# Lecture 19: Deployment/Ansible

AC215

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SEAS/ Harvard

# Announcements

- **Showcase Info - Missing ~7 projects**

  Form → https://forms.gle/CewUpMnmYq2BxupW6

- **React Zoom Session -**
  **Friday 11/15 - 3:00 - 4:30 PM** (will be recorded)

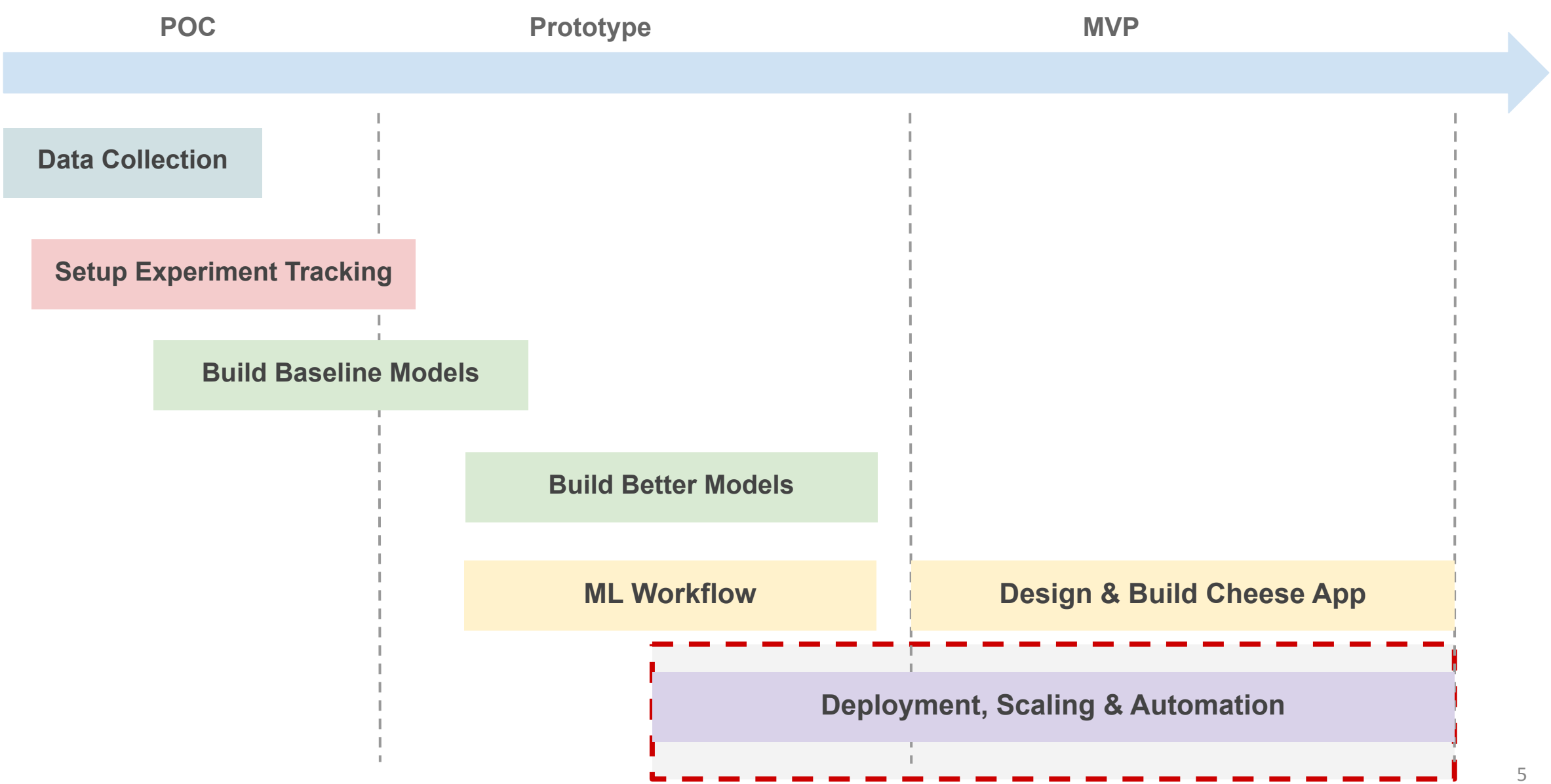
# Outline

1. Recap
2. Deployment

# Outline

1. **Recap**
2. Deployment

# Recap: Cheese App Status



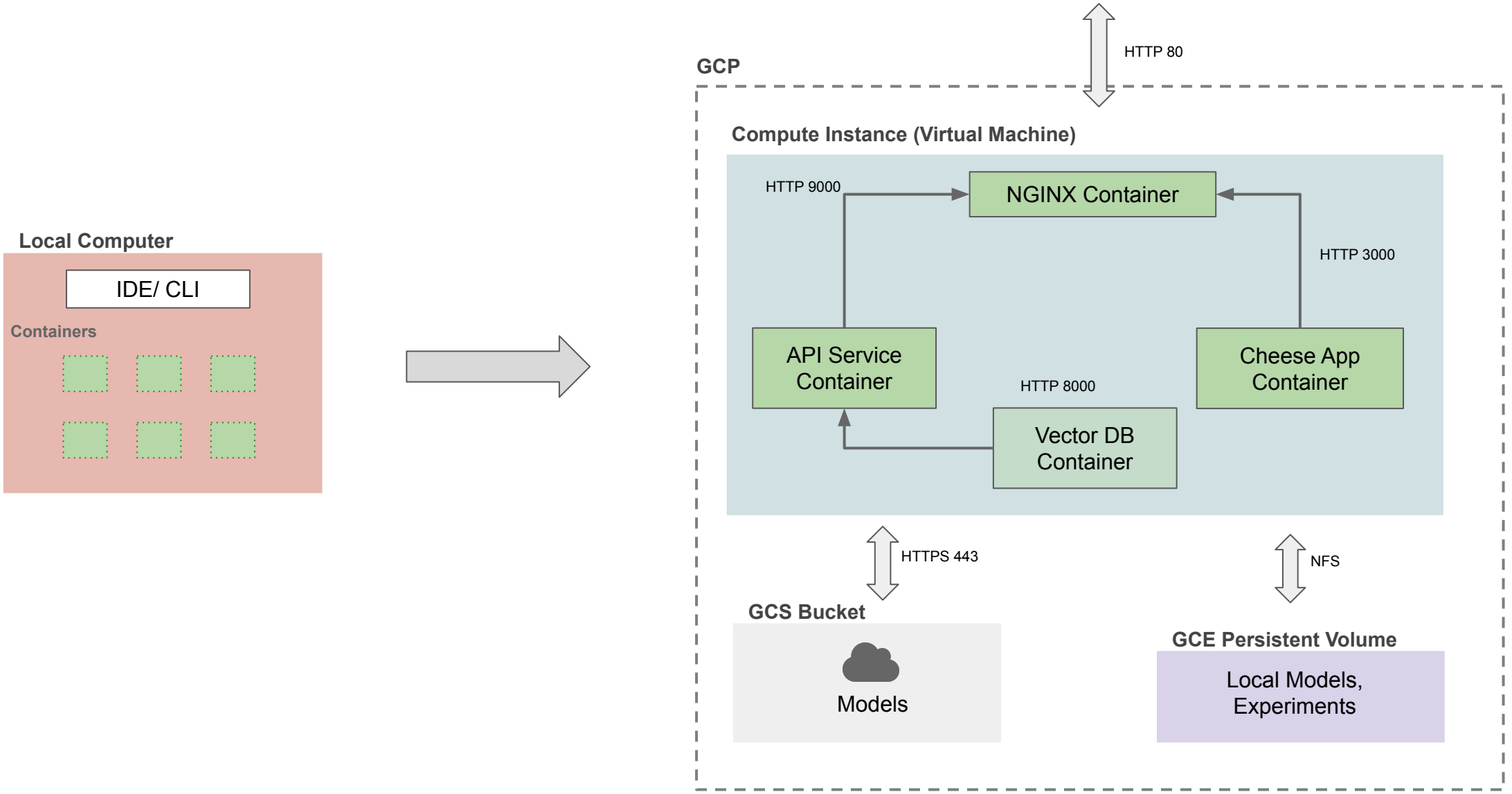
# Recap: APIs & Frontend App

- Everything we built is on our **local computer**
- We need to **deploy** this to a server so our users can access

# Outline

1. Recap
2. **Deployment**

# Deployment: Goal



# Tutorial: Deployment Steps (Manual)

**Push to Docker Hub:** Build and push Docker images for API service and Frontend to Docker Hub repository

**Setup VM