Japan-Taiwan Data and AI Module Platform for Analyzing Remote Sensing data, Part 3

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The Goal

- We want to share our
  - Programs
  - Computational resources
  - Data resources

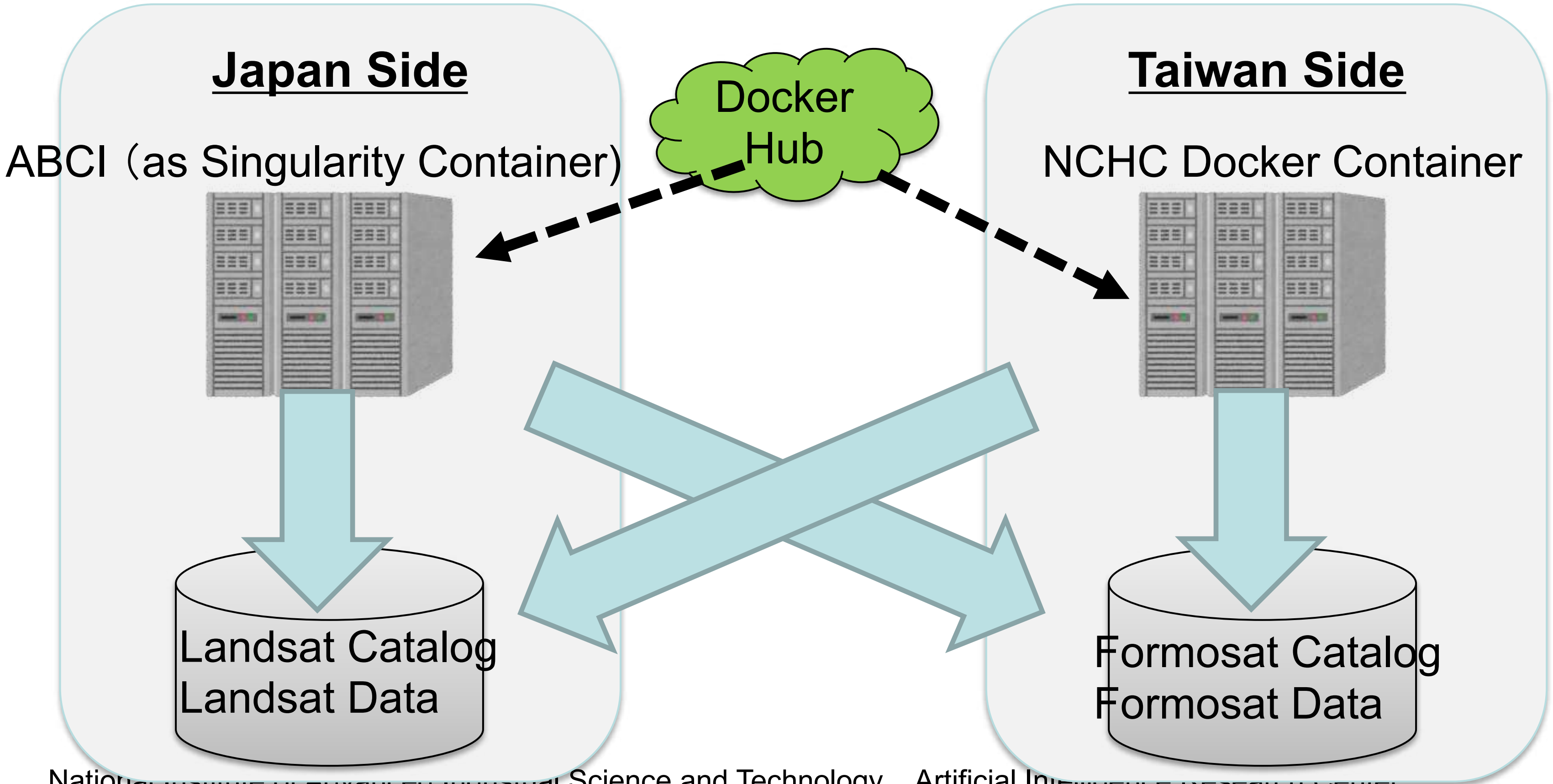
Background

- Program
  - AIST - Machine Learning module that detect objects in the satellite images
- Computers
  - AIST- ABCI – a cluster for AI
  - NCHC – Clusters
- Data
  - AIST – Landsat 8 satellite images
  - NCHC/NSPO – Formosat satellite images

→ How can we share them?

Demo at PRAGMA 36

- Sharing computing resources and data resources
- Interoperable ML module on Docker hub
- Deploy and run the module for any combination of the resources.

