



Leibniz-Rechenzentrum
der Bayerischen Akademie der Wissenschaften

The background of the slide is a photograph of a modern, multi-story building with a glass and metal facade, likely the LRZ building. The image is overlaid with a semi-transparent blue filter. A large, semi-transparent white rectangle is centered on the page, containing the title and author information.

Introduction to the LRZ Compute Cloud

April 2021 | PD Dr. Juan J. Durillo

Agenda

First steps

Motivation
What is Cloud Computing?
Introduction to OpenStack



Hands-on Sessions

The LRZ Compute Cloud via Web



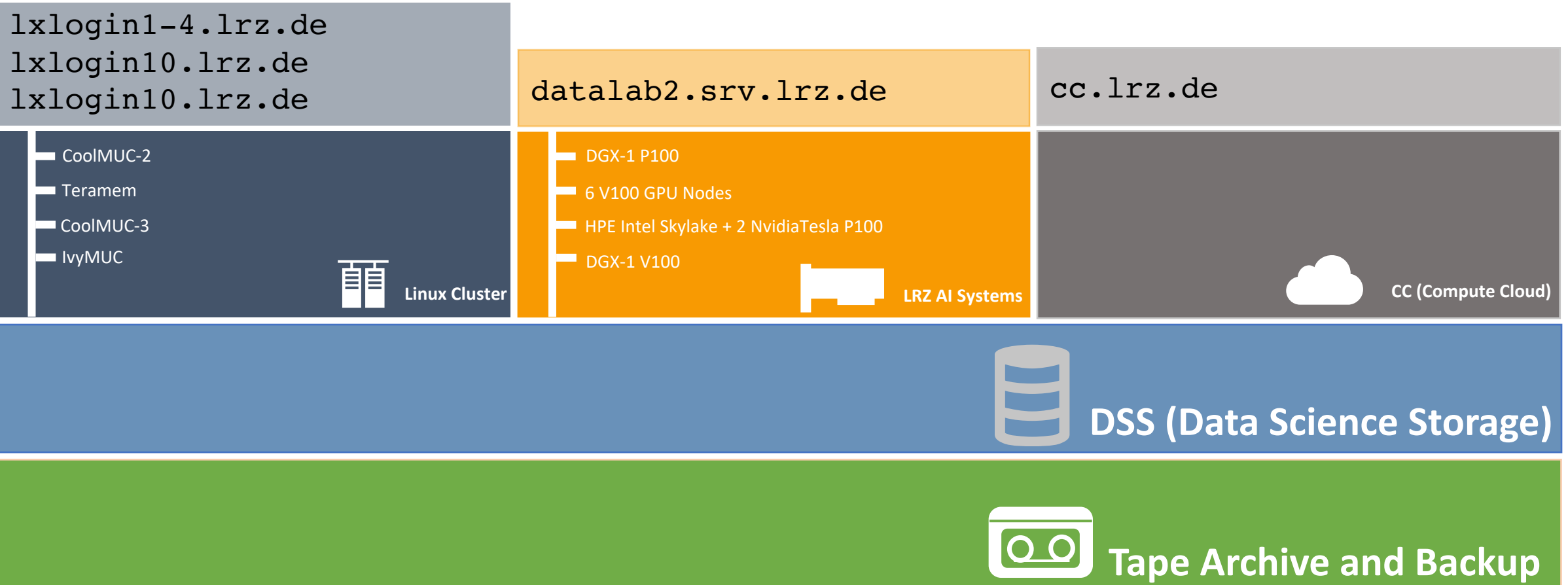
The LRZ Compute Cloud and the OpenStack Client tools

Final touch

Wrap-up

Introduction to the LRZ AI Infrastructure

LRZ Systems Offer



Use case 1: You need to install a web server. You know very well how to manage a given Linux Distro (let's say Ubuntu) and you manage yourself very well with the Nginx server.

- What are your options?

- Buy a small server

- Expensive (hardware + electricity)
- Maintenance slowdown



Expensive and high Latency

- SuperMUC-NG / Linux Cluster

- Difficult to install new software
- In which compute node are you running? You need to open port 80 there!



Lack of flexibility

Use case 2: You would like to do a hands-on demo with Docker containers and using the latest deep learning framework, showing how it performs in CPUs and GPUs. The hands-on is tomorrow and 100 students are registered.

- What are your options:

- Buy 100 small servers

- Expensive

- Once the hands-on is finished, what do you do with 100 servers?

- What happens if at last minute a 101th student enrolls in the hands-on?



Not scalable



Environmental
Unfriendly

- SuperMUC-NG / Linux Cluster / Other cluster

- Batch system: how can you assure your 5 jobs run exactly at the time of the hands-on

- Install the framework on SLES12



They are designed for completely different
use cases

Introduction to the LRZ Compute Cloud

What are our needs?



- On-demand delivery of infrastructure (hardware/servers), storage, databases, ...
- Quickly provisioned, remotely,
- Charge for usage
- Flexible
- Easy to manage
 - automation
 - treat all as code
-

These are the components that describe cloud computing (simply cloud)

It is not about the servers, but the services

Defining Cloud Computing

- No unique/single definition

Cloud Computing is a collection of technologies.

A (weak) definition

Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet.

Wikipedia

The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

Google definition

Defining Cloud Computing



The practice of storing regularly used computer data on multiple servers that can be accessed through the Internet.

Merriam-Webster

Informal: computing with large datacenters.
Computing as a utility outsourced to a third party or internal organization.

Stanford Lecture
CS349D on Cloud
Computing

A model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., network, storage, servers, applications,) that can be rapidly provisioned and released with minimal management effort or service interaction.

NIST –
National Institute of
Standards and
Technology

Five Characteristics of Cloud Computing

- **On-Demand**

A consumer can request and receive access to a service offering without an administrator or some sort of support staff having to fulfil the request manually.

- **Broad Network accesses**

Cloud services should be easy to access. Ideally only a basic network connection should be required.

- **Flexibility**

Ability to grow with user demand. If the system is well defined it should be relatively easy for the provider to add more resources.

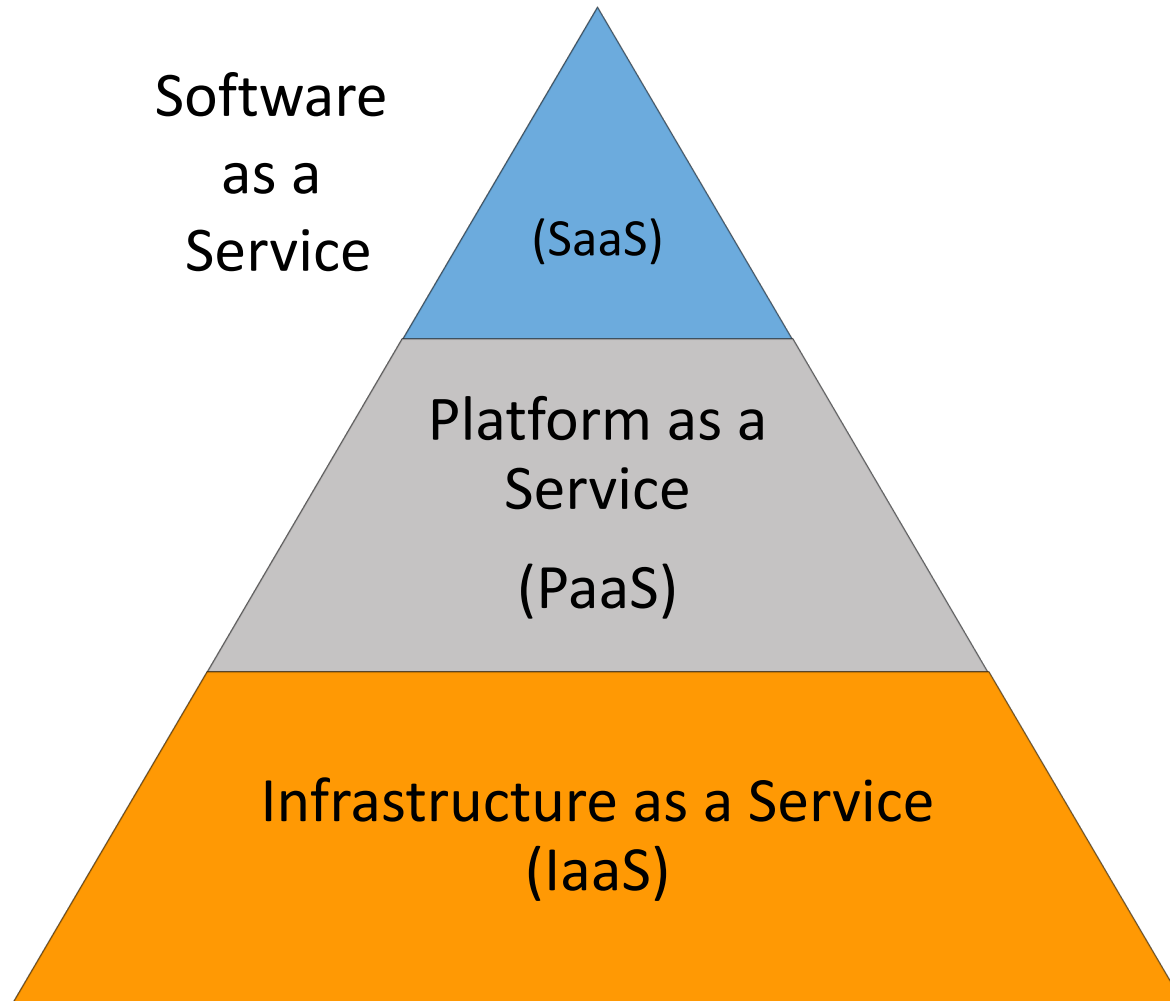
Five Characteristics of Cloud Computing

- **Resource Pooling**

A user will not need all the resources available to her. When resources are not used, they should be released, and other users can benefit of it or they can be simply not used (not consuming energy.)