Environment:** Create VM instance on GCP and install Docker, create required folders and set permissions

**Deploy Containers:** Run Docker containers for API service and Frontend, creating a dedicated network for communication

**Configure Web Server:** Setup Nginx as reverse proxy, configure routing for API and Frontend services

Cheese App - Deployment to GCP (Manual)

# Deployment Automation

In our manual deployment there were various steps to keep track of.

We want to automate this!

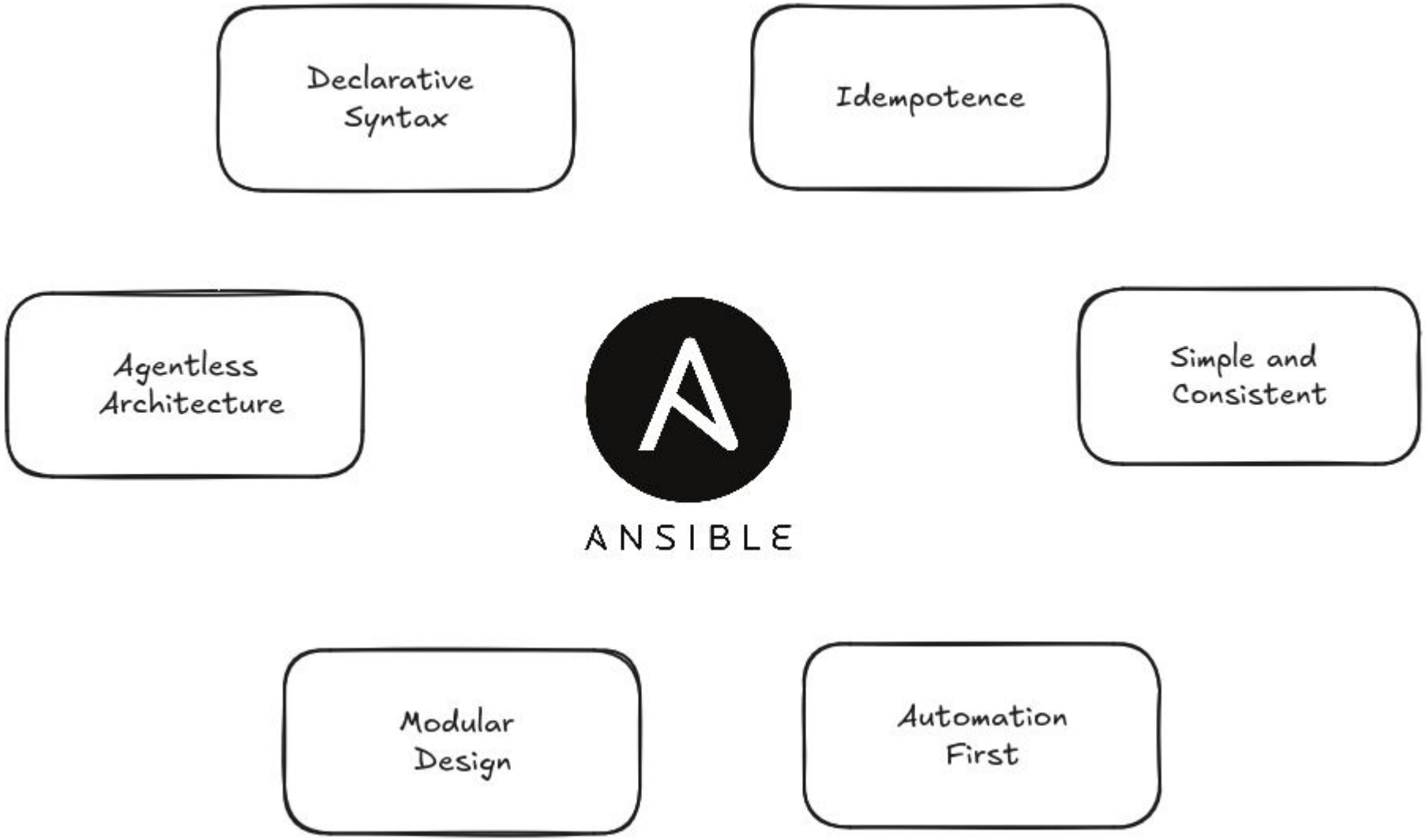
# Ansible

- Is a tool for infrastructure automation
- Think of infrastructure as code
- Ansible scripts (playbooks) consist of instructions for tasks like
  - Server & Cluster creation/deletion
  - Software installation & setup
  - Networking setup
- Everything is code, so you can check it into GitHub and share

