container using control groups.

The same environment can be prepared easily, even on different host machines.

A: Virtualizing RRS Environment

B: Design of the simulations scheme

- We design a scheme with AWS ECS and S3.
- It allows researchers to procure computational resources flexibly.
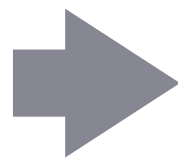
Key points for this study

② **Flexible computing resources**

C: Design of the batch jobs

D: Automating configuration

B: Design of the simulations scheme

Run the Docker container on AWS

Create Environment

Cloudformation

Provide Image

ECR

Create Tasks

ECS

Batch

Queue

Lambda

Create Instances

Execute Simulation

EC2   EC2   EC2

API Gateway

S3

Web Interface

Store the agent programs and logs

User
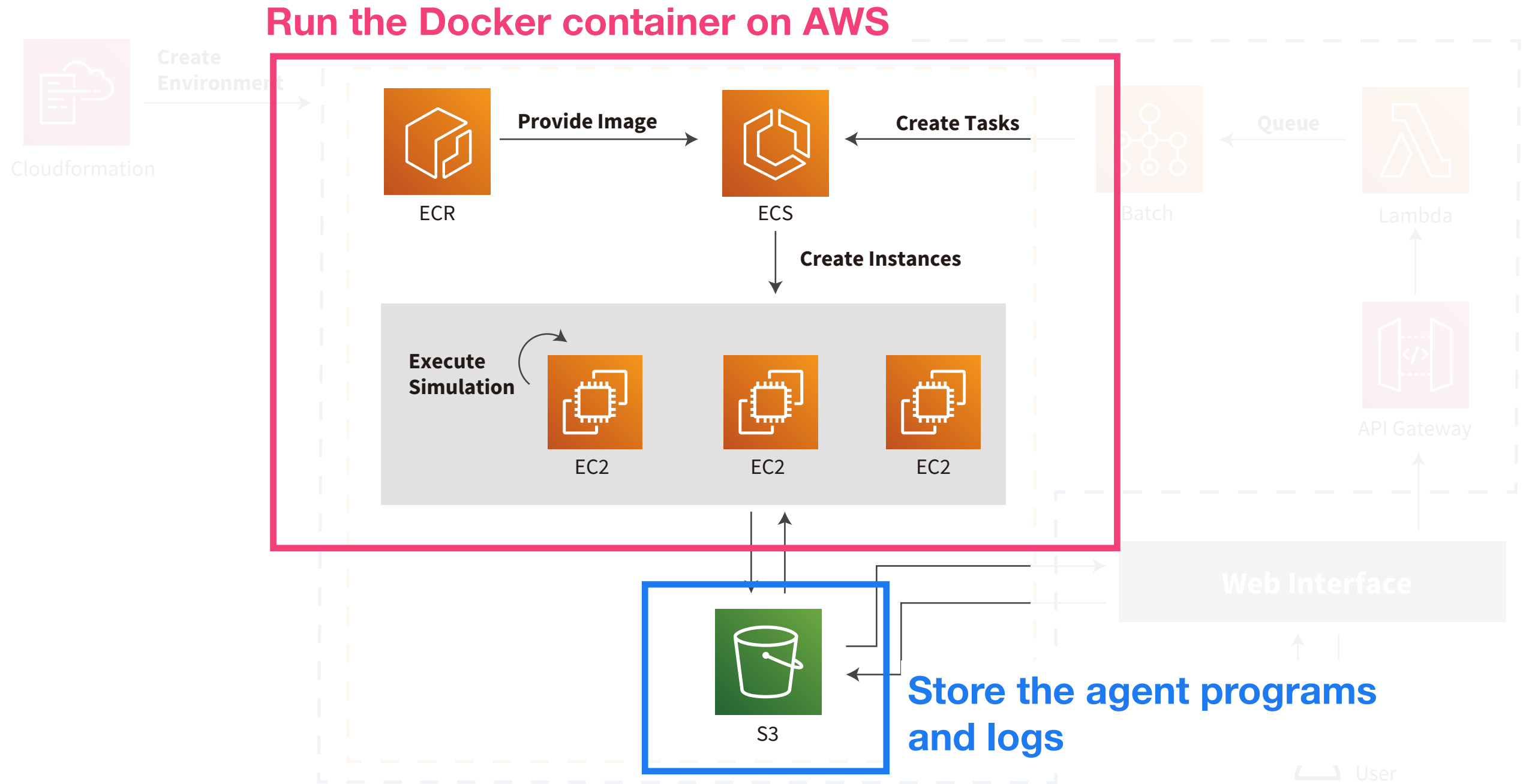
AWS EC2

We use AWS EC2 to procure computational resources flexibly.