- **Measured service**

Cloud services must have the ability to measured usage. Usage can be quantified using various metrics, such as time, bandwidth used, and data used. This ability to measure allow what is known as pay as you go model.



- SaaS – Fully developed software solution to be used
 - e.g., Google Drive
- PaaS – Provides a framework on top of which is possible to build, deploy, and manage software products
 - e.g., Heroku
- IaaS - Provides a completely virtualized computing infrastructure that is provisioned and managed over the internet
 - e.g., LRZ Compute Cloud

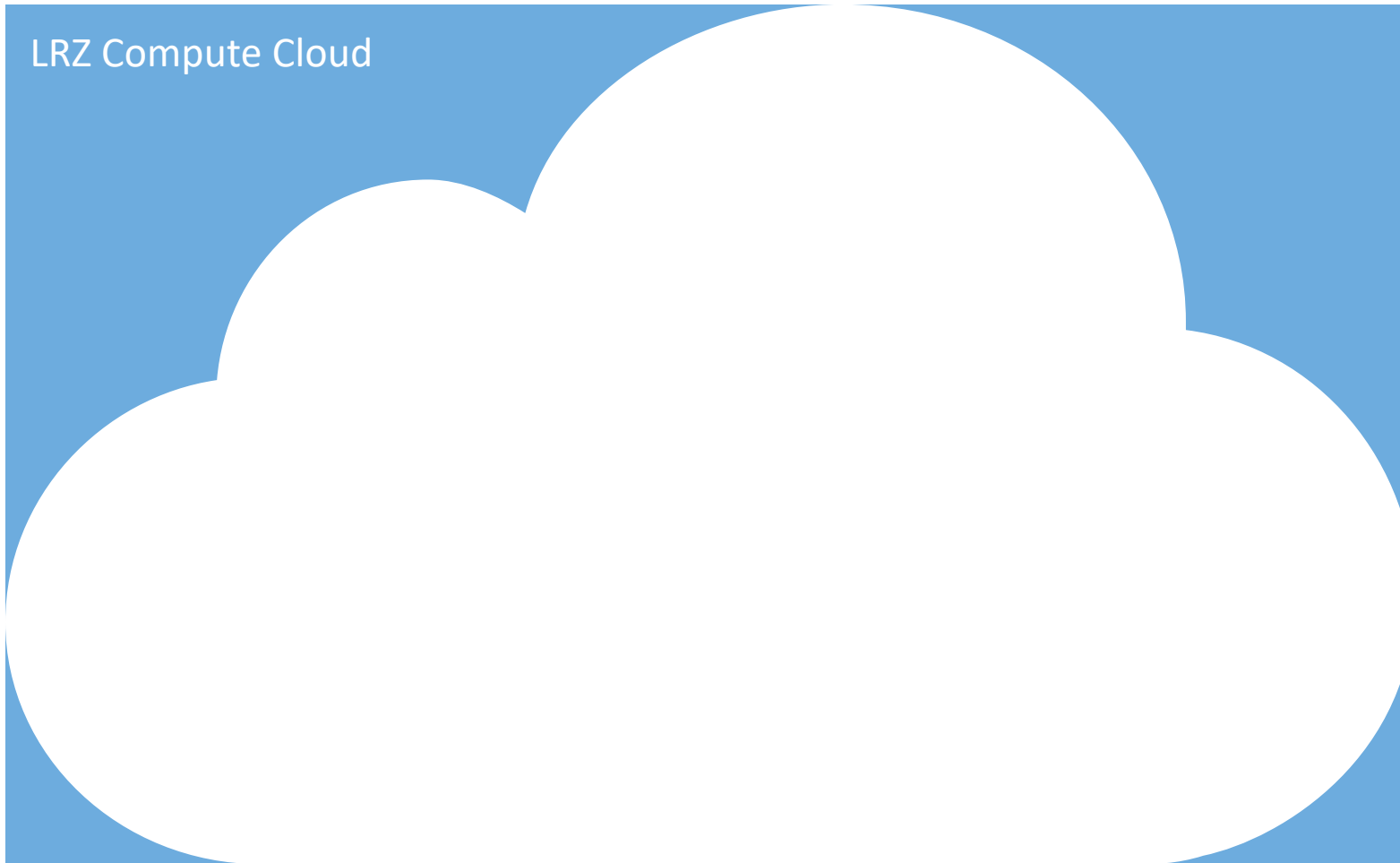
Introduction to OpenStack

- What do we need for transforming a set of resources (data center) into a cloud?
 - to manage/admin the hardware
 - to provision machines to users
 - to allow users to authenticate
 - to manage the network across resources
 - ...

OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed and provisioned through APIs with common authentication mechanism.

- OpenStack bundles together a bunch of different technologies, addressing the different needs transforming resources into a Cloud Service

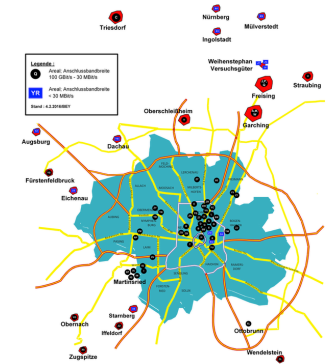
The LRZ Compute Cloud at a Glance



Internet



MWN



Introduction to OpenStack - Terminology

- Image

A single file which contains a virtual disk with a bootable operating system installed on it. Images are like a template of a computer's root drive. They contain the operating system and can also include software and layers of your application, such as database servers, web servers, and so on.



FreeBSD



CentOS

Introduction to OpenStack - Terminology

- Instance

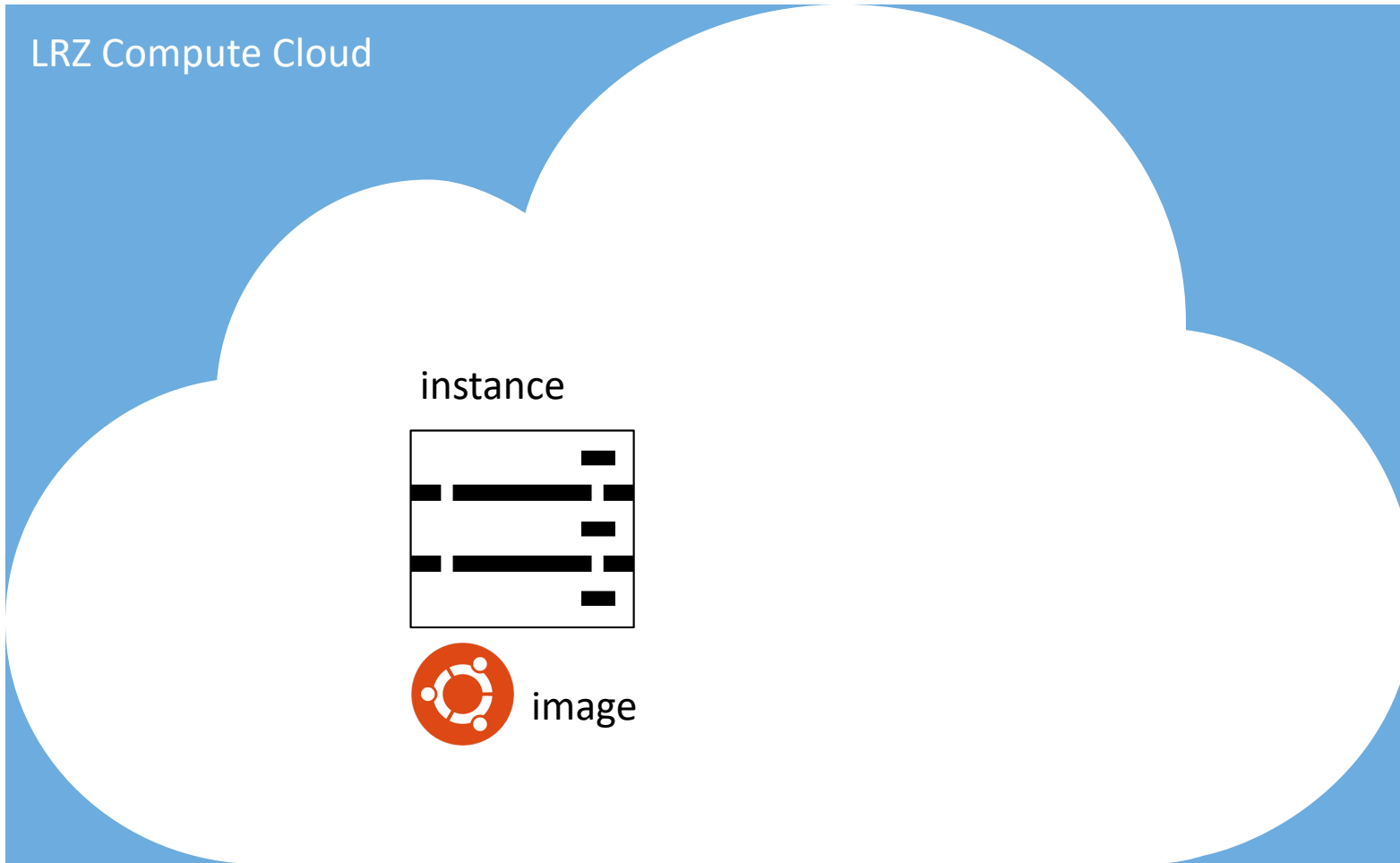
A copy of an image running as a virtual server the cloud. We will also call it server.

- Flavor

Flavors define the compute, memory, and storage capacity of instances. To put it simply, a flavor is an available hardware configuration for a server.