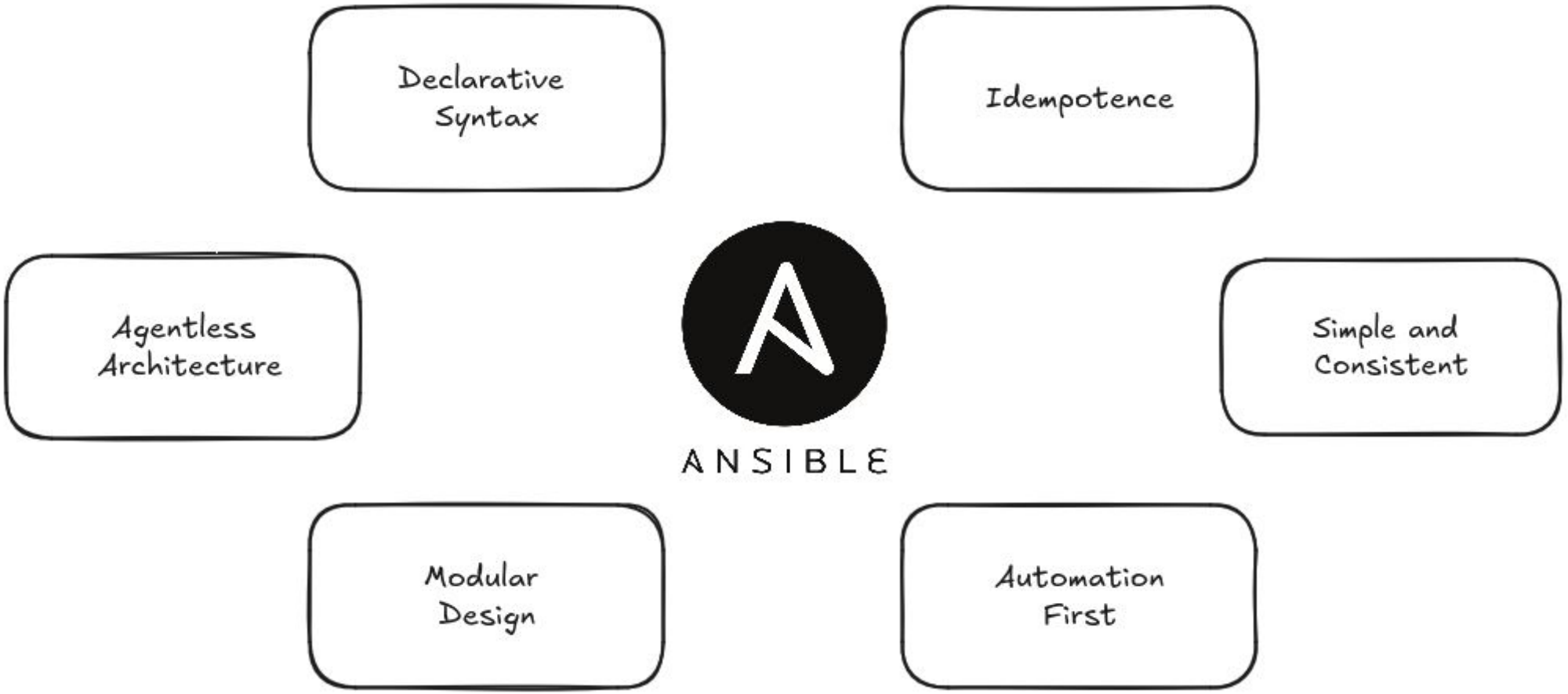
# Ansible: History

- Ansible was created by Michael DeHaan in 2012 and acquired by Red Hat in 2015.
- It configures systems like Linux and Windows without needing an agent, using SSH or Windows Remote Management.
- The control node runs on any system with Python.
- System setup is defined in a simple **domain specific language** written in files called playbooks.

# Ansible : Principles



# Ansible : Principles



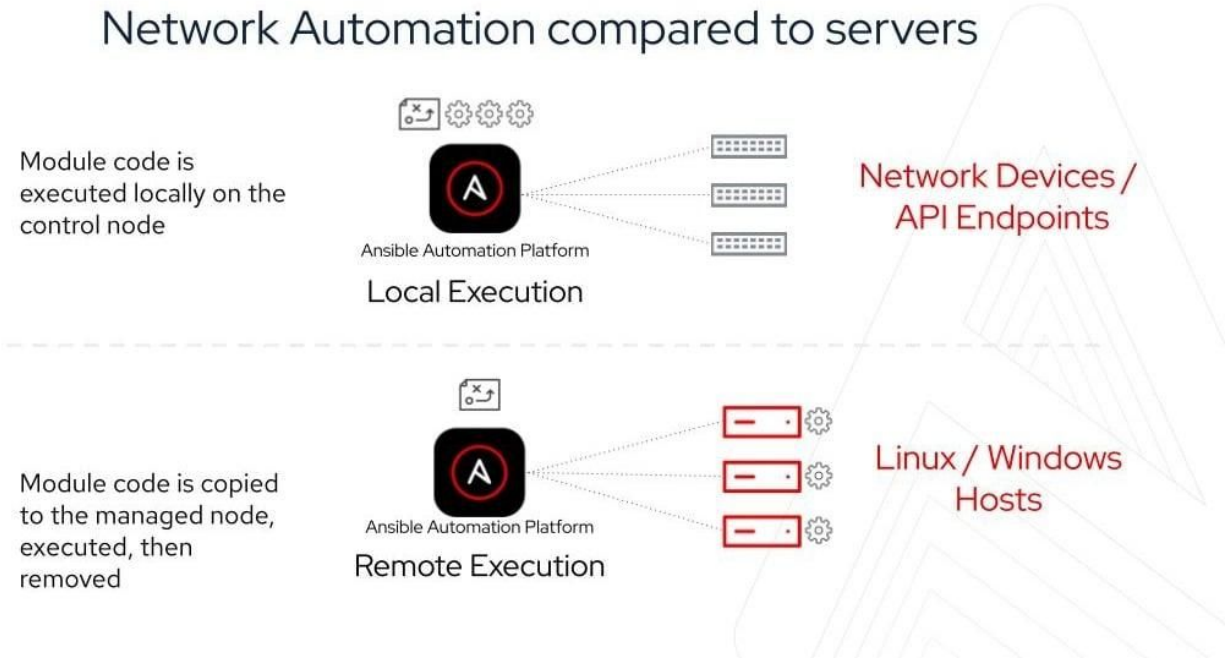
# Ansible: Concepts

- Ansible commands
- Playbooks
- Inventory
- Fact Gathering
- Plays
- Tasks
- Modules

# Ansible: Concepts

Ansible connects to managed nodes and pushes out small programs — called **modules** — to them.

Ansible **executes** these modules **remotely** (over SSH by default) and removes them when finished.




ANSIBLE MANAGED HOSTS DON’T NEED ANY INSTALLED AGENTS

# Ansible :  Commands

**Running Ad-Hoc Commands with Ansible**

ansible <target> -m <module> -a "<arguments>" -i <inventory>

- <target>: Specifies the host(s) or group(s) to run the command on.
- -m <module>: Defines the module to use (e.g., ping, shell, yum).
- -a "<arguments>": Provides arguments for the module (e.g., commands for shell).
- -i <inventory>: Points to the inventory file listing the hosts.