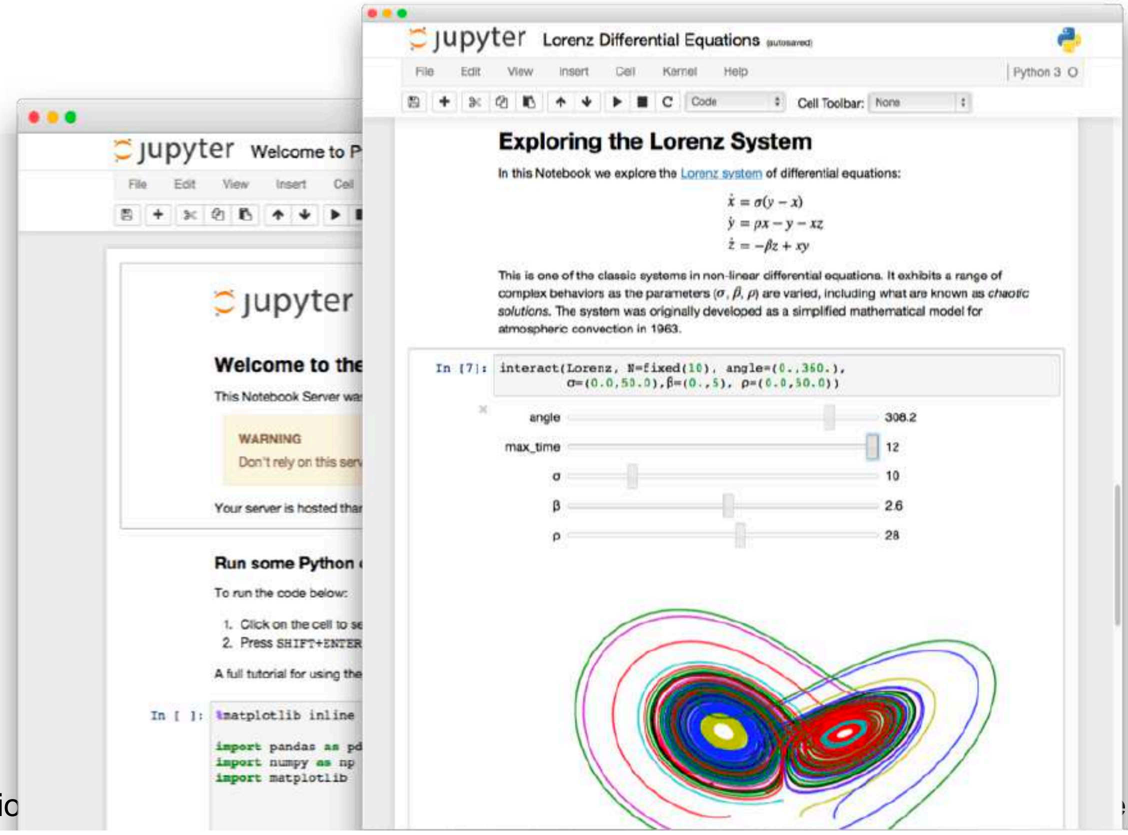


How can we share programs?

- Sharing code as a container is not enough
- **User Environment** is required
  - To explore data and codes

Jupyter Notebook

- De facto standard for data analysis tasks
- Iterative exploration on dataset



jupyter Welcome to P
File Edit View Insert Cell
jupyter Lorenz Differential Equations (autosaved)
File Edit View Insert Cell Kernel Help
Python 3
Code
Cell Toolbar: None

jupyter

Welcome to the

This Notebook Server was

WARNING

Don't rely on this serv

Your server is hosted thar

Run some Python

To run the code below:

1. Click on the cell to se
2. Press SHIFT+ENTER

A full tutorial for using the

```
In [ ]: %matplotlib inline

        import pandas as pd
        import numpy as np
        import matplotlib
```

Exploring the Lorenz System

In this Notebook we explore the Lorenz system of differential equations:

$$\dot{x} = \sigma(y - x)$$
$$\dot{y} = \rho x - y - xz$$
$$\dot{z} = -\beta z + xy$$

This is one of the classic systems in non-linear differential equations. It exhibits a range of complex behaviors as the parameters (σ, β, ρ) are varied, including what are known as *chaotic solutions*. The system was originally developed as a simplified mathematical model for atmospheric convection in 1963.

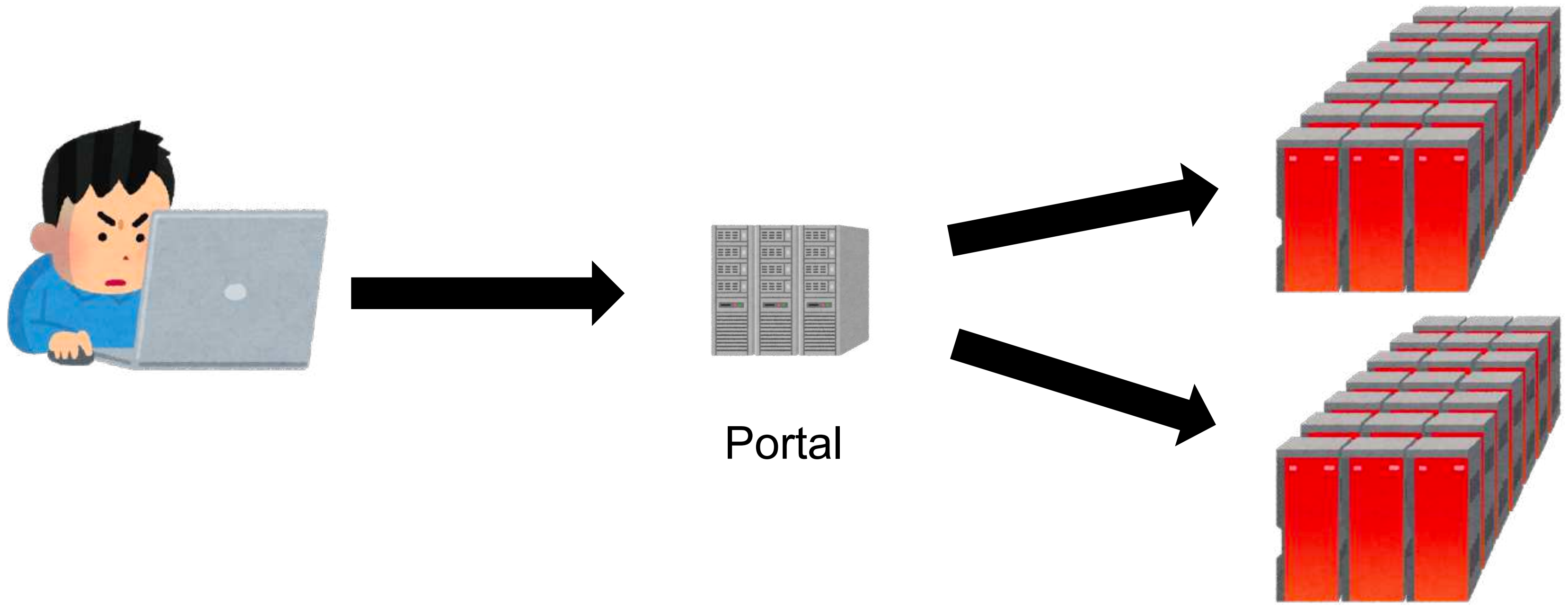
```
In [7]: interact(Lorenz, N=fixed(10), angle=(0.,360.),
                 σ=(0.0,50.0),β=(0.,5), ρ=(0.0,50.0))
```