Name	vCPUs	RAM	Remarks	Access
tiny	1	512 MB	for testing purposes only, most Operating Systems will not boot due to restricted resources	public
nvidia-v100.2	40	700 GiB	use 2 GPUs on a GPU node (use entire GPU node)	restricted, contact us
nvidia-v100.1	20	350 GiB	use 1 GPU on a GPU node	restricted, contact us
lrz.xlarge	10	47.5 GiB	use 1/4 compute node	public
lrz.xhuge	48	1488 GiB	use 1/4 of the hugemem node	restricted, contact us
lrz.small	1	4.75 GiB	use 1/40 compute node	public
lrz.medium	2	9.5 GiB	use 1/20 compute node	public
lrz.large	4	19 GiB	use 1/10 compute node	public
lrz.huge	24	744 GiB	use 1/8 of the hugemem node	restricted, contact us
lrz.4xlarge	40	190 GiB	use entire compute node	restricted, contact us
lrz.4xhuge	192	5952 GiB	use entire hugemem node	restricted, contact us
lrz.2xlarge	20	95 GiB	use 1/2 compute node	restricted, contact us
lrz.2xhuge	96	2976 GiB	use 1/2 of the hugemem node	restricted, contact us

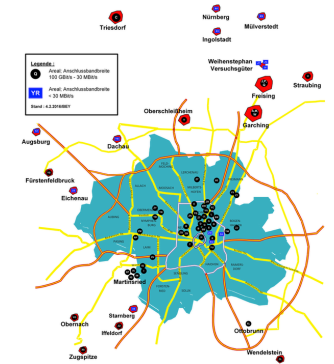
The LRZ Compute Cloud at a Glance



Internet



MWN

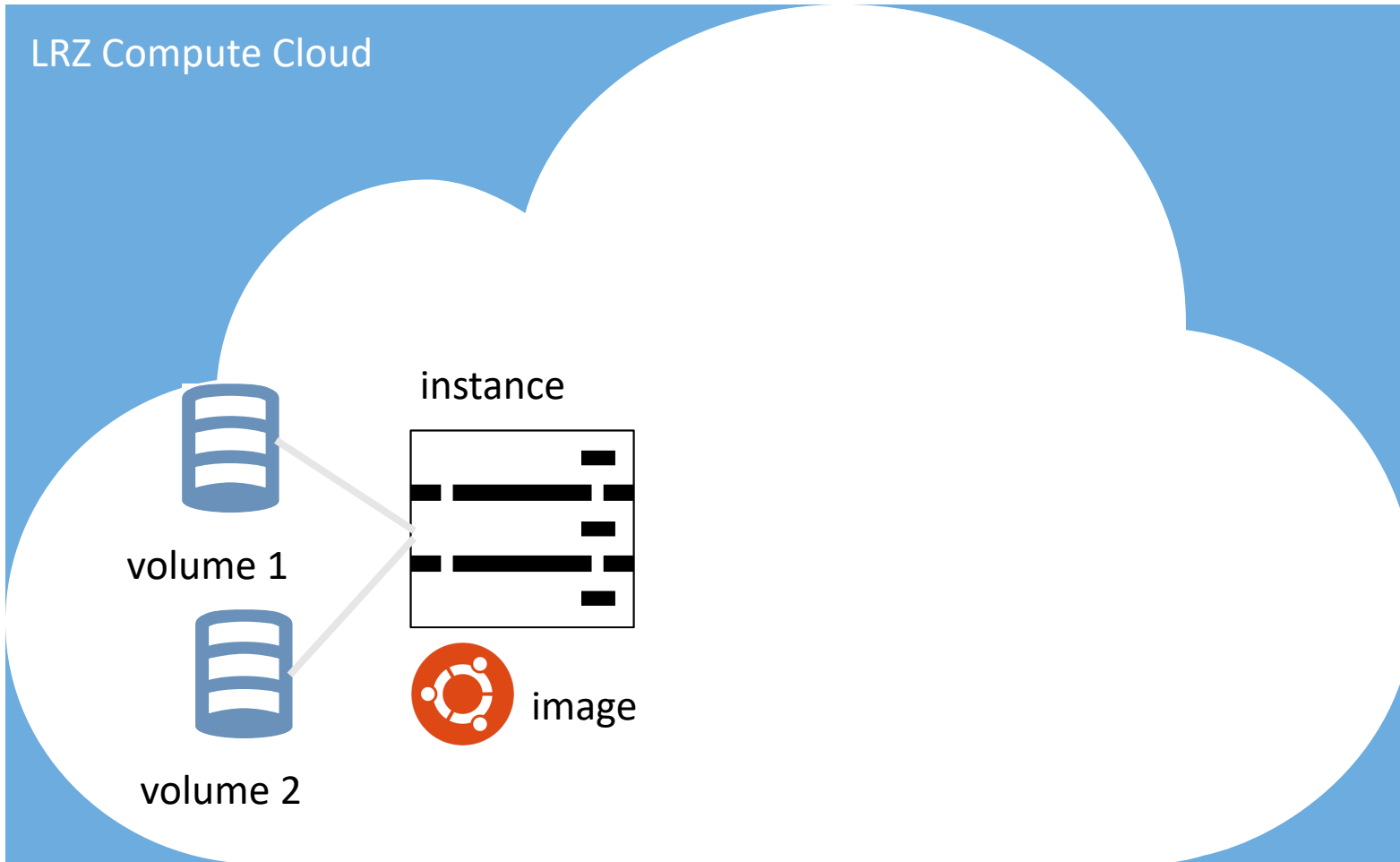


Introduction to OpenStack - Terminology

- Volume

A volume is a detachable block storage device, similar to a USB hard drive. You can attach a volume to only one instance. But an instance can attach several volumes

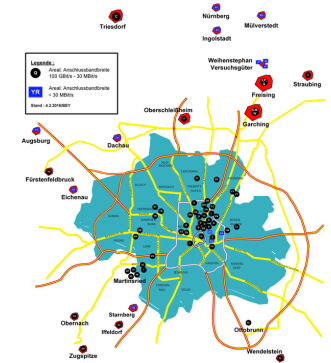
The LRZ Compute Cloud at a Glance



Internet



MWN



Introduction to OpenStack - Terminology

- **Networking**

Openstack provides networks, subnets, and routers as object abstractions. Each abstraction has functionality that mimics its physical counterpart: networks contain subnets, and routers route traffic between different subnets and networks. Instances are created within internal private networks. These networks can be routed to external networks (e.g., Internet or or MWN) via a virtual router.

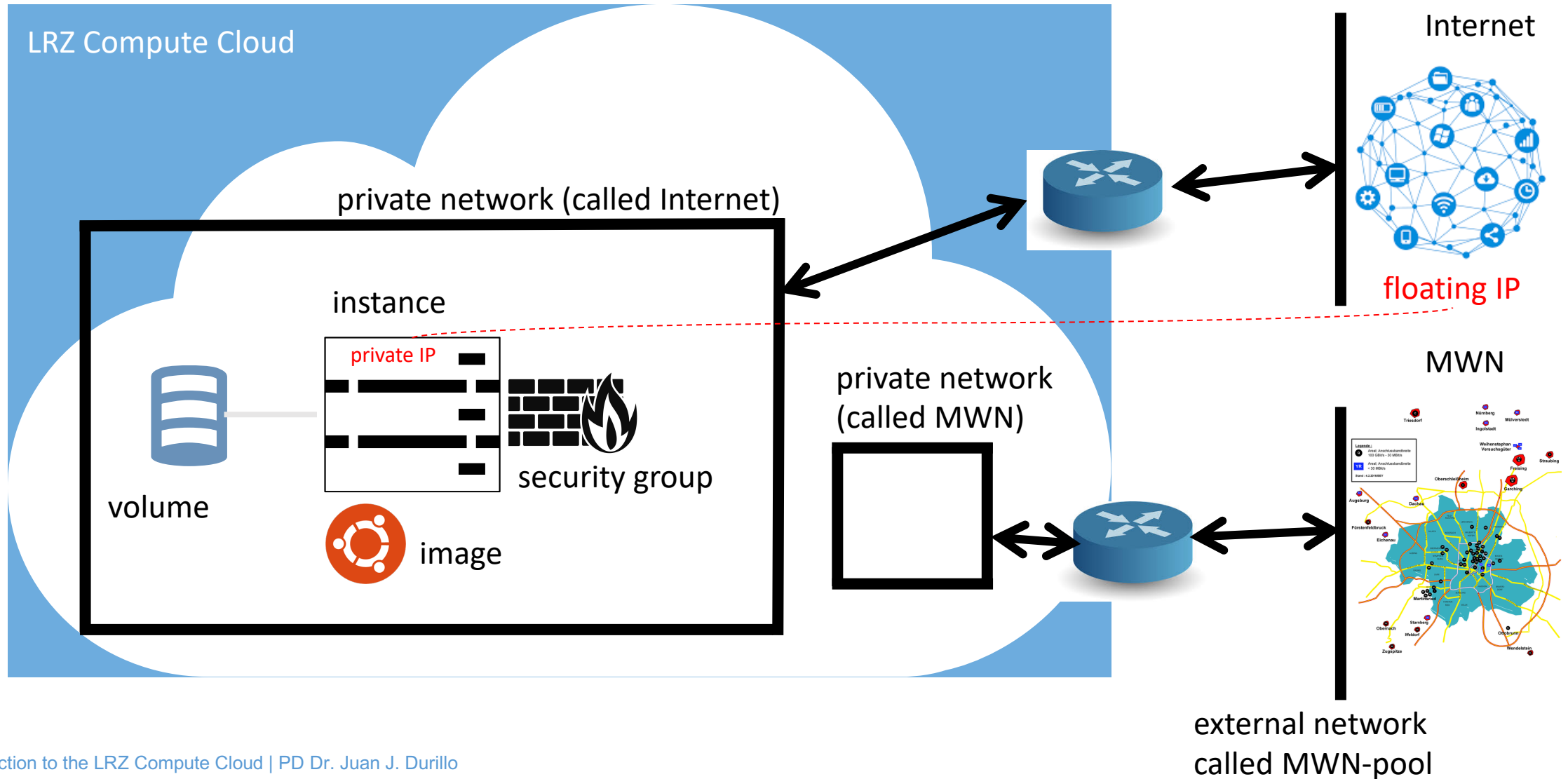
- **Private and Floating IP**

Each instance has a fixed IP within its private Network. That IP can be associated to an IP of the external network that network is connected by means of what it is called *floating IP address*. The floating IP address will allow addressing the instance from the outside.