# Ansible :  Commands

**Some useful adhoc commands**

**# ping all your managed hosts**

ansible all -m ping

**# list all  managed hosts**

ansible all --list-hosts

**# gather facts on managed hosts**

ansible webservers -m gather_facts

# Ansible : Commands

**More useful adhoc commands**

**# gather facts on specific host**

ansible webservers -m gather_facts – limit 172.16.250.132

**# install apache2 on webservers with privilege escalation**

ansible webservers -m apt -a name=apache2 --become --ask-become-pass

**# update apt cache on all servers with privilege escalation**

ansible all -m apt -a update_cache=true --become --ask-become-pass

# Ansible Playbook command

**Running Playbooks with Ansible**

ansible-playbook <playbook_file.yml> -i <inventory> [options]

- <playbook_file.yml>: YAML file with tasks and configurations to automate.
- -i <inventory>: Inventory file listing hosts or groups.
- [options]: Additional options, such as --check (dry-run) or --limit (run on specific hosts).

# Ansible :  Commands

**Adhoc commands become tasks in plays/playbook**

**We run plays/playbooks via ansible command**

```
ansible-playbook --ask-become-pass site.yml
```

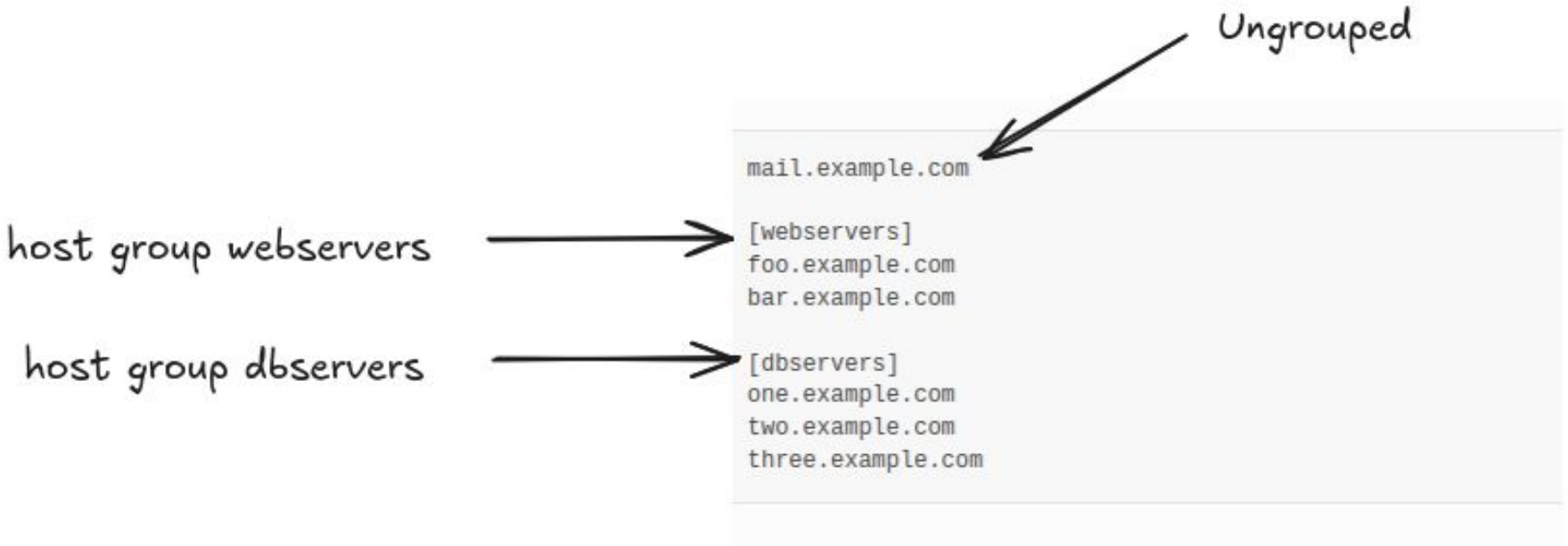
# Ansible : Playbooks

- Ansible Playbooks manage system behavior written in a Domain Specific Language (DSL) based on YAML (Yet Another Markup Language)
- The declarative syntax is easy to read and supports modular design.
- Playbooks are highly sensitive to indentation.

```
---
- name: Update web servers
  hosts: webservers
  remote_user: root

  tasks:
  - name: Ensure apache is at the latest version
    ansible.builtin.yum:
      name: httpd
      state: latest

  - name: Write the apache config file
    ansible.builtin.template:
      src: /srv/httpd.j2
      dest: /etc/httpd.conf

- name: Update db servers
  hosts: databases
  remote_user: root

  tasks:
  - name: Ensure postgresql is at the latest version
    ansible.builtin.yum:
      name: postgresql
      state: latest

  - name: Ensure that postgresql is started
    ansible.builtin.service:
      name: postgresql
      state: started
```

# Ansible : Inventory

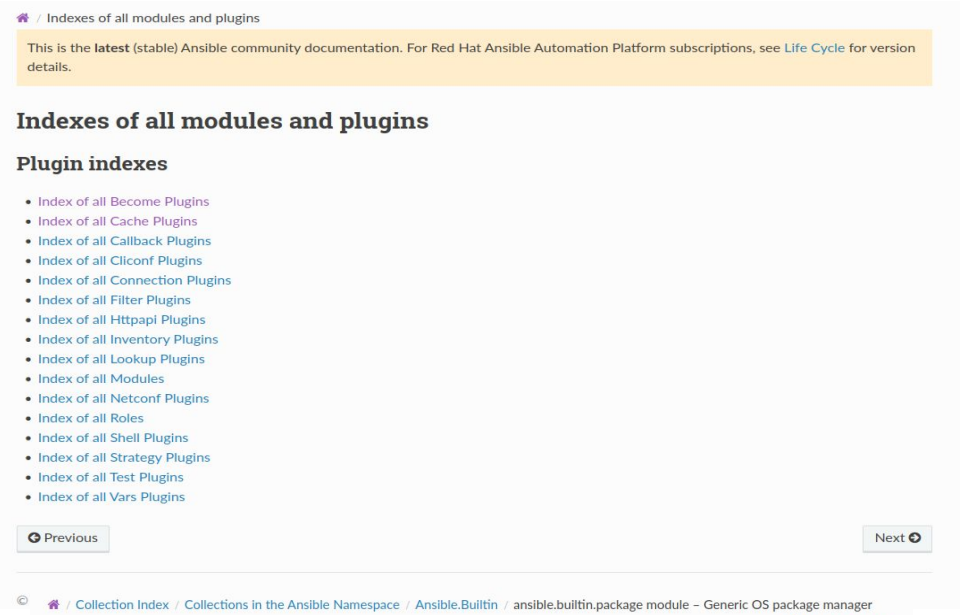
- The inventory file lists hosts and organizes them into groups.
- Hosts are identified by domain names or IP addresses.
- Groups are defined by headers in the file.
- Hosts outside any group are placed in the “ungrouped” group.
- Ansible also includes a default group named “all,” containing all hosts.