angle	308.2
max_time	12
σ	10
β	2.6
ρ	28

https://jupyter.org/

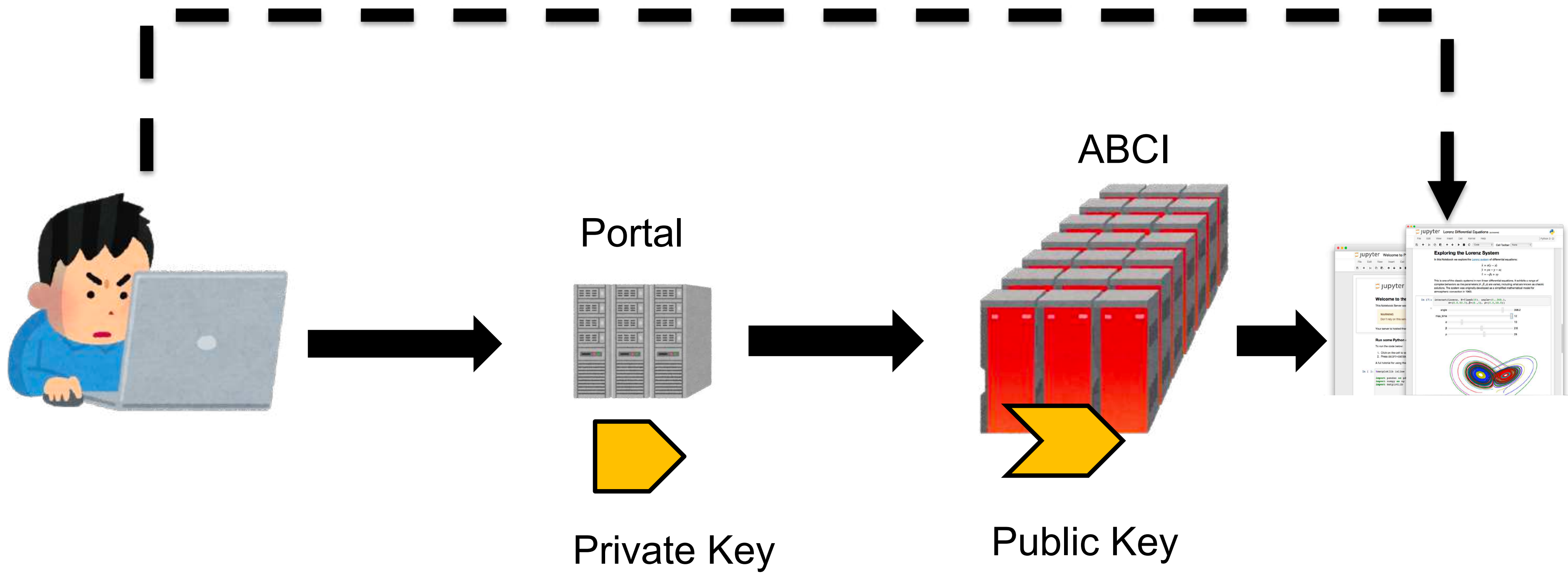
The Scenario

- Users log on to a portal via Web browser
- Select computational / data resources and code
- Start up notebooks on the specified computer resource and access it with the Web browser



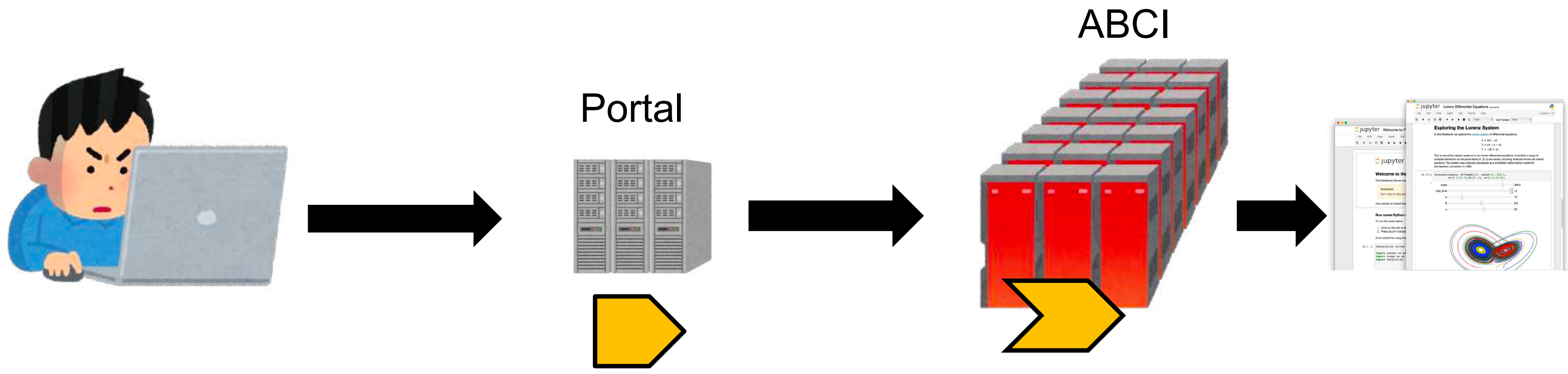
Naïve implementation

- Install the Private key on the Portal
- Directly connect to the notebook server