- **Security group**

A security group acts as a virtual firewall for servers and other resources on a network. It is a container for rules for allowing different types of network traffic to and from an instance.

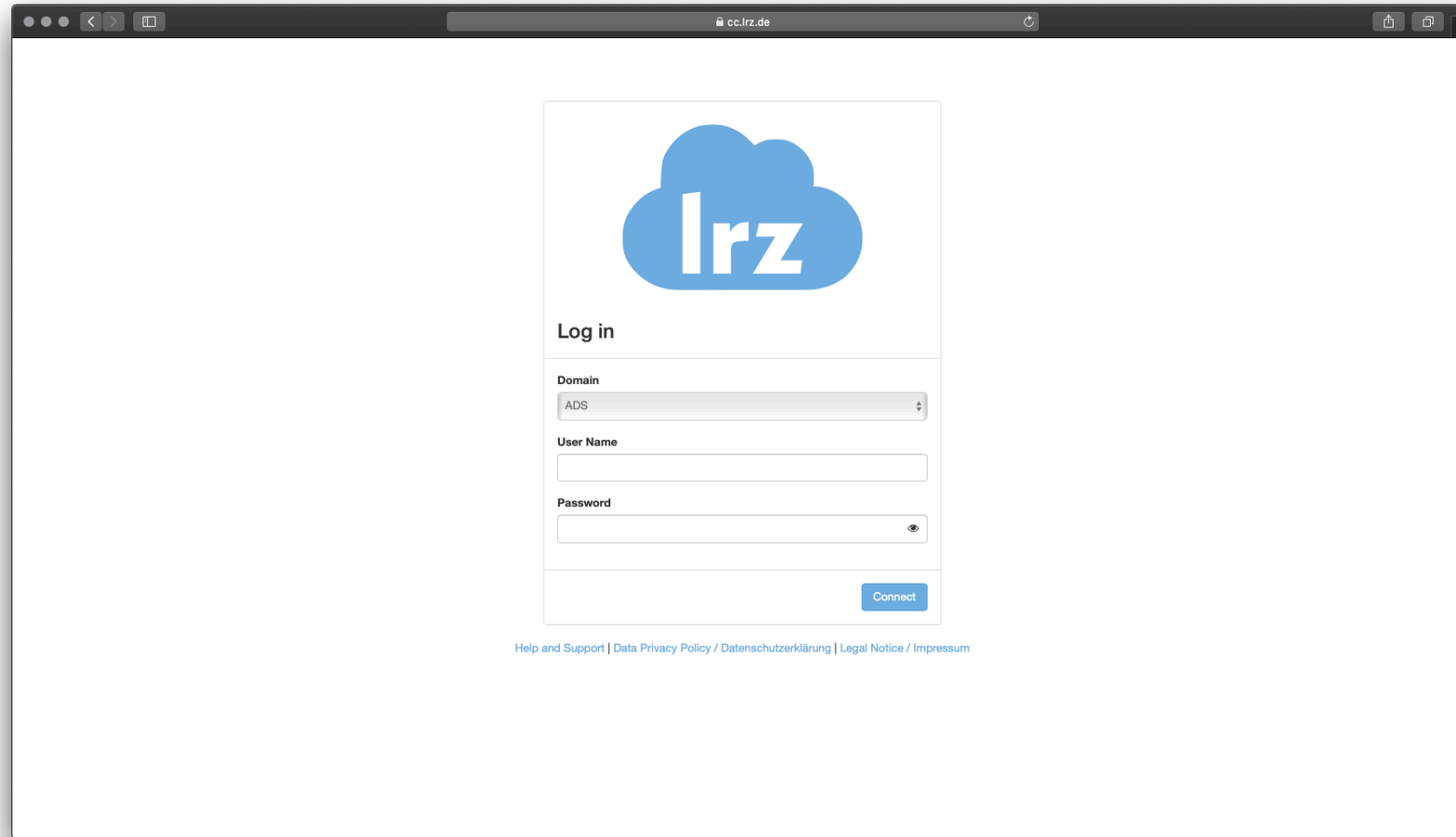
The LRZ Compute Cloud at a Glance



Login into Instances

- De-facto operation is no Graphical Interface on the provided images
 - Although it is possible (e.g., <https://rv.lrz.de>)
- Accessing instances via ssh
 - No login based on password by default (public and private keys!)
- Openstack must be aware of your public key(s) to add it(them) to newly created instances (otherwise you will not be able to login)
 - You can import a public key of a keypair generated using your method of preference
 - You can generate a keypair using Openstack
 - the private key will be downloaded to your computer
 - the public will be recorded by Openstack

The Compute Cloud Web Interface



The Compute Cloud Web Interface



Left panel.
Allows you to operate
with the CC.

The screenshot shows the LRZ Compute Cloud web interface. The left sidebar contains a navigation menu with categories: API Access, Compute (selected), Instances, Images, Key Pairs, Volumes, Network, Orchestration, and Identity. The main content area is titled 'Project / Compute / Overview' and is divided into two sections. The 'Limit Summary' section features six circular gauges representing resource usage: Instances (Used 1 of 4), VCPUs (Used 40 of 160), RAM (Used 753,664 of 753,664, No Limit), Floating IPs (Allocated 6 of 50), Security Groups (Used 8 of 10), and Volumes (Used 5 of 10). Below this is the 'Usage Summary' section, which includes a date range selector (2019-09-29 to 2019-09-30) and a 'Submit' button. The usage summary lists: Active Instances: 1, Active RAM: 736GB, This Period's VCPU-Hours: 1504.24, This Period's GB-Hours: 752.12, and This Period's RAM-Hours: 28342240.03. A 'Download CSV Summary' button is located to the right. At the bottom, a table displays usage for one instance:

Instance Name	VCPUs	Disk	RAM	Time since created
demo-isc	40	20GB	736GB	4 months, 3 weeks

Resources Limits.
Shows you what
you are allow and
what you have in
use.

Summary.
Show the instances
you have. They
might be in
different status.

The Compute Cloud Web Interface

Allows a more informative view of our instances

Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
demo-isc	vol:Ubuntu-18.04-LTS-bionic	192.168.128.43 Floating IPs: 138.246.232.37	nvidia-v100.2	lrz_durillo_key	Shelved Offloaded	nova	None	Shut Down	4 months, 3 weeks	Disassociate Floating IP

Allows creating new instances / Deleting existing ones

Instance Name. Not mandatory, but convenient as will see later in this course

Resources used by this instance

Summary of this instance IPs

Status of the instance.

Allows operating this instance (e.g., attach a volume, associate new floating IP)

Introduction to the LRZ Compute Cloud

The Compute Cloud Web Interface



The screenshot shows the 'Key Pairs' page in the LRZ Compute Cloud web interface. The breadcrumb navigation is 'Project / Compute / Key Pairs'. The page title is 'Key Pairs'. There are buttons for '+ Create Key Pair', 'Import Public Key', and 'Delete Key Pairs'. A search bar is present with the text 'Click here for filters.'. Below the search bar, it says 'Displaying 2 Items'. The table has two columns: 'Name' and 'Fingerprint'. There are two rows of key pairs, each with a 'Delete Key Pair' button.

Name	Fingerprint
access_from_windows	51:93:d4:5f:c1:8b:09:fd:da:11:19:a3:1e:34:ec:32
lrz_durillo_key	c8:ea:48:d1:64:03:42:b5:bb:b9:0a:a4:4d:9f:41:a3

The screenshot shows the 'Volumes' page in the LRZ Compute Cloud web interface. The breadcrumb navigation is 'Project / Volumes / Volumes'. The page title is 'Volumes'. There are buttons for '+ Create Volume', 'Accept Transfer', and 'Delete Volumes'. A search bar is present with the text 'Filter'. Below the search bar, it says 'Displaying 8 Items'. The table has columns: 'Name', 'Description', 'Size', 'Status', 'Type', 'Attached To', 'Availability Zone', 'Bootable', 'Encrypted', and 'Actions'. There are 8 rows of volumes, each with an 'Edit Volume' button. The 'data' volume has an 'Update Metadata' button.