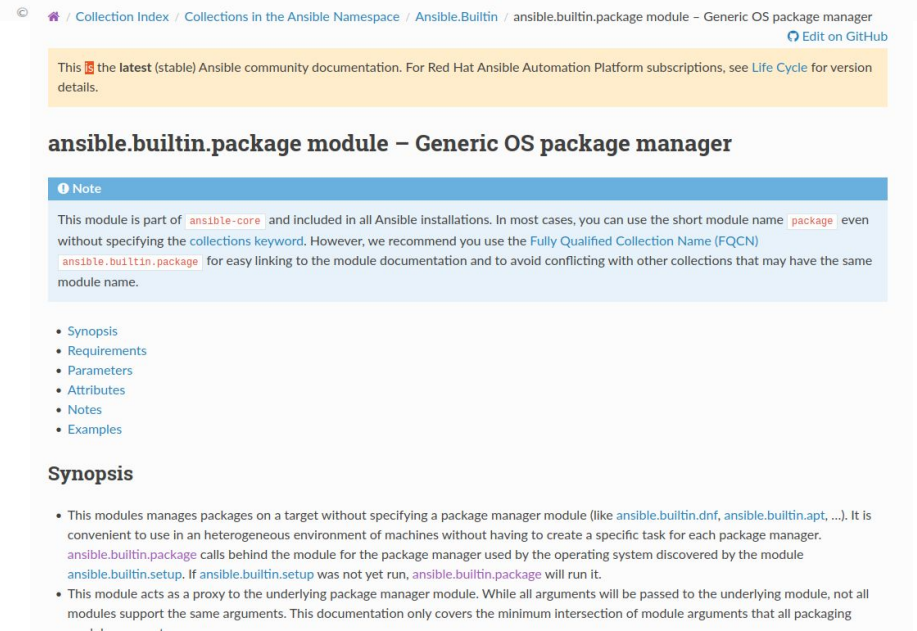


# Ansible : Modules

- **Modules** represent the desired state of the system.
- These modules are designed to be **idempotent** when possible, only making changes to a system when necessary.

You can find Ansible modules in the Ansible Documentation, which lists all available modules by category. Additionally, modules are included in the standard Ansible installation and can be browsed directly on your system, typically located in /usr/share/ansible/plugins/modules.



# Ansible : Fact Gathering

**# gather facts on specific host**

ansible webservers -m gather_facts –limit 172.16.250.132

**info can be used to define variables or conditions later on**


```
        "scheduler_mode": "deadline",
        "sectors": "167772160",
        "sectorsize": "512",
        "size": "80.00 GB",
        "support_discard": "0",
        "vendor": null,
        "virtual": 1
    }
},
"ansible_distribution": "CentOS",
"ansible_distribution_file_parsed": true,
"ansible_distribution_file_path": "/etc/redhat-release",
"ansible_distribution_file_variety": "RedHat",
"ansible_distribution_major_version": "7",
"ansible_distribution_release": "Core",
"ansible_distribution_version": "7.5.1804",
"ansible_dns": {
    "nameservers": [
        "127.0.0.1"
    ]
},
"ansible_domain": "",
"ansible_effective_group_id": 1000,
"ansible_effective_user_id": 1000,
"ansible_env": {
    "HOME": "/home/zuul",
    "LANG": "en_US.UTF-8",
    "LESSOPEN": "||/usr/bin/lesspipe.sh %s",
    "LOGNAME": "zuul",
    "MAIL": "/var/mail/zuul",
    "PATH": "/usr/local/bin:/usr/bin",
    "PWD": "/home/zuul",
    "SELINUX_LEVEL_REQUESTED": "",
    "SELINUX_ROLE_REQUESTED": "",
    "SELINUX_USE_CURRENT_RANGE": "",
    "SHELL": "/bin/bash",
    "SHLVL": "2",
    "SSH_CLIENT": "REDACTED 55672 22",
    "SSH_CONNECTION": "REDACTED 55672 REDACTED 22",
    "USER": "zuul",
    "XDG_RUNTIME_DIR": "/run/user/1000",
    "XDG_SESSION_ID": "1",
    "_": "/usr/bin/python2"
},
"ansible_eth0": {
    "active": true,
    "device": "eth0",
    "ipv4": {
        "address": "REDACTED"
```

# Anatomy of a playbook

*'-' at the lowest level of indentation represent* ***plays***

***hosts*** *apply* ***plays*** *to host groups defined in the inventory file*

**becomes** determines privilege escalation

**tasks** are defined for each **play**

each **task** has a **name**

each **task** has a **module** that defines what the task doe

```
---
- name: Configure webserver on the server instance
  hosts: appserver
  connection: ssh
  become: true

  tasks:
    # Create and Setup Nginx
    - name: Copy nginx config files
      copy:
        src: "./nginx-conf/nginx"
        dest: "/conf"
    - name: Create nginx container
      docker_container:
        name: "nginx"
        image: "nginx:stable"
        state: started
        recreate: yes
        published_ports:
          - 80:80
          - 443:443
        networks:
          - name: "{{docker_network_name}}"
        volumes:
          - /conf/nginx/nginx.conf:/etc/nginx/nginx.conf


    - name: "Restart nginx container"
      shell: "docker container restart nginx"
```

**Plays**

**Tasks**

**Modules**

# Deployment Steps (Ansible / Automation)

1. Setup local container to connect to GCP
2. Build and push docker images to GCR
3. Create Compute Instance (VM) in GCP
4. Provision the server (Installed required softwares)
5. Setup Docker containers in VM Instance
6. Setup a web server to expose our app to the outside world