AWS provides a computing resource called Amazon EC2, which has the following features.

- Flexibility to change resources such as processors, storages, networking, and operating systems.
- Large resources available, including 64vCPU (up to 3.9GHz) and 512GiB of memory
- Bare metal with direct access to underlying server is available.

*AWS offers a program for NPOs with 2,000 USD valid for 12 months

Researchers can use any scale of computing resources when they want it.

B: Run the *Docker container* on AWS

It is hard for researchers to prepare and execute containers repeatedly with Amazon EC2 manually.

➡️ We use **Amazon ECS,** which is a service to manage the running of containers on EC2.
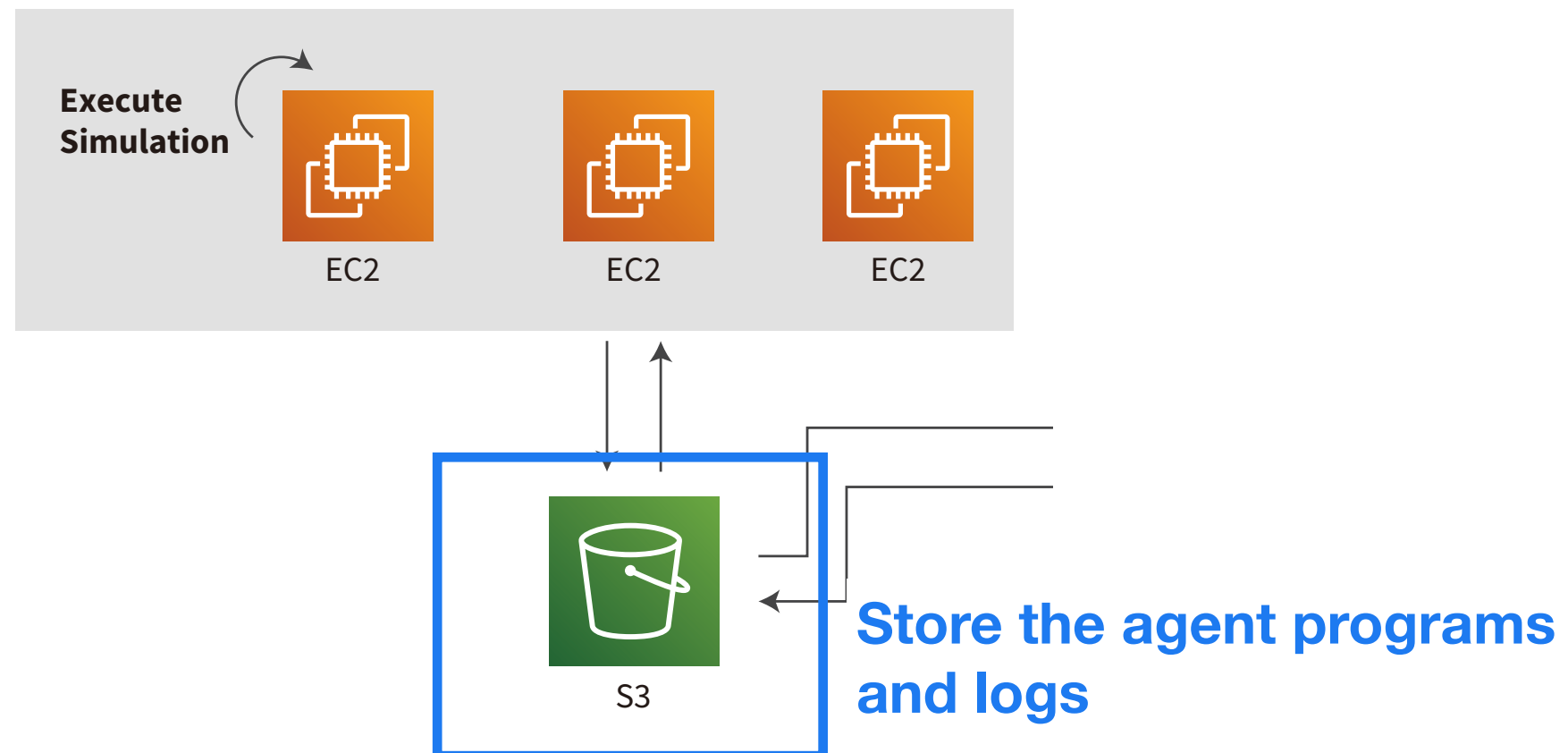
Run the Docker container on AWS
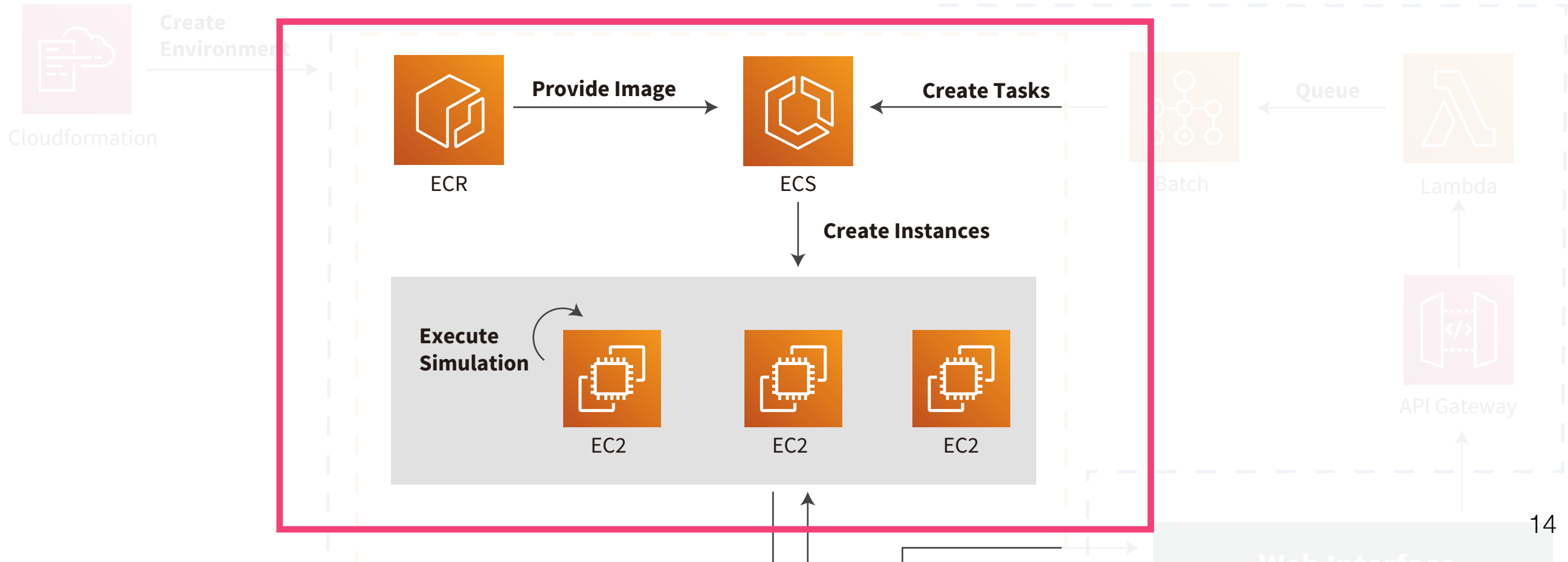
Store the agent programs and logs

