Session 4

- Research method (from Session 3)
- Guest presentation:
  - Sohail Khan on computer vision
- Cloud computing, NREC and OpenStack
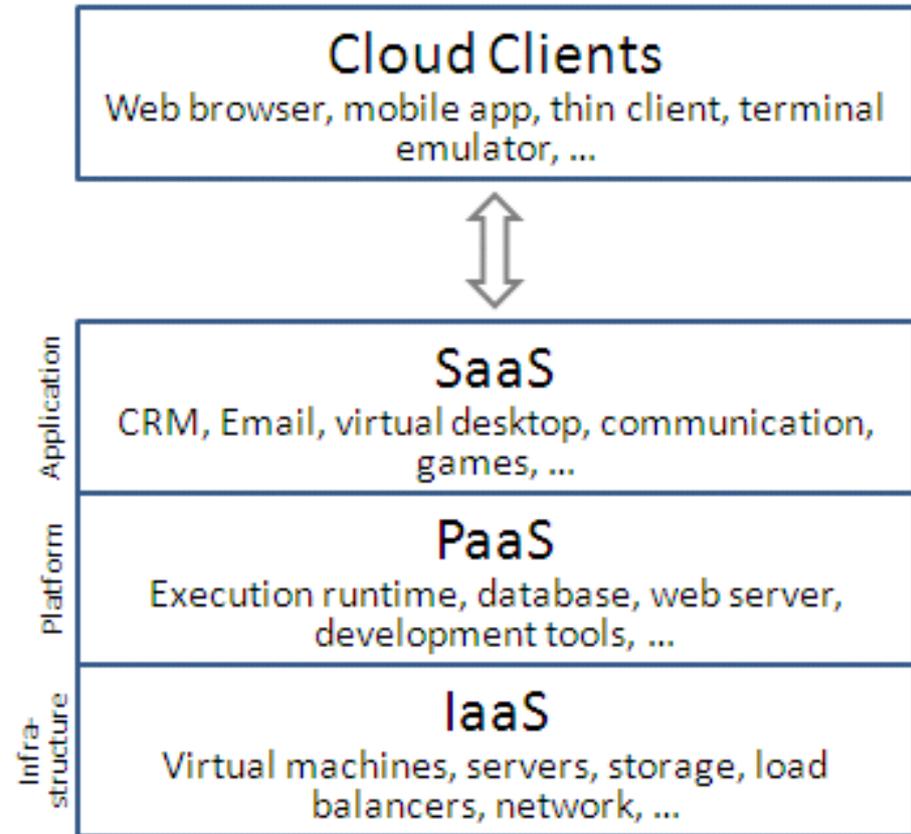- Practical Linux
- Exercises 3 & 4

OpenStack and the NREC cloud

Cloud computing

- Cloud computing:
  - *computing resources and services available on demand*
  - typically *non-locally*
  - *without direct active management* by the user
- e.g.,
  - data storage (cloud storage)
  - computing power (virtual machines, GPUs, TPUs)
  - web hosting
  - GMail, office365, GitHub...

Cloud Clients
Web browser, mobile app, thin client, terminal emulator, ...

Application

SaaS
CRM, Email, virtual desktop, communication, games, ...

Platform

PaaS
Execution runtime, database, web server, development tools, ...

Infra-structure

IaaS
Virtual machines, servers, storage, load balancers, network, ...

Cloud computing

- Advantages:
  - focus on core business, competitive advantage
  - economy of scale, shared costs, higher specialisation
  - flexibility, scalability, avoid lock-in
- Dangers:
  - dependency on provider, lock-in
  - giving away information, software, processes
  - can be(come) expensive
- Some commercial providers:
  - Amazon AWS
  - Google Cloud, access to GPUs, TPUs
  - IBM Cloud, including Watson