# Setup local container /GCP

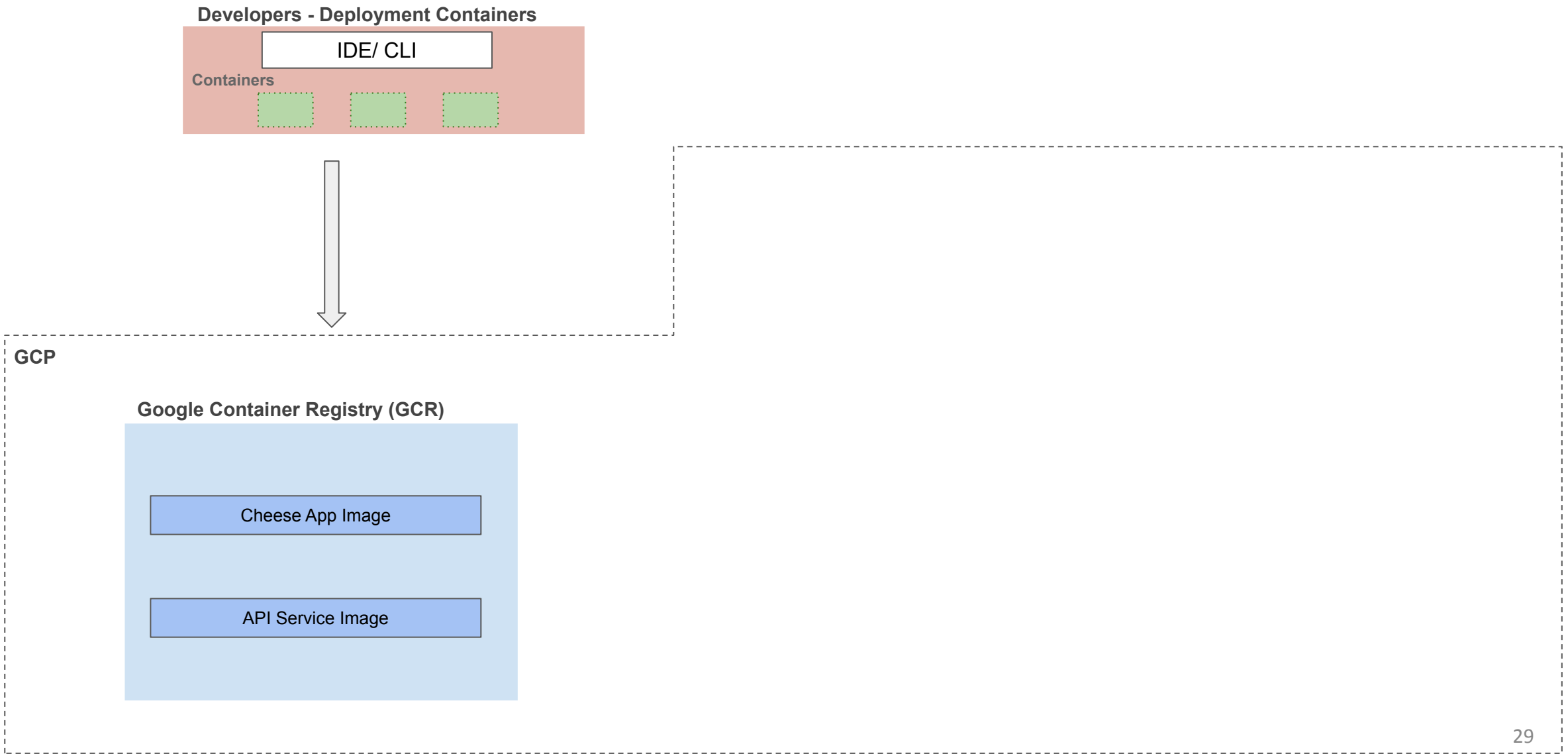
Setup required GCP

- Enable APIs
- Create service accounts
  - **deployment** (To deploy everything to GCP)
  - **gcp-service** (To read containers from GCR in VM)