It is necessary to store the data persistent because the data inside a container is deleted when the container shutdown.

➡ We use **Amazon S3**, which is one of the object storage systems and can manage files via REST API.

Execute Simulation

EC2   EC2   EC2

S3

Store the agent programs and logs

A: Virtualizing RRS Environment

B: Design of the simulations scheme

C: Design of the batch jobs

- We design batch jobs with Amazon Batch.
- It allows researchers to manage and monitor the simulations easily.
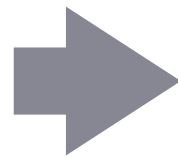
Key points for this study

③ **Automatic executions of various simulations**

D: Automating configuration

C: Run repeatedly & Queueing Jobs

ECR → **Provide Image** → **ECS** ← **Create Tasks** ← **Batch**

Create Instances

Execute Simulation

EC2   EC2   EC2

S3
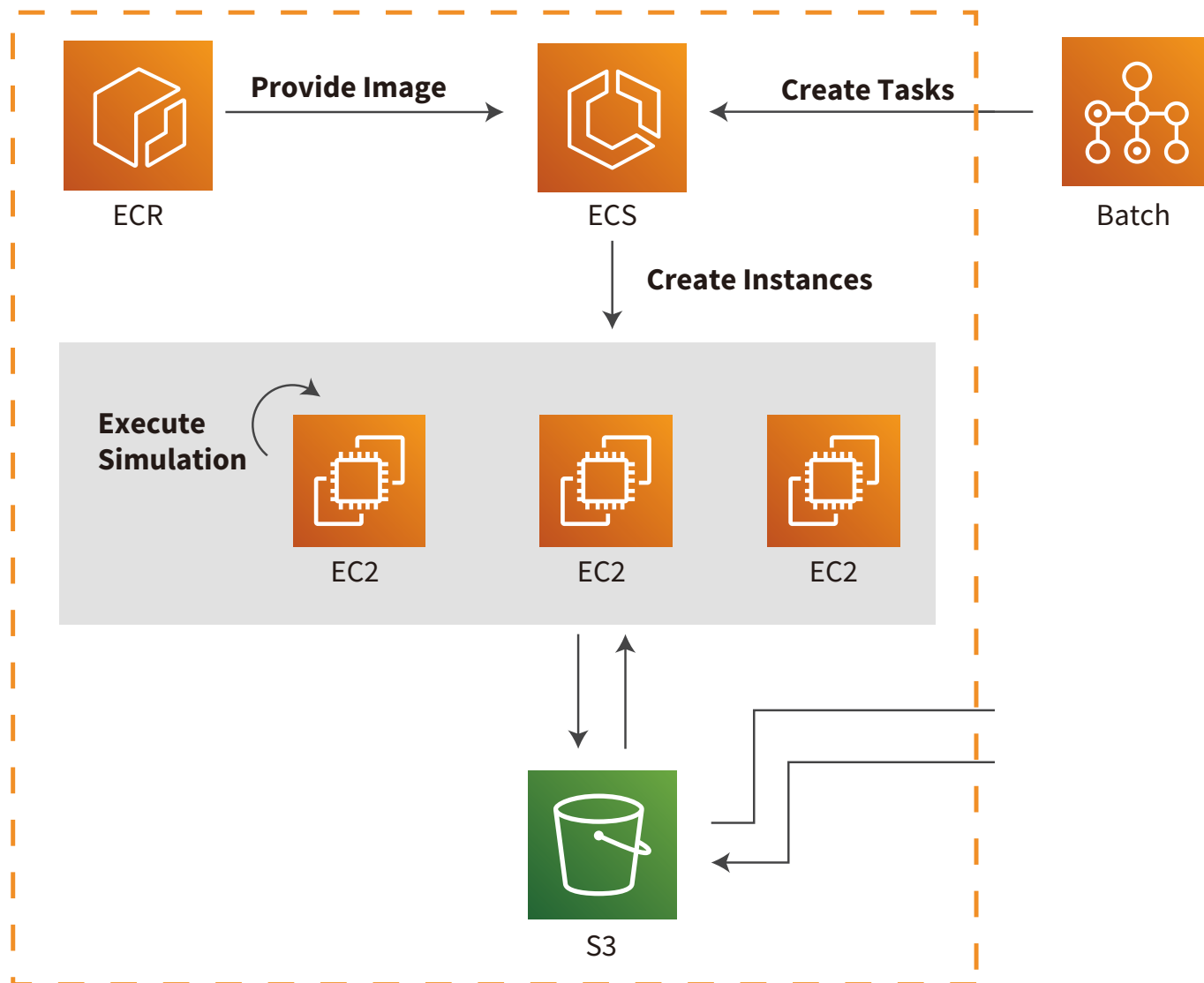
AWS Batch

- Fully managed service to execute and manage batch processing.

- Automatically allocate computing resources, automatically run simulations, and terminate the process.

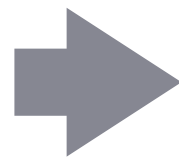**There is no need to manage server clusters that you use to run your jobs.**

A: Virtualizing RRS Environment

B: Design of the simulations scheme

C: Design of the batch jobs

D: Automating configuration

- We automate configure with AWS CloudFormation.