NREC

- The Norwegian Research and Education Cloud (NREC)
  - since 2016
  - collaboration project between UiB and UiO
  - hosted locally (Bergen, Oslo)
  - almost only open-source software
- The NREC cloud provides
  - self service via a *web portal* to manage virtual machines
  - *command line tools* and programming language *APIs*
  - accessing and using the *virtual machines* as ordinary ones
  - *efficiency* by consolidating small virtual machines onto larger metal ones
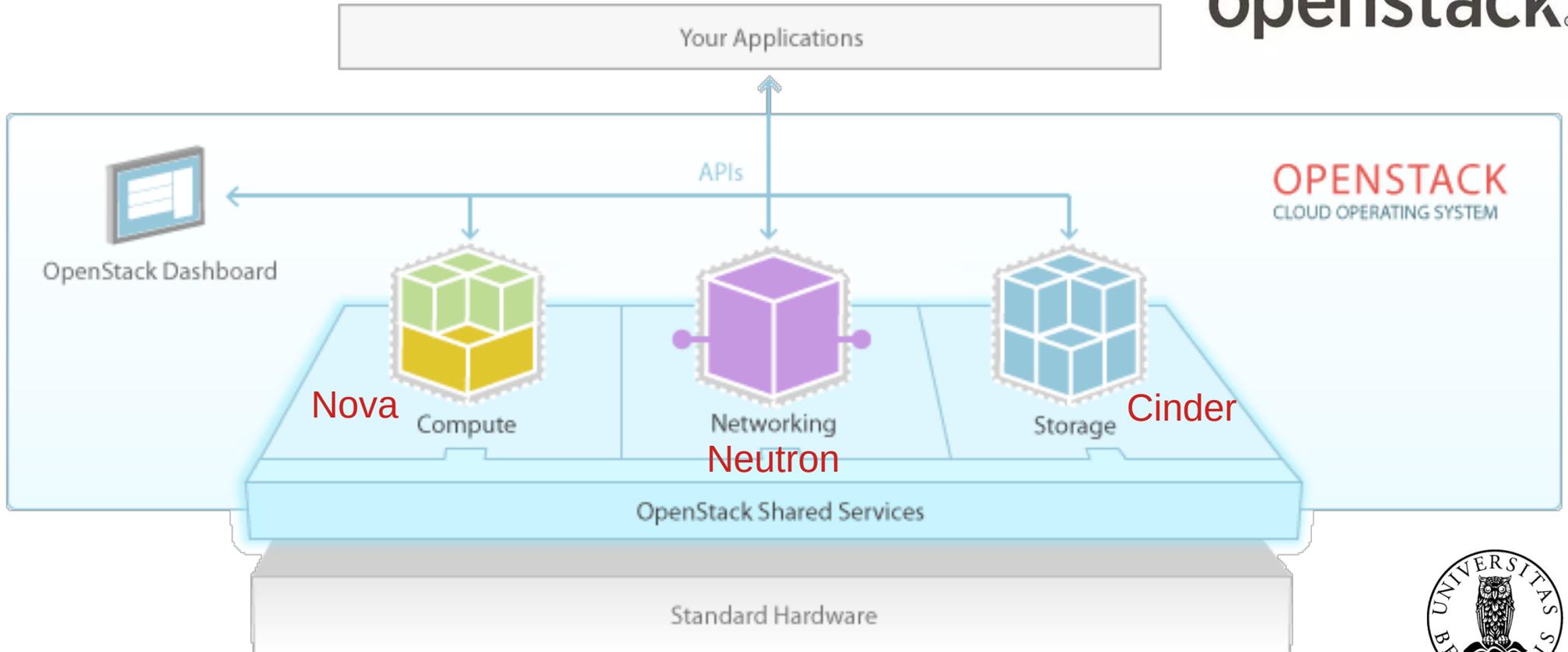 - *elasticity* and *scalability* (up to your quota)

OpenStack

- OpenStack:
  - framework for Infrastructure-as-a-Service (IaaS)
  - a «cloud operating system»
  - open-source
  - comprehensive, with components for delivering:
    - computing, networking and storage resources
    - identity and security
    - web UI, CLI, API

OpenStack architecture

Your Applications

OpenStack Dashboard

APIs

OPENSTACK
CLOUD OPERATING SYSTEM

Nova — Compute

Neutron — Networking

Cinder — Storage

OpenStack Shared Services

Standard Hardware

https://docs.openstack.org/zed/user/

OpenStack components

- Compute (Nova) - manages compute instances, supports creating, scheduling and deleting machines on demand

- Block Storage (Cinder) - provides persistent block storage to running instances, facilitates creation and management of block storage devices

- Identity service (Keystone) - authentication and authorization, provides endpoints to all other services

- Image service (Glance) - stores and retrieves virtual machine disk images, also used to create

- Dashboard (Horizon) - provides a web-based self-service portal, supports launching an instance, assigning IP addresses, configuring access, etc.