Name	Description	Size	Status	Type	Attached To	Availability Zone	Bootable	Encrypted	Actions
3896da63-2f67-4417-91bb-6a7d32d35cc8	-	30GiB	In-use	ceph	/dev/vda on test	nova	Yes	No	Edit Volume
0c5b5550-947b-44c5-a20a-46ba298a5d97	-	30GiB	Available	ceph	-	nova	Yes	No	Edit Volume
10a34d24-1d7b-46a4-bd3e-f1556a1d3918	-	30GiB	Available	ceph	-	nova	Yes	No	Edit Volume
tensorflow-gpu-volume	-	25GiB	Available	ceph	-	nova	Yes	No	Edit Volume
c706810c-dcd3-4f6a-9214-aadc8e6c801	-	20GiB	Available	ceph	-	nova	Yes	No	Edit Volume
63e9cb62-3bb5-44d3-be13-7421d12ff5a2	-	20GiB	Available	ceph	-	nova	Yes	No	Edit Volume
data	data for isc 2019 demo	80GiB	Reserved	ceph	-	nova	No	No	Update Metadata
f5bb6f63-cd0c-4c0f-a79a-b396ee8a72d0	-	20GiB	Reserved	ceph	-	nova	Yes	No	Update Metadata

Hands on Session 1

- Create a Ubuntu-based server running Nginx
- Tasks
 - Create an instance
 - Generate a new keypair
 - A file with the extension .pem will be downloaded to your machine (the private key)
 - **In Linux:** change the permission of the downloaded file to 600 (\$ chmod 600 ...)
 - **In Windows with WSL:** copy the downloaded file to inside the WSL (/mnt/c/ allows you accessing C:\ in windows from WSL,) and once copied, change the permissions as in the Linux case
 - **In Windows with Putty:** import it using Putty Generator (follow our first day course explanation!) (check <https://stackoverflow.com/questions/3190667/convert-pem-to-ppk-file-format> if you need help)

(to be continued in next slide)

Hands on Session 1

- Create a Ubuntu-based server running Nginx
- Tasks
 - Create an instance
 - Choose Ubuntu as image
 - CPU only flavor (preferably a small one)
 - Should be accessible from Internet
 - Place the instance on the private network called internet
 - Once the instance is created assign it a floating IP from the Internet pool
 - Access the instance via SSH
 - Create a security group that allow ingress connections to port 22
 - Add this security group to the instance

Hands on Session 1

- Create a Ubuntu-based server running Nginx

- Tasks

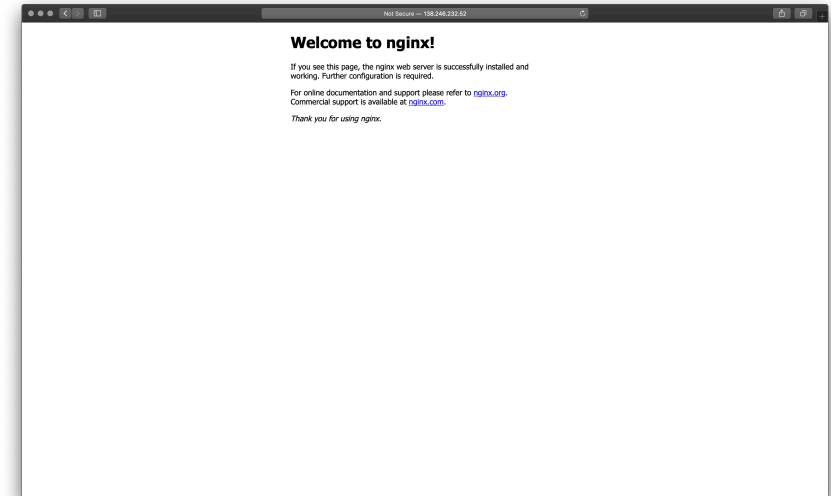
- Install Nginx

- Log into the instance (user is ubuntu)
 - Execute the following script

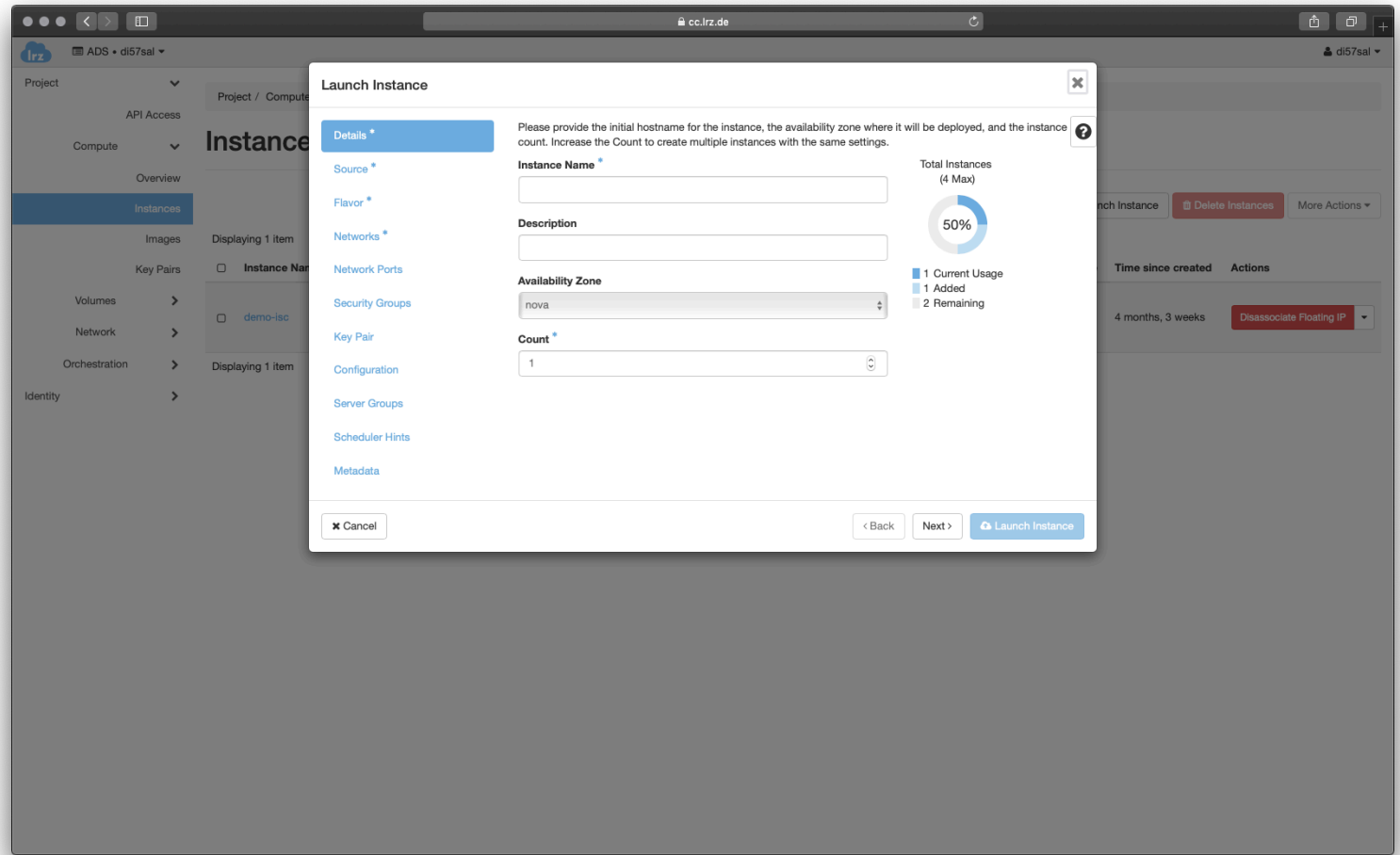
```
$ sudo apt update  
$ sudo apt upgrade -y  
$ sudo apt install nginx
```

- Test it

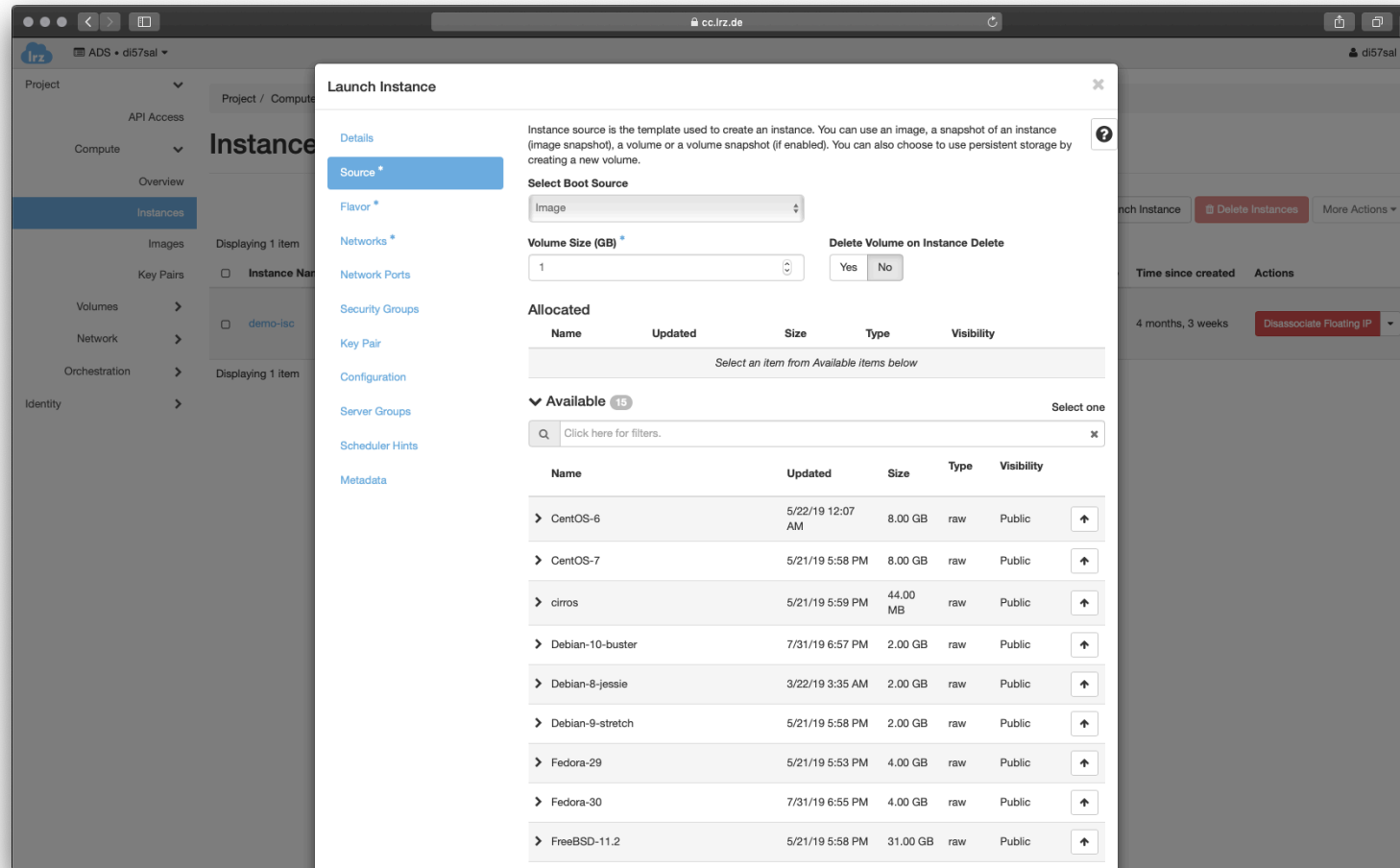
- Open a browser in your local machine and navigate to the instance floating IP
 - What is missing?
 - By default all traffic to and from the instance is disabled unless enabled via a security group
 - Create a security group allowing ingress traffic to port 80 and test again



The Compute Cloud Web Interface – Back Up Slides



The Compute Cloud Web Interface – Back Up Slides



Launch Instance

Source *

Flavor *

Networks *

Network Ports

Security Groups

Key Pair

Configuration

Server Groups

Scheduler Hints

Metadata

Instance source is the template used to create an instance. You can use an image, a snapshot of an instance (image snapshot), a volume or a volume snapshot (if enabled). You can also choose to use persistent storage by creating a new volume.