- It allows researchers to configure the platform with just a few clicks on the AWS console.
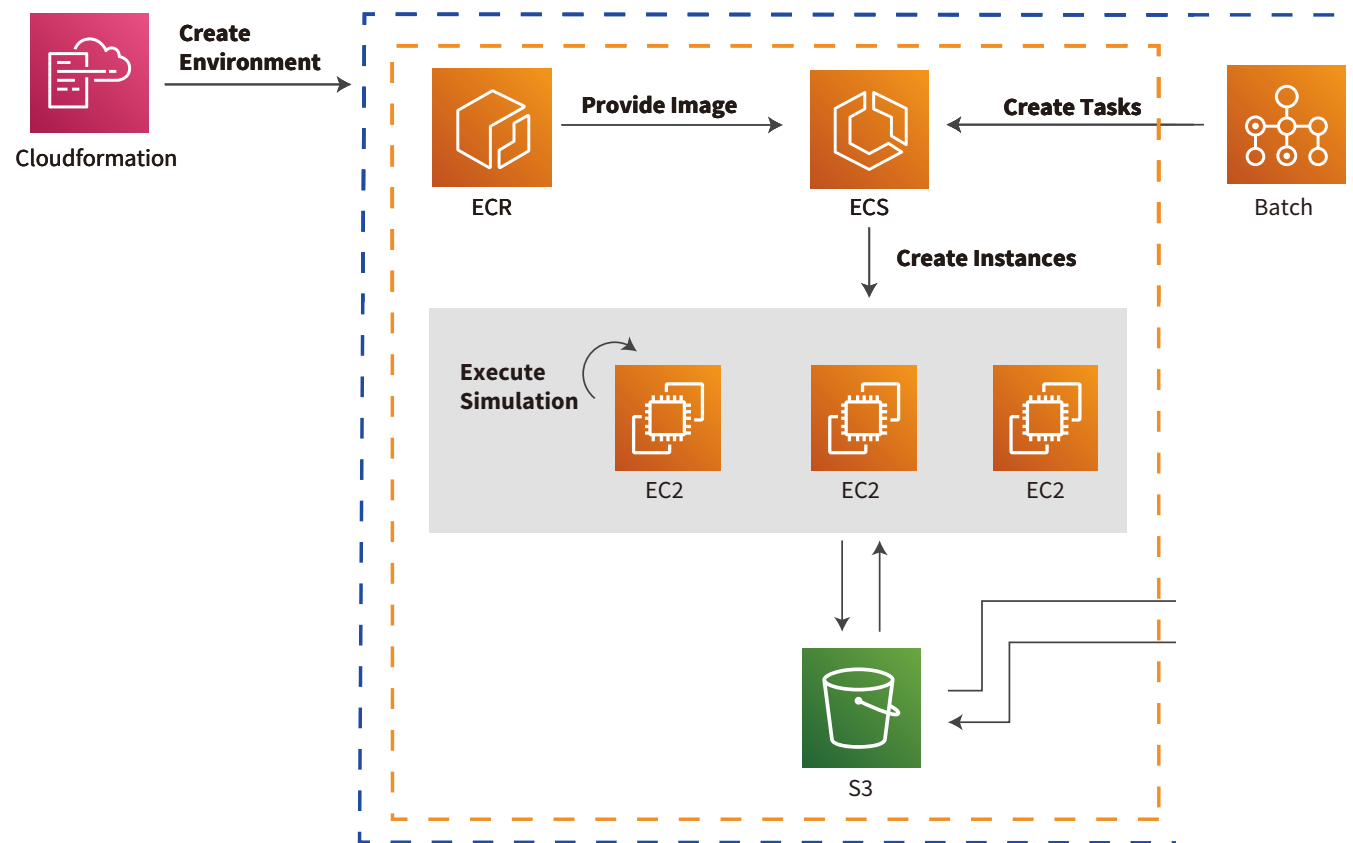
Key points for this study

① **Without complex preparation to use**

D: Automating configuration

Preparation of the systems we have described need complicated configuration on the AWS console.

Cloud formation

- Define resources and dependencies in template files.

- Configure and launch all resources at once using a template file.

Everyone can automatically reproduce a simulation environment using the template files.

A complemental module: Web Interface

Preparation of this platform is still difficult for beginner.

➡️ We developed a Web Interface, and it is allowed to use the RRS platform easier.