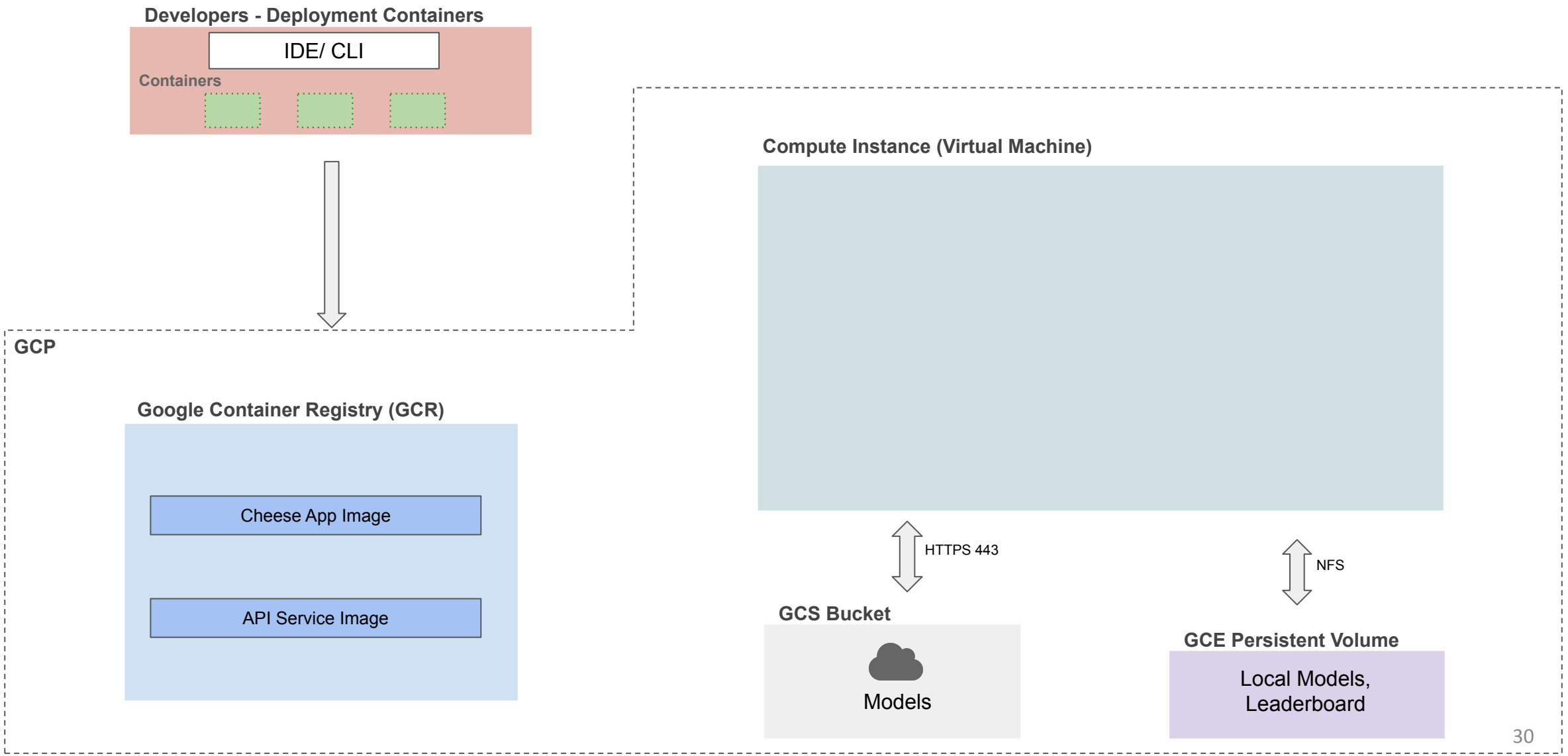
Setup local deployment container

- Add secret keys
- Set GCP project we want to connect to

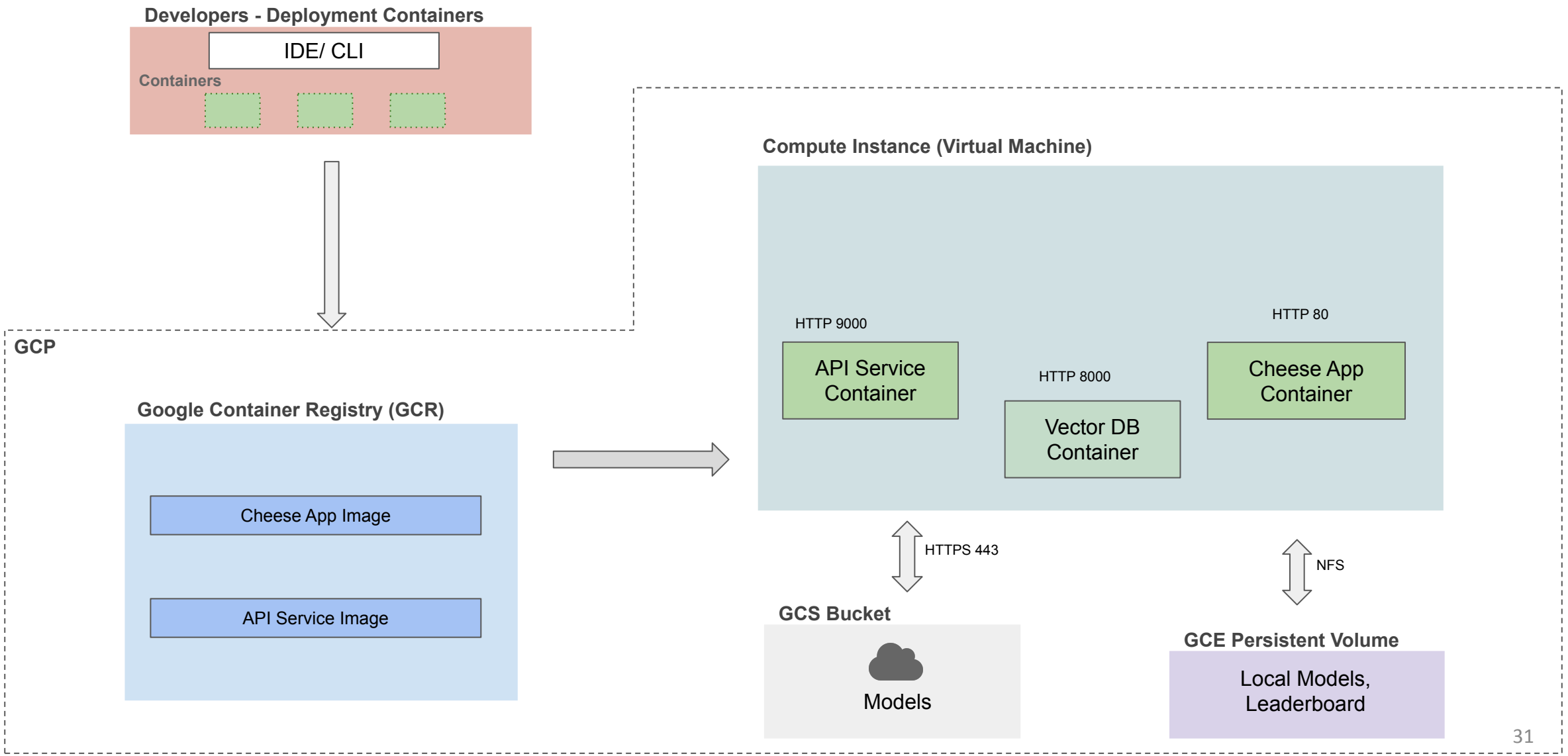
# Build & Push Docker Images to GCR



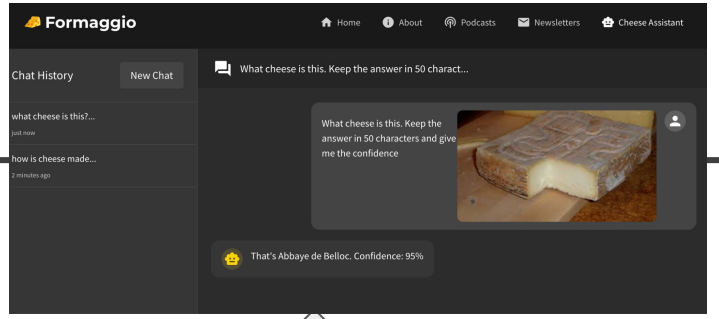
# Create Compute Instance (VM)



# Setup Docker Containers in VM



# Setup Web Server to expose App




HTTP 80

Developers - Deployment Containers

IDE/ CLI

Containers

GCP

Compute Instance (Virtual Machine)

HTTP 9000

NGINX Container

HTTP 3000

API Service Container

Cheese App Container

HTTP 8000

Vector DB Container

Google Container Registry (GCR)

