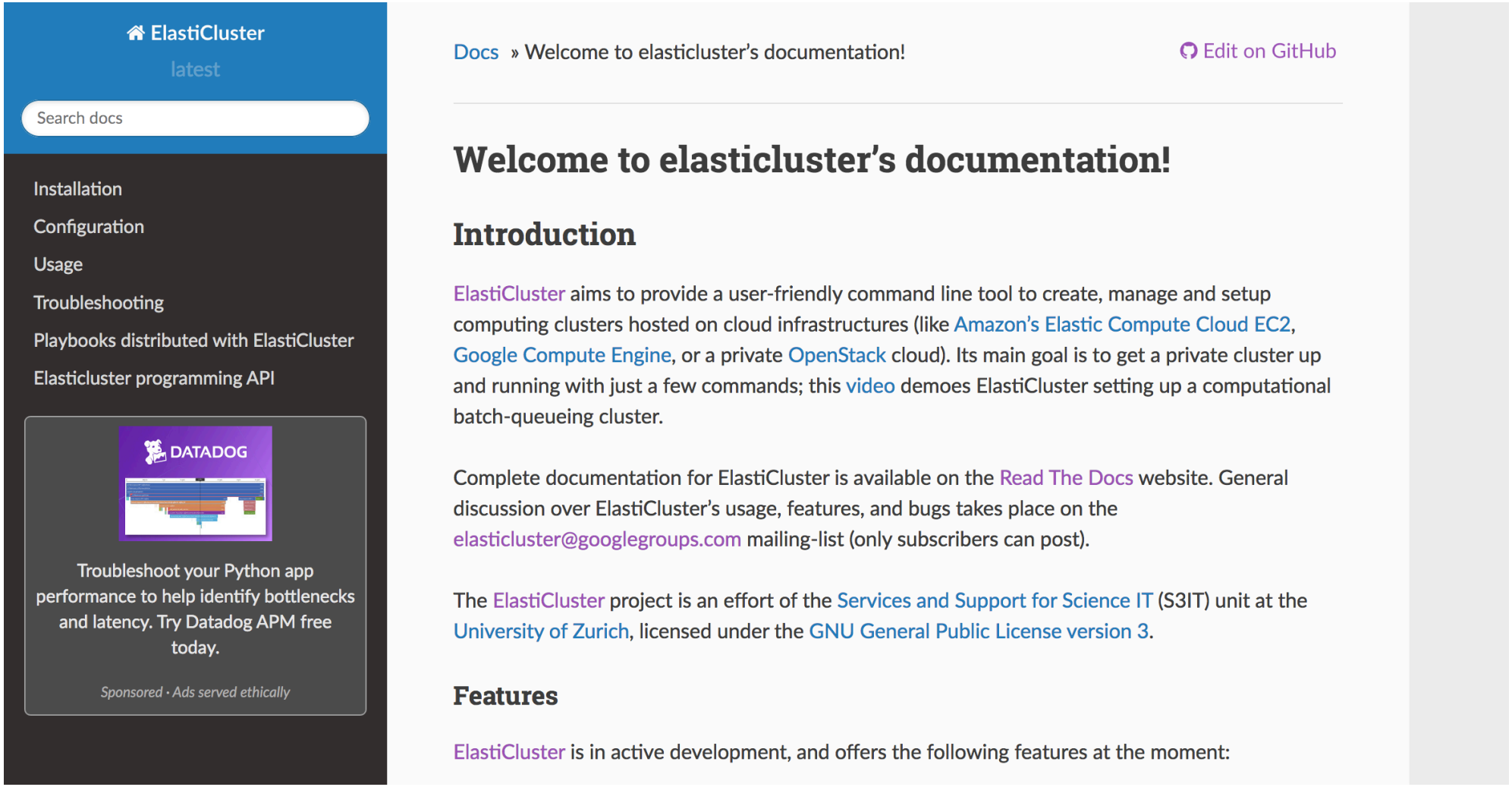
Part 2.
Create a cluster on the cloud
Elasticluster tutorial