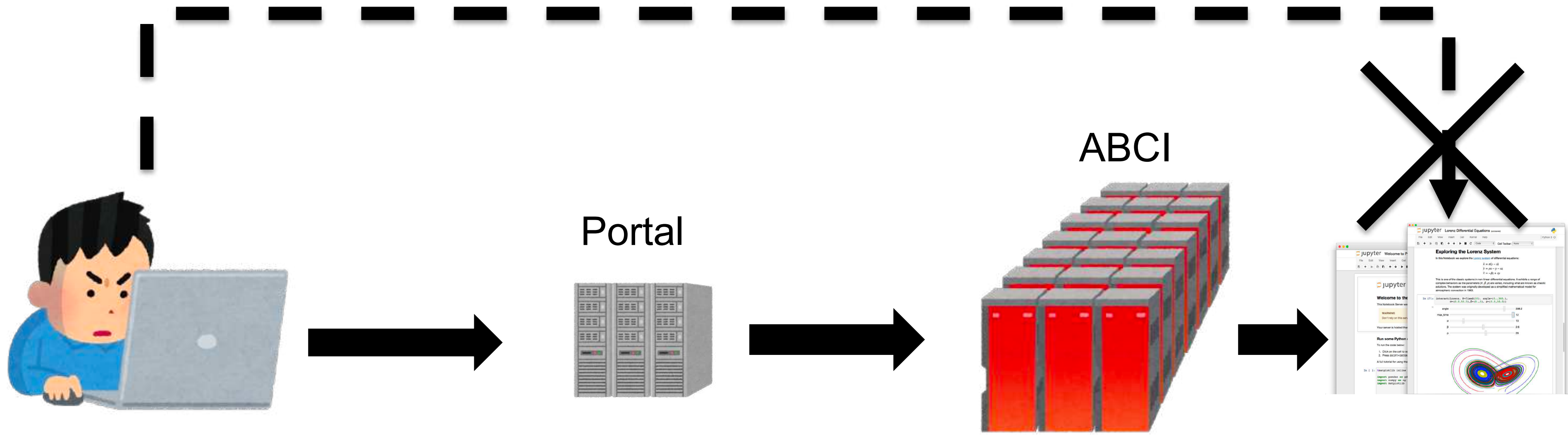
Technical Issue 1

- Where to keep private keys to log on the computational resources
  - To submit jobs to the computer, ssh connection is required
  - We don't want to keep user's private keys on the portal
    - If the portal is compromised, the attacker can do anything on the computational resources



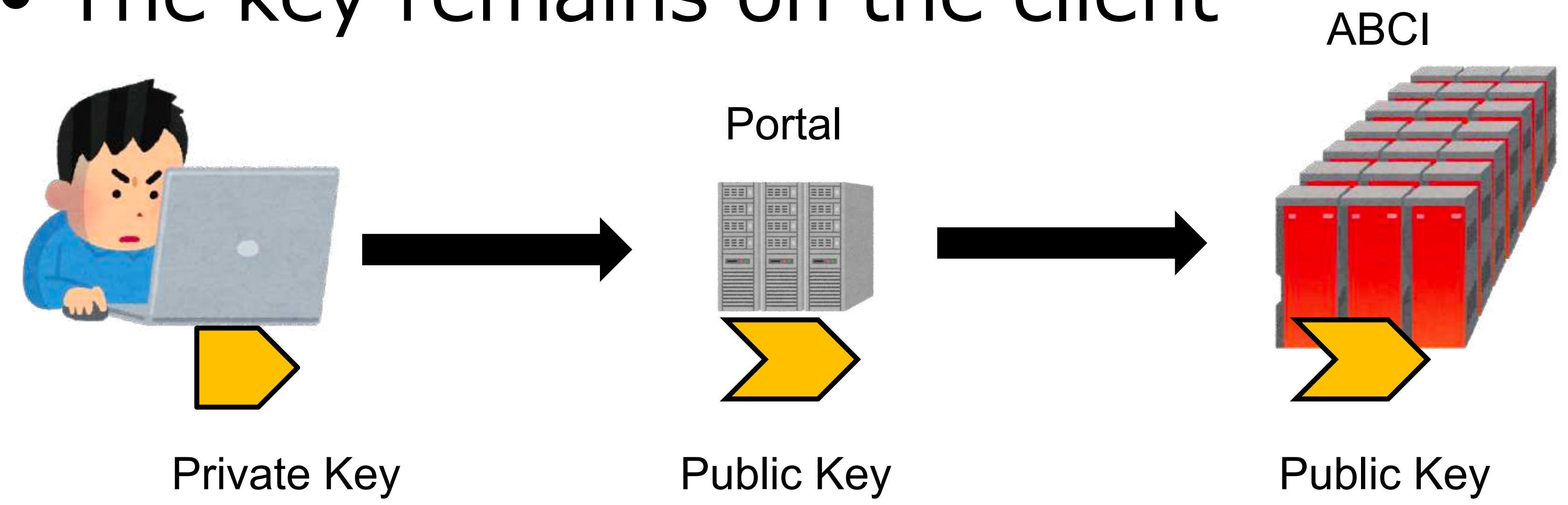
Technical Issue 2

- How to connect to the notebook on the computational resources
  - Supercomputers typically does not allow direct connections to the computational nodes
  - Outbound communication might be allowed, inbound communication is prohibited, typically.



How to Connect to supercomputers: Solution 1.