Select Boot Source

Image

Volume Size (GB) *

1

Delete Volume on Instance Delete

Yes No

Allocated

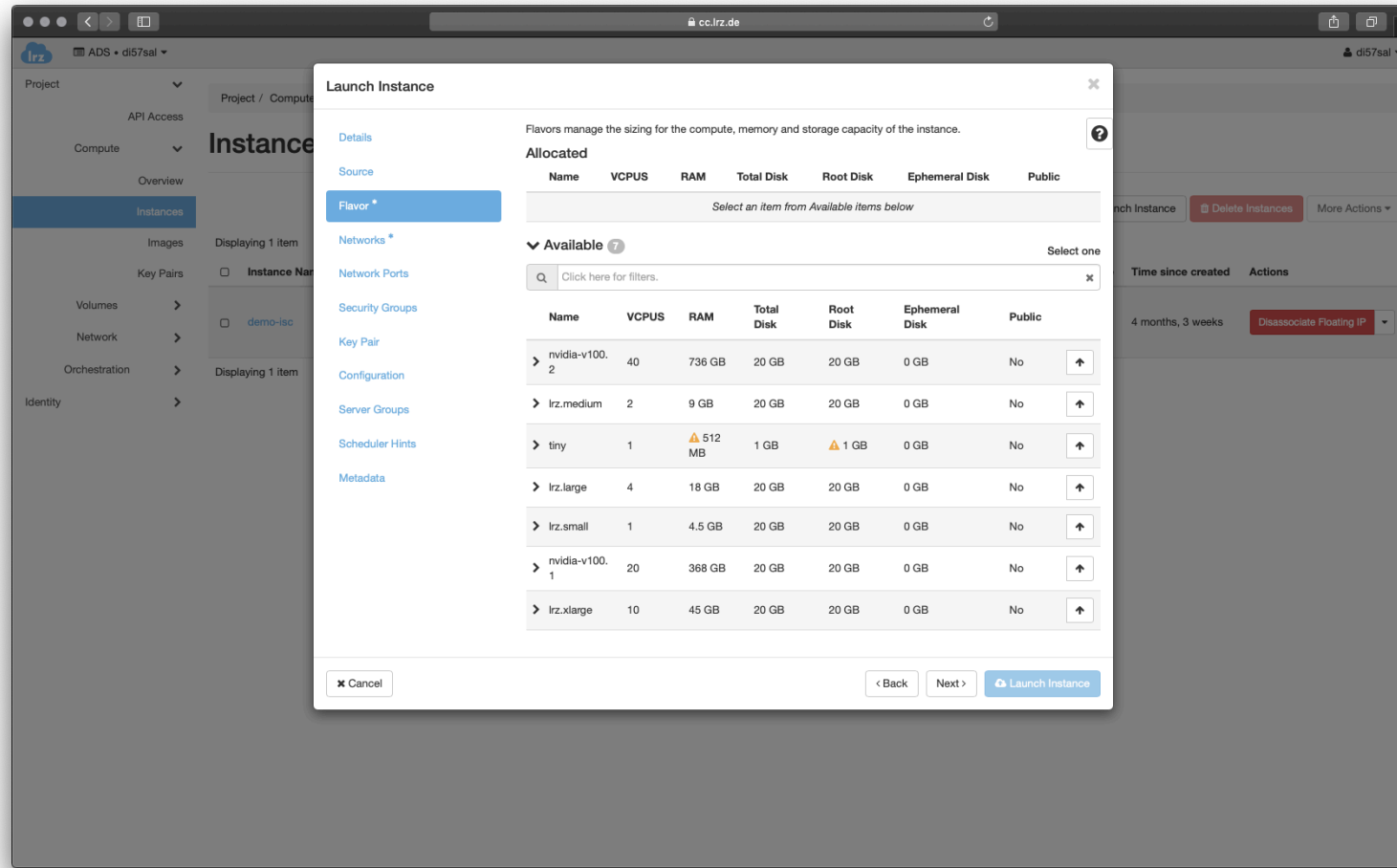
Name	Updated	Size	Type	Visibility
Select an item from Available items below				

Available 15 Select one

Q Click here for filters. x

Name	Updated	Size	Type	Visibility
> CentOS-6	5/22/19 12:07 AM	8.00 GB	raw	Public
> CentOS-7	5/21/19 5:58 PM	8.00 GB	raw	Public
> cirros	5/21/19 5:59 PM	44.00 MB	raw	Public
> Debian-10-buster	7/31/19 6:57 PM	2.00 GB	raw	Public
> Debian-8-jessie	3/22/19 3:35 AM	2.00 GB	raw	Public
> Debian-9-stretch	5/21/19 5:58 PM	2.00 GB	raw	Public
> Fedora-29	5/21/19 5:53 PM	4.00 GB	raw	Public
> Fedora-30	7/31/19 6:55 PM	4.00 GB	raw	Public
> FreeBSD-11.2	5/21/19 5:58 PM	31.00 GB	raw	Public

The Compute Cloud Web Interface – Back Up Slides



Launch Instance

Flavors manage the sizing for the compute, memory and storage capacity of the instance.

Allocated

Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public
Select an item from Available items below						

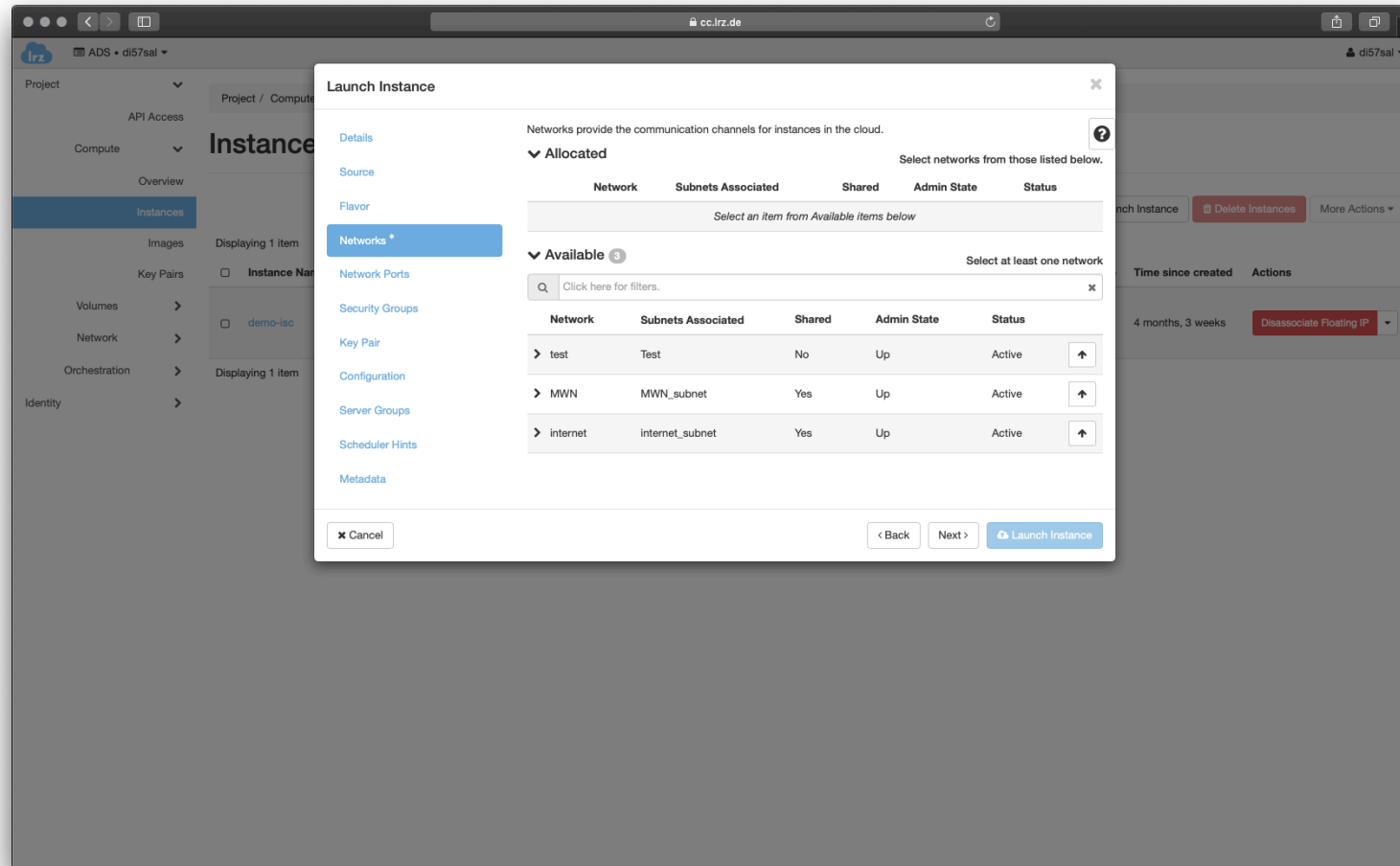
Available 7

Click here for filters.