Learn how to create your own computer cluster

Norwegian Research and Education Cloud (NREC) Openstack cloud

Elasticluster



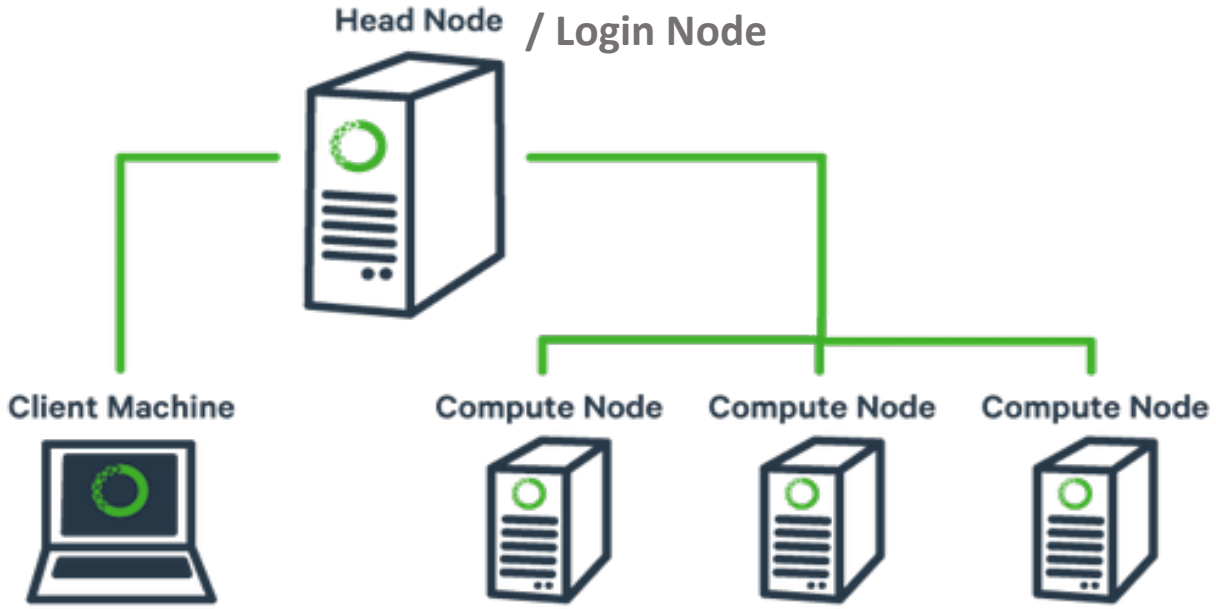
https://elasticluster.readthedocs.io/en/latest/index.html

What is Elasticluster and when to use it

- *"ElastiCluster aims to provide a user-friendly command line tool to create, manage and setup computing clusters hosted on cloud infrastructures (like Amazon's Elastic Compute Cloud EC2, Google Compute Engine, or a private OpenStack cloud)."*
- Uses a combination of python and ansible to achieve this
- Example use-case:
  - You have access to a cloud resource
  - You do not have access to an HPC resource, or you do not want to use your quota there
  - You would like to run some application that requires more cores than you have available (general use-case for cluster computing) and that can benefit from more cores i.e. be parallelized

Simplified view of a computing cluster

- A cluster is comprised of
  - A master machine and/or login-node
  - A set of compute-nodes/worker-nodes
  - A cluster management and job scheduling system orchestrating the jobs that come in
    - SLURM