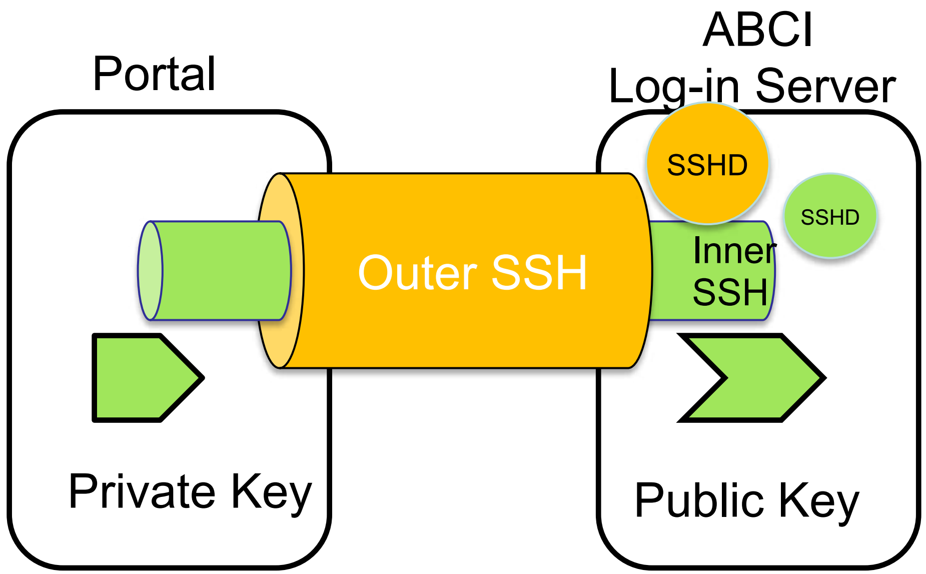
- Use ssh authentication forwarding
- The key remains on the client



- This is not enough since the user have to stay logged in on the Portal

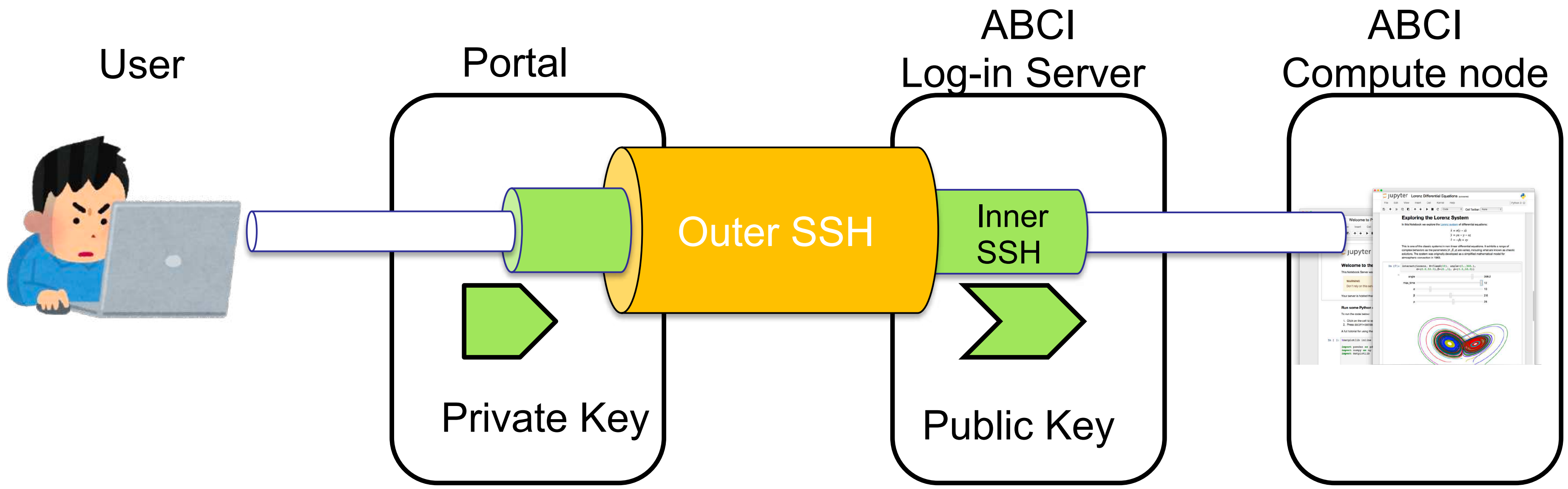
Solution 2: Nested SSH trick

- Establish a tunnel with the original keypair
  - Once the tunnel is established, the user can log out from the portal
- Invoke user-level SSHD, that works with another keypair with less capability
  - It can invoke container with notebooks only.



How to connect the notebook?

- Nested SSH tunneling!
- This is not enough, since the compute node is dynamically allocated
  - It is not possible to establish the tunnel when we start the inner SSH