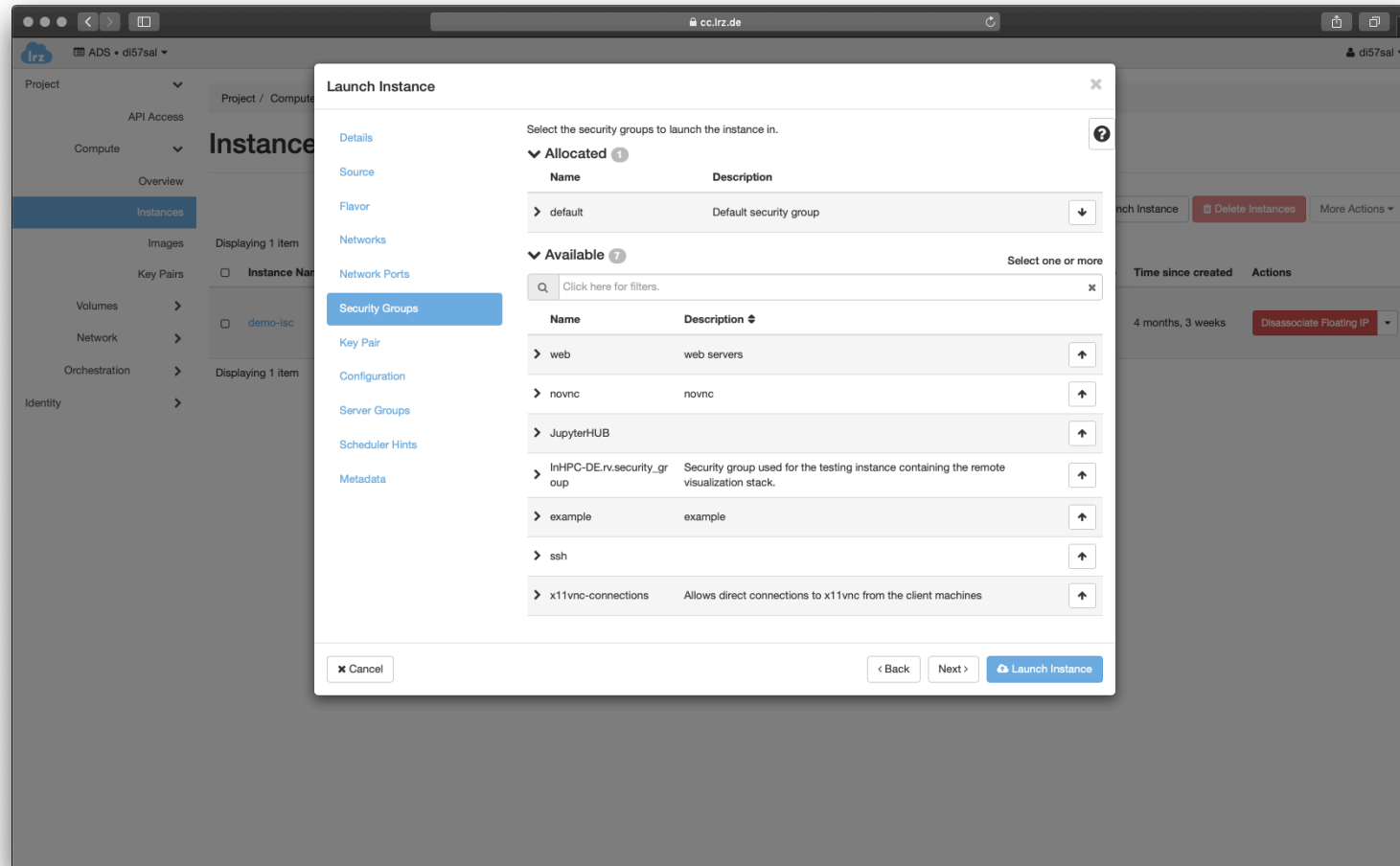
Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public
> nvidia-v100.2	40	736 GB	20 GB	20 GB	0 GB	No
> lrz.medium	2	9 GB	20 GB	20 GB	0 GB	No
> tiny	1	512 MB	1 GB	1 GB	0 GB	No
> lrz.large	4	18 GB	20 GB	20 GB	0 GB	No
> lrz.small	1	4.5 GB	20 GB	20 GB	0 GB	No
> nvidia-v100.1	20	368 GB	20 GB	20 GB	0 GB	No
> lrz.xlarge	10	45 GB	20 GB	20 GB	0 GB	No

Buttons: Cancel, < Back, Next >, Launch Instance

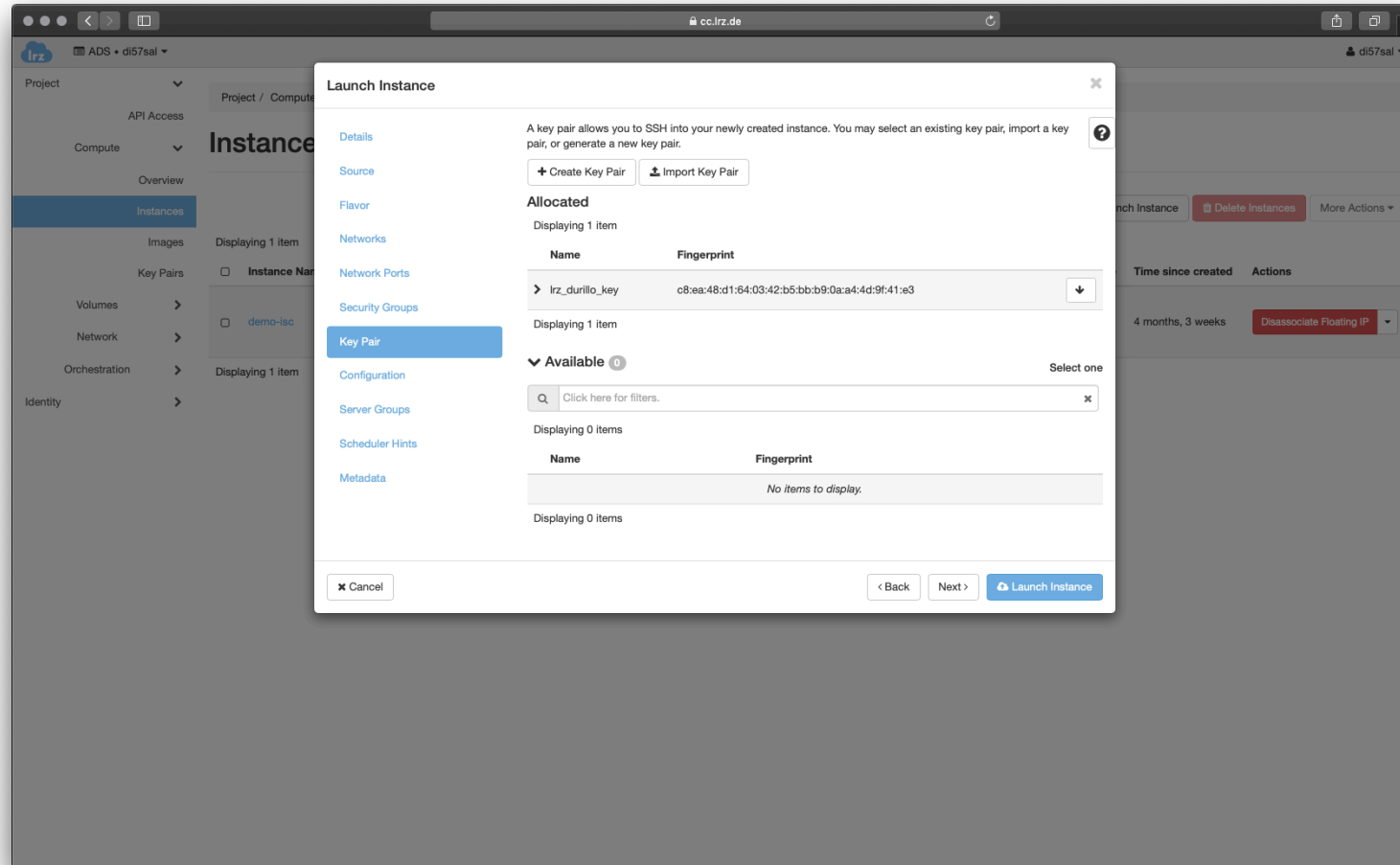
The Compute Cloud Web Interface – Back Up Slides