Steps needed to create your own cluster

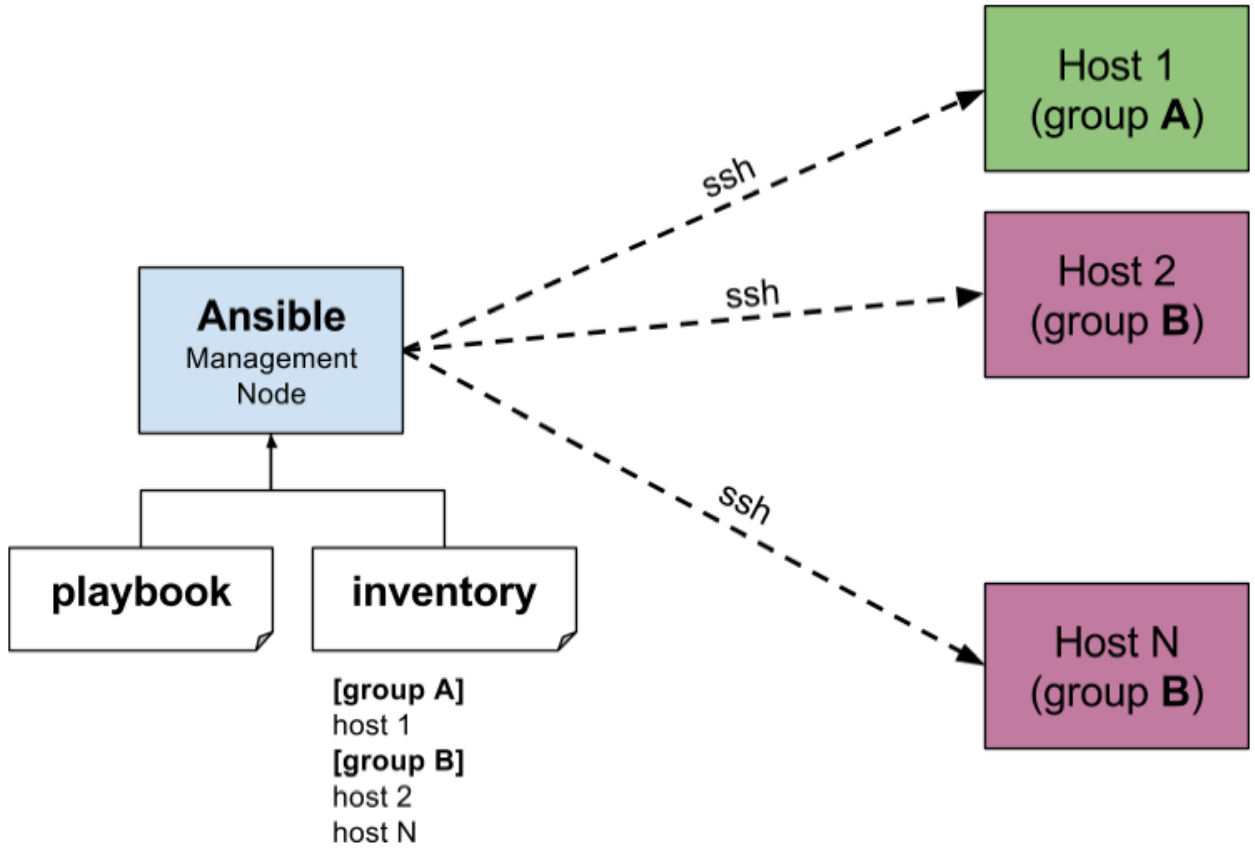
1. Create the virtual machines the cluster needs
   - One master machine
   - Several compute-nodes
2. Configure the machines
   - Install needed software
   - Adding any additional storage
   - Set up any needed shared storage
3. Log into master machine and submit a job

Your mini-cluster

- One login/master node
- Two compute/work nodes
- SLURM queueing system

Ansible

- Elasticluster configures machines using Ansible
- Ansible is an automation tool
  - Instructions are written in yaml-format
  - Skips steps already done, has various fault handling features, and options to run some tasks only by using tags etc, etc.
- You could just write a set of python scripts or a bash scripts that do the same, but that quickly becomes more time-consuming



Ansible terminology

- Ansible inventory file: A list of hostnames and/or ip-addresses in groups
- Ansible playbook: Set of instructions to perform: "*Playbooks are Ansible's configuration, deployment, and orchestration language.*"
- Ansible roles: framework for breaking down a playbook into a file-structure
  - Each role contains a set of variables, templates, files and tasks
  - Example: one role for configuring a compute node, and another for the frontend/login node

site.yml - playbook

```
---
- hosts: webservers
  roles:
     - common
     - webservers
```

Example inventory file

```
mail.example.com

[webservers]
foo.example.com
bar.example.com

[dbservers]
one.example.com
two.example.com
three.example.com
```

Example role folder structure

```
site.yml
webservers.yml
fooservers.yml
roles/
    common/
        tasks/
        handlers/
        files/
        templates/
        vars/
        defaults/
        meta/
    webservers/
        tasks/
        defaults/
        meta/
```