The Interface provides the following functions:

- Upload agents & maps

- Manage the simulation status

- Download results of the simulation

A complemental module: Web Log Viewer

You can use Web Log Viewer to visualize the disaster situations and rescue operations in 2D/3D.
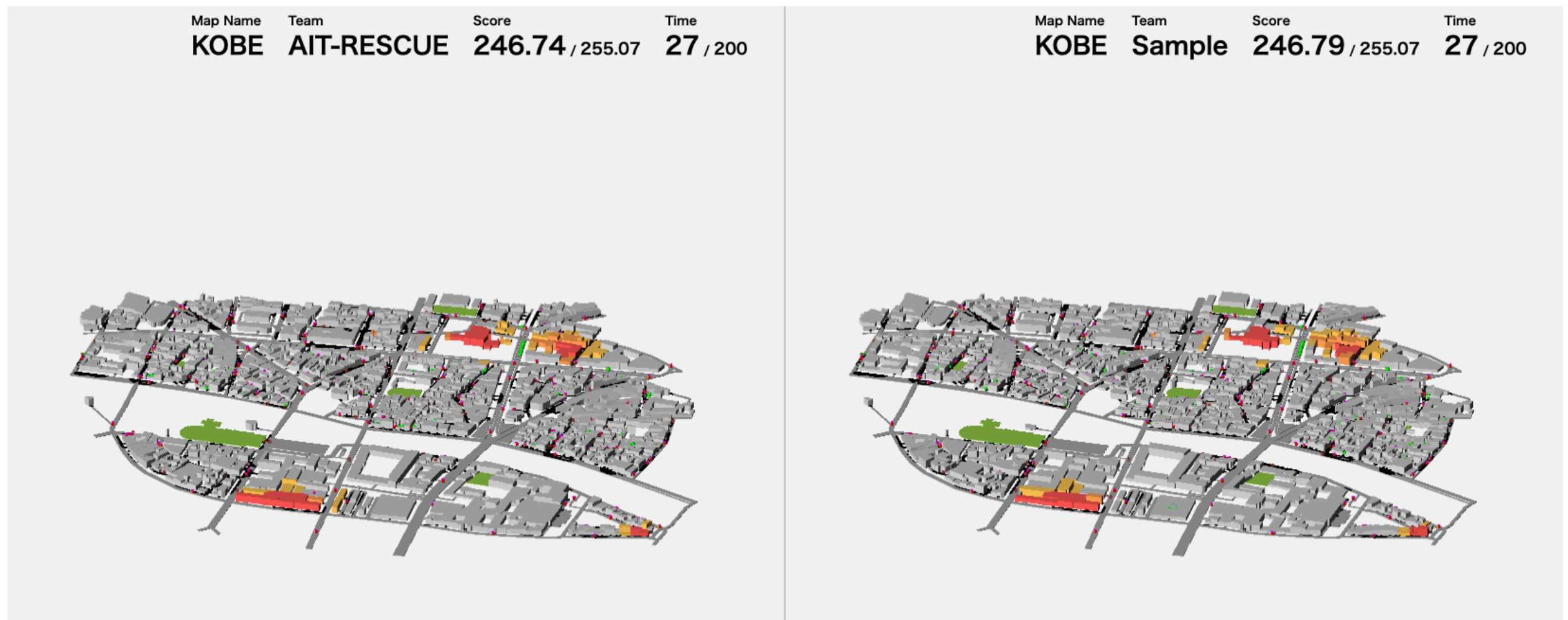
We can parallelly compare two simulations using two log files.

Case study: RoboCup JapanOpen 2020 online

We confirmed that the platform is effective through about 100 simulations

Pros:

- The simulations completed just by uploading source code and scenario.

- Computational resources can be distributed horizontally, resulting in a shorter competition time.

- It costs 27.34 USD for 100 simulations (0.2734 USD per simulation) and no initial cost was required.

Cons:

- It takes time and effort to maintain the template when AWS introduces or obsoletes some features.

Competition Results: https://maslab.aitech.ac.jp/result2020/

Conclusion

- We realized a comprehensive simulation platform.

  - The platform allows deploying RRS by clicking a few times on AWS console.

- We can use the platform not only for studies but also competitions.

We prepared the template file for the RRS:

https://maslab.aitech.ac.jp/~haseaki/rrs-aws/

Web Log Viewer can watch at:

http://execution.aichi-u.ac.jp:3000/