Cheese App Image

API Service Image

HTTPS 443

NFS

GCS Bucket

Models

GCE Persistent Volume

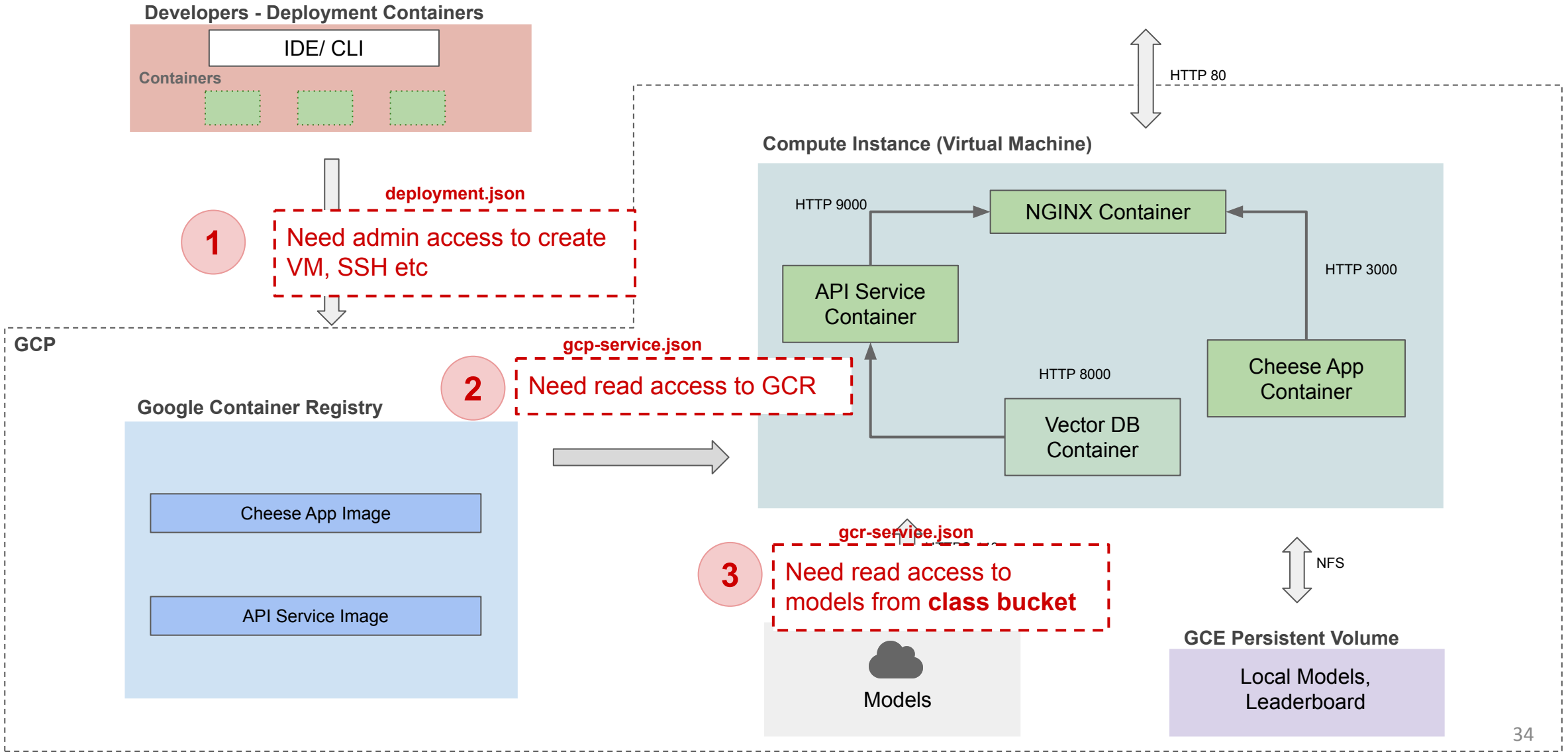
Local Models, Leaderboard

# Why did we need 2 service accounts?

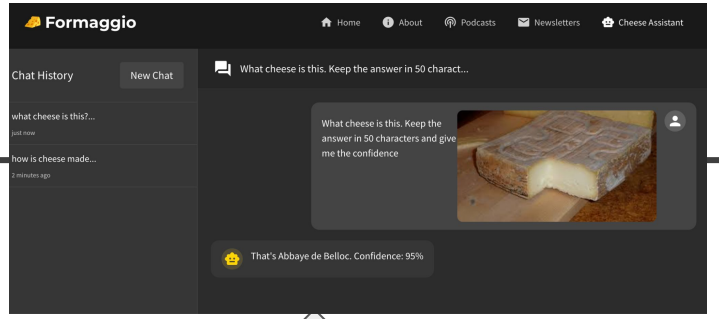
Why do we need the following service accounts?

- **deployment**
  - Has admin access to **your** group GCP project
- **gcp-service**
  - Has read access to **your** group GCP projects GCR
  - Has access to Vertex AI to perform inference

# Why did we need 2 service accounts?



# Test the App




HTTP 80

Developers - Deployment Containers

IDE/ CLI

Containers

GCP

Compute Instance (Virtual Machine)

HTTP 9000

NGINX Container

HTTP 3000

API Service Container

HTTP 8000

Cheese App Container

Vector DB Container

Google Container Registry

Cheese App Image

API Service Image

HTTPS 443

NFS

GCS Bucket

Models

GCE Persistent Volume

Local Models, Leaderboard

# Tutorial: Deployment to GCP (Ansible)

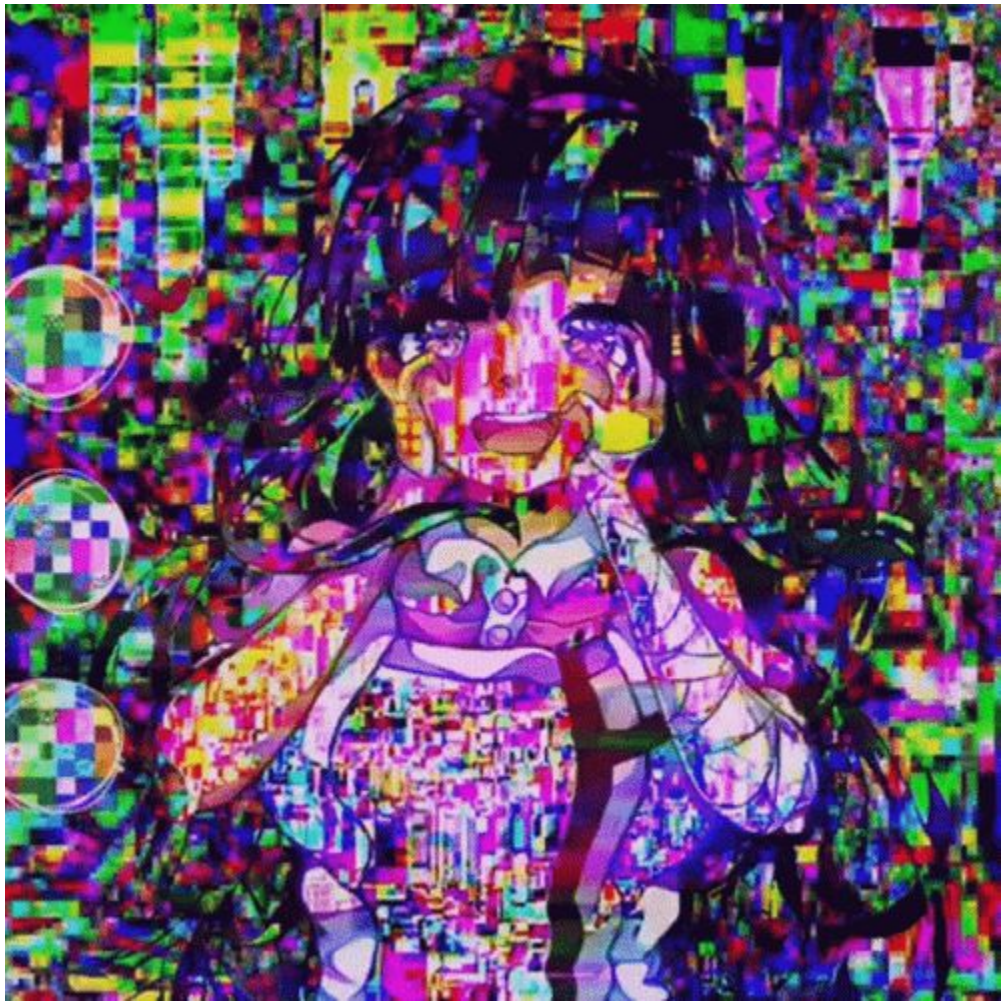
Cheese App - Deployment to GCP (Ansible)

**Build & Push Images**: Use `deploy-docker-images.yml` to build and push Docker containers to Google Container Registry (GCR)

**Create VM Instance:** Deploy a Compute Engine VM using `deploy-create-instance.yml` with the specified configuration in `inventory.yml`

**Provision Instance:** Install required dependencies and setup environment using `deploy-provision-instance.yml`

**Deploy Application:** Configure and launch Docker containers (API, Frontend, Nginx) using `deploy-setup-containers.yml` and `deploy-setup-webserver.yml`



# DON’T FORGET TO DELETE


THANK YOU!!!