Demo of running a small ansible script

- Task: Install nano on all the admin nodes

1. Get a list of machines (here called hosts) to run on
   - Can be grouped by servers, like e.g. a set of login machines, compute machines, all machines etc etc
   - Can be created in a variety of ways
     - Manually
     - If you set up your machines with elasticluster, you will find the list of hosts – the so-called inventory file in ~/.elasticluster/storage/inventory_<your-cluster-name>
     - Command-like client for the cloud architecture you are using – for us: openstack client
       - openstack server list
       - Needs installation, see e.g. https://docs.openstack.org/mitaka/user-guide/common/cli_install_openstack_command_line_clients.html

```
[admin]
student00 ansible_host=158.39.48.136
student01 ansible_host=158.39.75.98
student02 ansible_host=158.37.63.228
student03 ansible_host=158.39.48.48
student04 ansible_host=158.37.63.242
student05 ansible_host=158.39.48.10
student06 ansible_host=158.39.48.68
student07 ansible_host=158.39.48.18
student08 ansible_host=158.39.48.75
student09 ansible_host=158.39.48.29
student10 ansible_host=158.39.48.54
```

Ansible demo contd.

2. Create a playbook

- This is the recipe for ansible to follow – it contains everything that ansible needs to perform the tasks you define
- Our demo will install the nano text editor using yum
  - Example: ansible yum module doc: https://docs.ansible.com/ansible/latest/modules/yum_module.html
- Run the playbook:

```
ansible-playbook -i hosts_inf9380_simple -l student00 --
private-key=~/.ssh/inf9380-ssh  demo_role.yml
```

Ansible demo contd.

- Perform the same things, but now using a role

```
- hosts: admin
  become: true


  roles:
   - demo
```

```
site.yml
webservers.yml
fooservers.yml
roles/
    common/
        tasks/
        handlers/
        files/
        templates/
        vars/
        defaults/
        meta/
    webservers/
        tasks/
        defaults/
        meta/
```

Ansible demo contd.

- Run an ad-hoc command

```
  ansible –i hosts_inf9380_simple student00 –m yum –a "name=emacs
state=present" ––become
```

Elasticluster playbooks available

- Setup variables
  - General setup variables
  - Feature variables
    - Azure files
- Compute clusters
  - SLURM
  - GridEngine
  - Hadoop + Spark
  - HTCondor
  - Kubernetes
  - PBSPro
  - TORQUE
- Filesystems and storage
  - CephFS
  - GlusterFS
  - OrangeFS/PVFS2