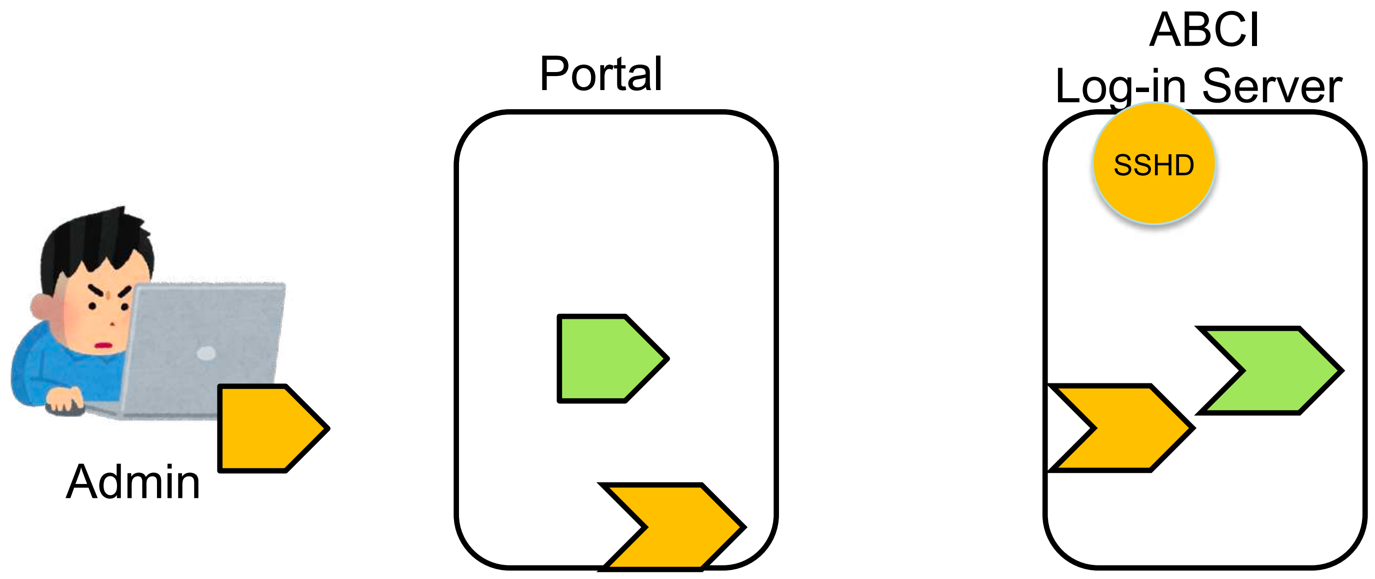
ON-the-fly tunnel management.

- We can add / delete tunnel **on the fly**
- Control Master allows us to dynamically share the connection.
- Control Master opens a socket file to control the sharing.

- > ssh –S SOCKET –O forward L:8000:HOSTNAME:8000 abci

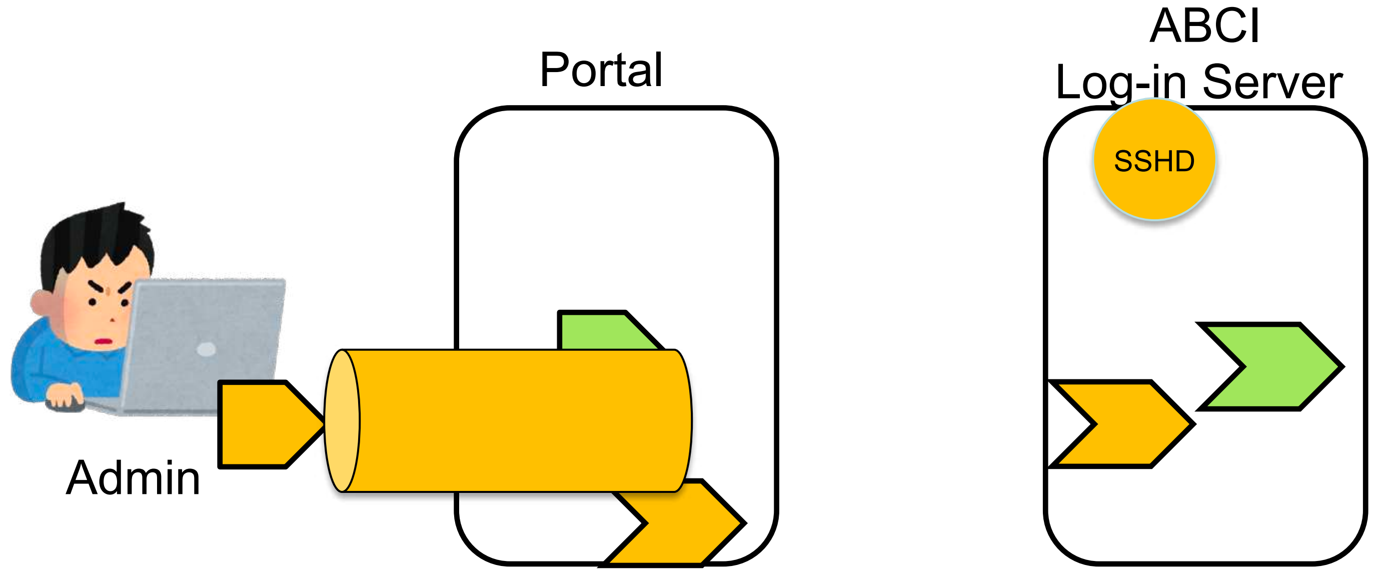
Summary

- Private Key is at the admin user's computer only
- Users can connect to the dynamically allocated computer resources