- Networking (Neutron) - enables network connectivity as a service, lets users define networks and attach resources to them

OpenStack overview (through the Dashboard)

- Compute tab
  - Overview: overview of active project
  - Instances: manage virtual machine instances (& emergency connection)
  - Images:
    - view images and instance snapshots, local or public
    - manage images, and launch instances from images and snapshots.
  - Key Pairs: manage SSH key pairs.
- Volume tab:
  - Volumes: manage volumes that can be mounted as disks
  - Snapshots: create and restore persistent copies of volumes
- Network tab:
  - Security Groups: manage security groups and rules

OpenStack instances

- Launch instance:
  - Flavor:
    - the size of a virtual machine and its characteristics
    - NREC has special high-performance flavours with GPUs
  - Image: a file with a virtual disk that has a bootable OS installed on it
  - Networks: IPv6, DualStack
  - Security Groups: which ports to open to/from which addresses
  - Key Pair: public SSH keys

- Make snapshot:
  - provides a copy of a currently running VM or volume (virtual disk)
  - can be stored into and restored from an external service

NREC sHPC instances

- Shared high-performance computing (sHPC) instances:
  - better processors
    - up to 64 processors 384Gb RAM
  - local hard drives
  - flavors for compute-heavy, memory-hungry and balanced workloads
  - isolated from the normal services.
  - much smaller overcommit ratios
  - scheduled downtime for maintenance
  - managed through OpenStack
    - must apply specially

NREC vGPU instances (beta)

- Shared virtual GPU (vGPU) instances:
  - running on metal GPUs
    - Tesla v100 with 16Gb RAM
  - pre-built images
  - managed through OpenStack
  - must apply specially
    - for "pure" vGPU projects
    - vGPU resources must be used
    - delete instance when no longer needed.

OpenStack security groups

- Which ports to open to/from which addresses
- Can be assigned to virtual machines (instances)
  - an instance always has the default security group (with *full egress*)
  - users can create additional groups
- Consists of rules:
  - ingress (incoming) or outgoing (egress)
  - protocol (TCP, SSH, HTTP...)
  - port or port range
  - CIDR (Classless Inter-Domain Routing), e.g.,
    - 129.177.13.204/24
    - 2001:700:200:13::204/64

OpenStack volumes

- Volume

- Volumes are block storage devices that you attach to instances to enable persistent storage. You can attach a volume to a running instance or detach a volume and attach it to another instance at any time. You can also create a snapshot from or delete a volume.

- Create volume:
  - source: empty or image
  - size

OpenStack command-line interface (CLI)

- More efficient than the dashboard
  - but a bit slow
  - we will use higher-level (scripted) Terraform instead
- Guide at https://docs.nrec.no/api.html#openstack-command-line-interface-cli
  - sudo apt install python3-openstackclient
  - pip install openstackclient (in a virtual environment)
  - configuration:
    - either: create keystone-rc.sh to set environment variables
    - or: create ~/.config/openstack/clouds.yaml

~/.config/openstack/clouds.yaml

- clouds:
  ```
  info319-cluster:
    auth:
      auth_url: https://api.nrec.no:5000/v3
      project_name: uib-your-project
      username: your@nrec.log.in
      password: sL6WUOiQb5R7fU0y
      user_domain_name: dataporten
      project_domain_name: dataporten
    identity_api_version: 3
    region_name: bgo
    interface: public
    operation_log:
      logging: TRUE
      file: openstackclient_admin.log
      level: info
  ```

- Pick up your password at
  - https://access.nrec.no
  - «Reset API password»
- Test with, e.g.,
  - openstack server list
- Also needed to run API
  - e.g., Terraform