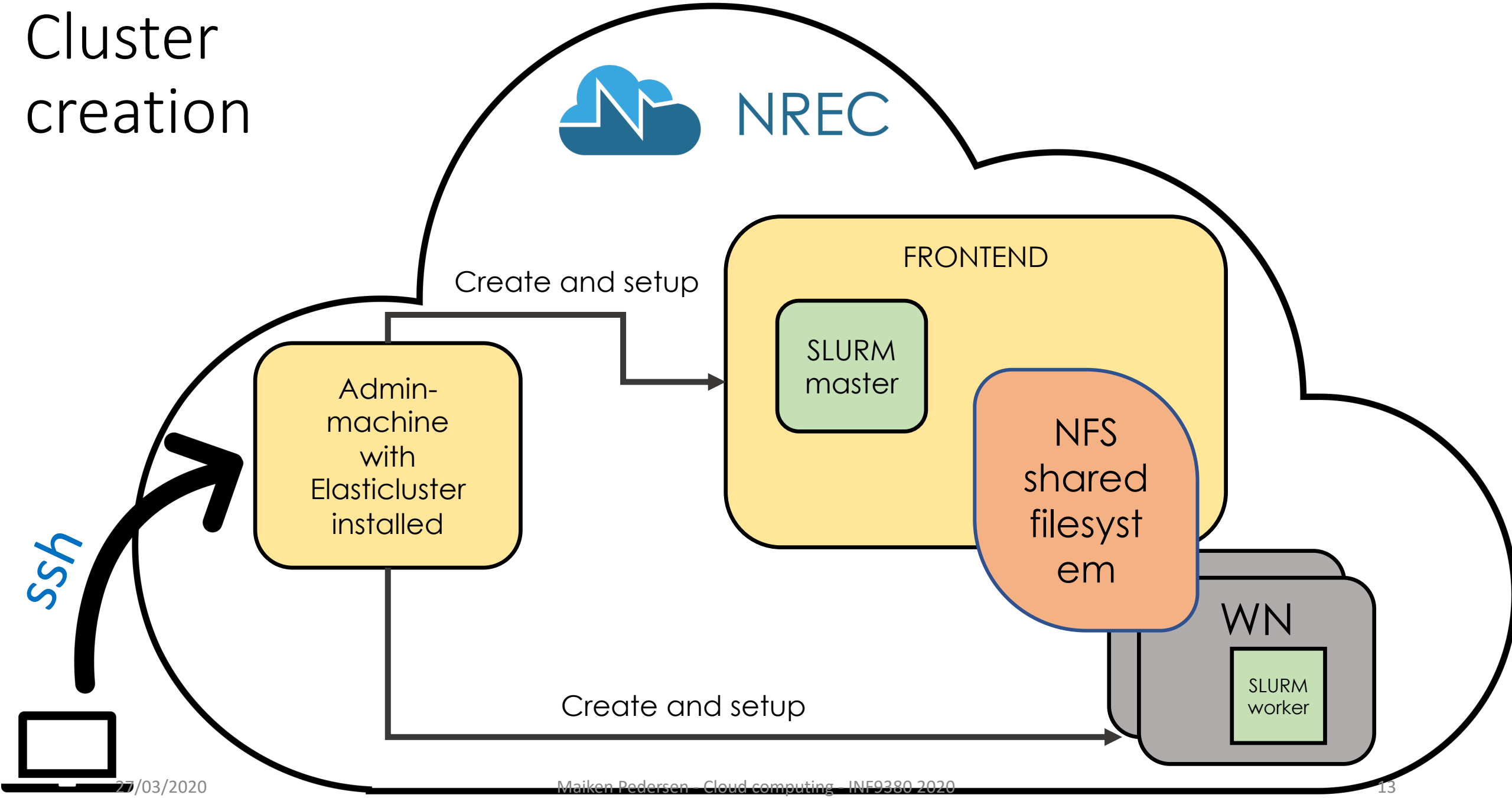
- Add-on software
  - Anaconda
  - Ansible
  - CUDA
  - Docker CE
  - EasyBuild
  - Ganglia
  - IPython cluster
  - HPC common
  - Julia language
  - JupyterHub
  - OpenCPU
  - R language
  - R Studio Server
  - SAMBA

Elasticluster cluster configuration file (INI format)

- [cloud] section
  - What cloud platform and how to authenticate
- [login] section
  - Login details to the cluster
- [setup] section
  - What playbooks to install
  - Definition of host groups
- [cluster] sections
  - Cluster name, here student00
  - Definition of the host machine types

```
[cloud/iaas]
provider=openstack
auth_url=https://api.uh-iaas.no:5000/v3
username=some-username@some-email
password=some-password-token
project_name=uio-itf-inf9380
user_domain_name=dataporten
project_domain_name=dataporten
region_name=osl
identity_api_version=3


[login/centos]
image_user=centos
image_user_sudo=root
image_sudo=True
user_key_name=inf9380-ssh
user_key_private=~/.ssh/inf9380-ssh
user_key_public=~/.ssh/inf9380-ssh.pub


[setup/slurm]
slow_but_safer=True
provider=ansible
global_var_multiuser_cluster=no
login_groups=slurm_master
compute_groups=slurm_worker,julia

[cluster/student00]
cloud=iaas
login=centos
setup=slurm
security_group=inf9380
login_nodes=1
compute_nodes=2
ssh_to=login
network_ids=62421b56-346d-4794-99b0-fc27fe4e700f
image_id=0f6d4a45-043b-4231-872d-4c8f1aee34fc

[cluster/student00/login]
flavor=m1.small

[cluster/student00/compute]
flavor=m1.small
```

Cluster creation



Let’s install elasticluster and create the clusters