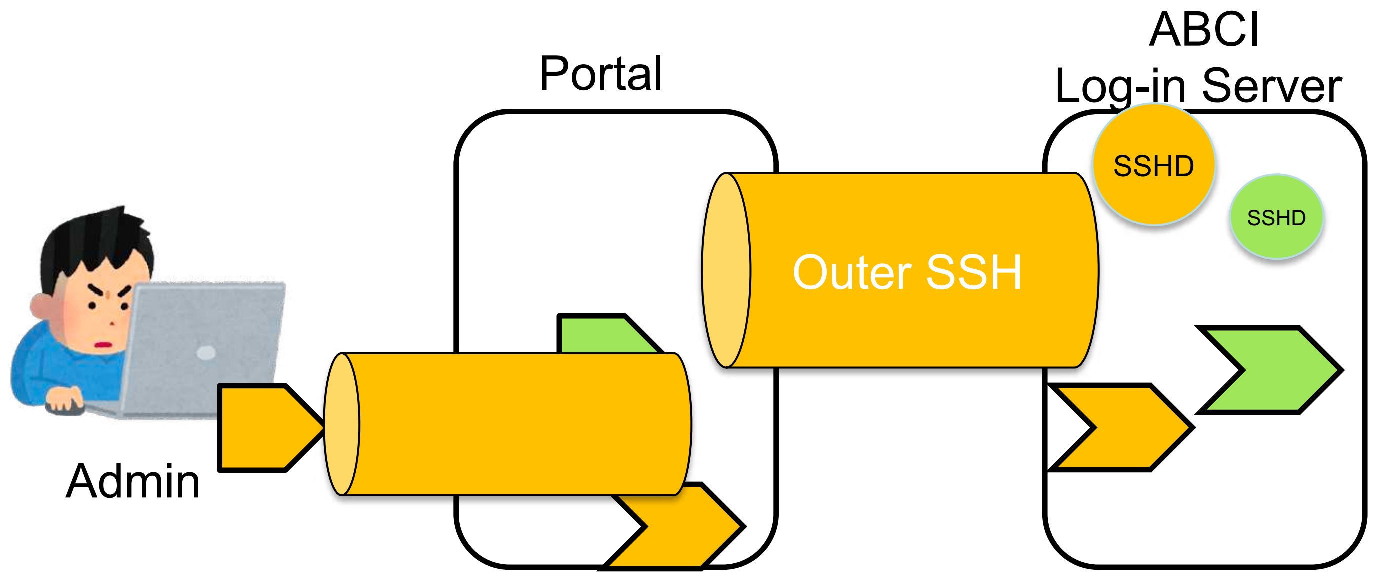
Step 1

- Admin logs in to the portal



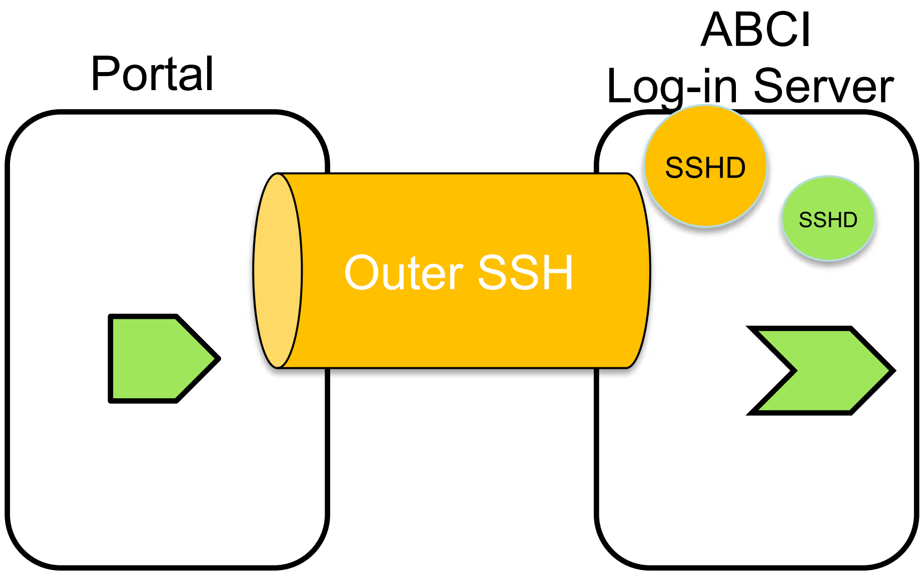
Step 2

- Establish the Outer SSH forwarding port for user-level inner SSH



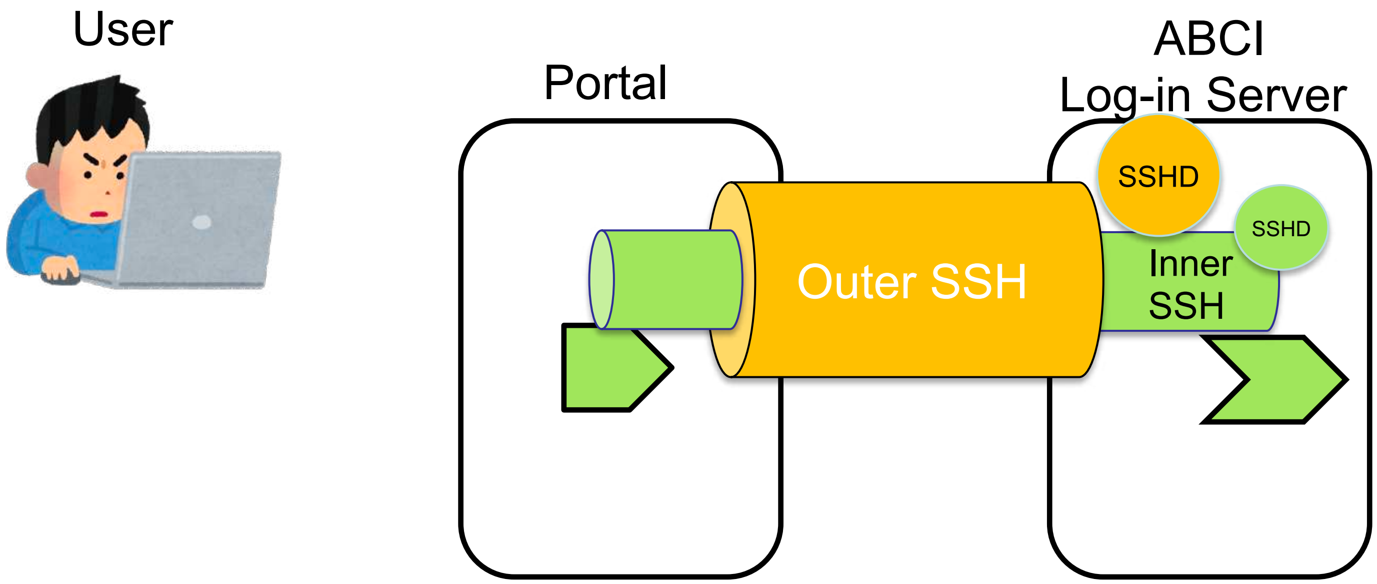
Step 2.5

- Admin logs out from portal.



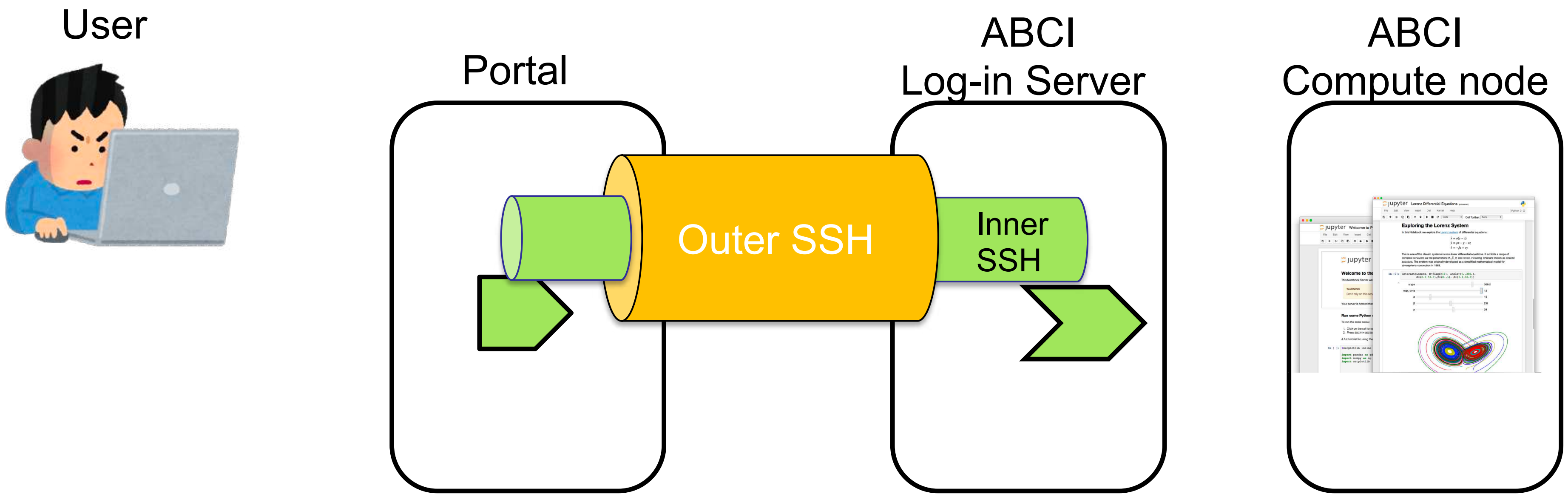
Step3

- User logs in the portal with **Web Browser**
  - and launch Jupyter notebook container process with inner SSH connection



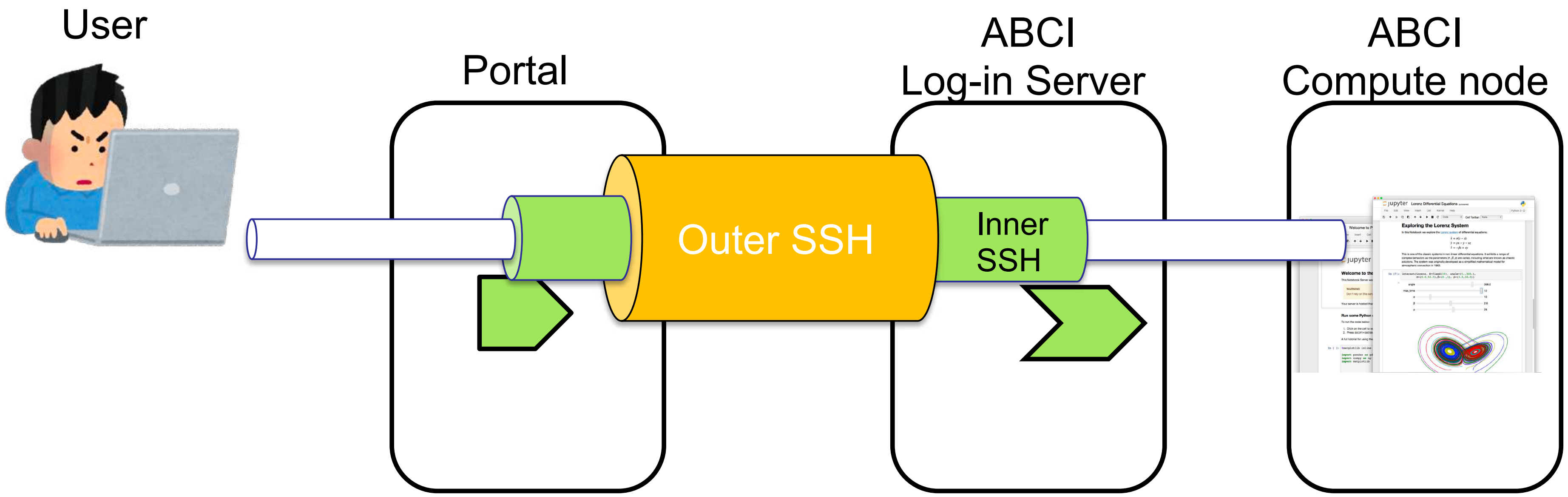
Step3.5

- Computer resources are allocated



Step4

- The Portal program add the port forwarding to give access to the user's browser.



Demo

Conclusion

- We believe Jupyter Notebook is a good candidate as a user interface for data exploration
- We can provide Notebooks on dynamically allocated computer resources with containers

Future work

- Investigate Jupyterhub and consider to integrate our portal with it
  - Jupyterhub uses outbound connection
- User authentication on the portal
- Notebook isolation
- Notebook sharing