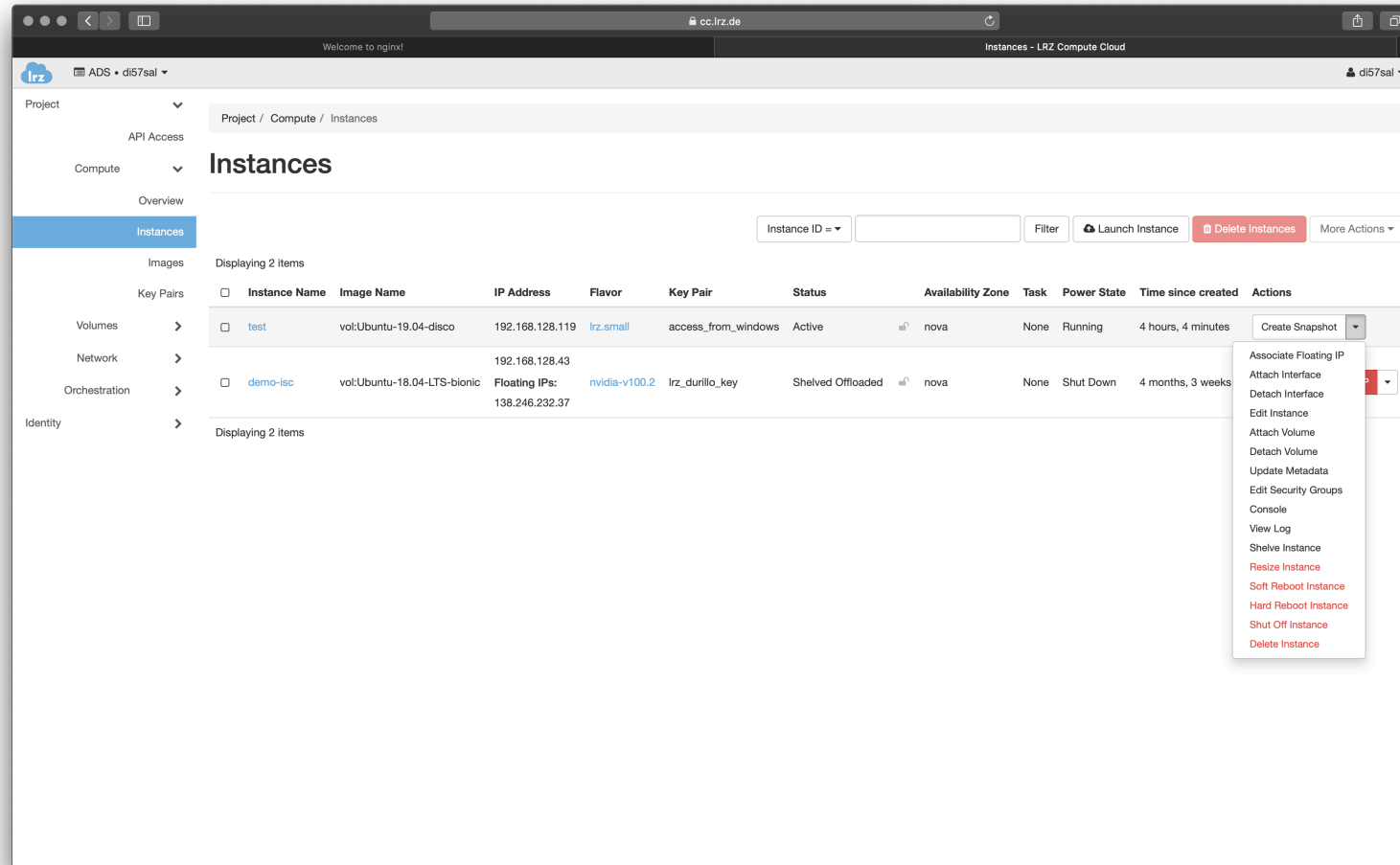
The Compute Cloud Web Interface – Back Up Slides



The Compute Cloud Web Interface – Back Up Slides



The Compute Cloud Web Interface – Back Up Slides



Project / Compute / Instances

Instances

Instance ID = Filter Launch Instance Delete Instances More Actions

Displaying 2 items

Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
<input type="checkbox"/> test	vol:Ubuntu-19.04-disco	192.168.128.119	lrz.small	access_from_windows	Active	nova	None	Running	4 hours, 4 minutes	Create Snapshot
<input type="checkbox"/> demo-isc	vol:Ubuntu-18.04-LTS-bionic	Floating IPs: 192.168.128.43 138.246.232.37	nvidia-v100.2	lrz_durillo_key	Shelved Offloaded	nova	None	Shut Down	4 months, 3 weeks	<ul style="list-style-type: none"> Associate Floating IP Attach Interface Detach Interface Edit Instance Attach Volume Detach Volume Update Metadata Edit Security Groups Console View Log Shelve Instance Resize Instance Soft Reboot Instance Hard Reboot Instance Shut Off Instance Delete Instance

Displaying 2 items

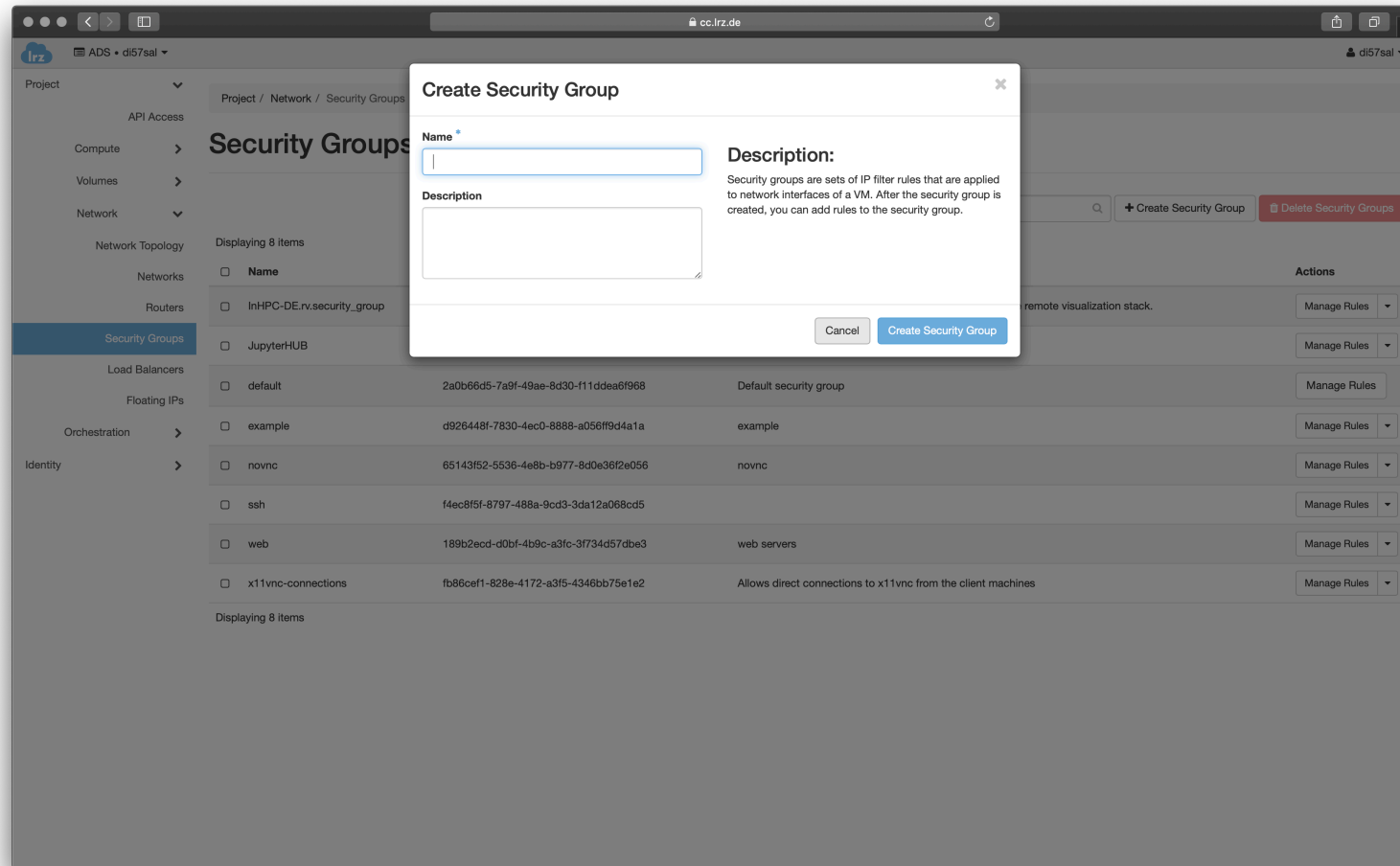
The Compute Cloud Web Interface – Back Up Slides



The screenshot displays the LRZ Compute Cloud Web Interface. The browser address bar shows 'cc.lrz.de'. The user is logged in as 'di57sal'. The left sidebar contains a navigation menu with categories: Project, API Access, Compute, Volumes, Network, Network Topology, Networks, Routers, Security Groups (highlighted), Load Balancers, Floating IPs, Orchestration, and Identity. The main content area is titled 'Security Groups' and shows a list of 8 items. At the top right of the main area, there is a search filter, a '+ Create Security Group' button, and a 'Delete Security Groups' button. The table below lists the security groups with columns for Name, Security Group ID, Description, and Actions.

<input type="checkbox"/>	Name	Security Group ID	Description	Actions
<input type="checkbox"/>	InHPC-DE.rv.security_group	d1cdda6d-60b9-4d97-ab6b-1736b3595e80	Security group used for the testing instance containing the remote visualization stack.	Manage Rules
<input type="checkbox"/>	JupyterHUB	8474f2ab-1c1c-4477-aa24-cb4f6f848ef8		Manage Rules
<input type="checkbox"/>	default	2a0b66d5-7a9f-49ae-8d30-f11ddea6f968	Default security group	Manage Rules
<input type="checkbox"/>	example	d926448f-7830-4ec0-8888-a056ff9d4a1a	example	Manage Rules
<input type="checkbox"/>	novnc	65143f52-5536-4e8b-b977-8d0e36f2e056	novnc	Manage Rules
<input type="checkbox"/>	ssh	f4ec8f5f-8797-488a-9cd3-3da12a068cd5		Manage Rules
<input type="checkbox"/>	web	189b2ecd-d0bf-4b9c-a3fc-3f734d57dbe3	web servers	Manage Rules
<input type="checkbox"/>	x11vnc-connections	fb86cef1-828e-4172-a3f5-4346bb75e1e2	Allows direct connections to x11vnc from the client machines	Manage Rules

The Compute Cloud Web Interface – Back Up Slides



The Compute Cloud Web Interface – Back Up Slides



Project / Network / Security Groups / Manage Security Group Rules

Manage Security Group Rules: InHPC-DE.rv.security_group (d1cdda6d-60b9-4d97-ab6b-1736b3595e80)

+ Add Rule Delete Rules

Displaying 7 items

<input type="checkbox"/>	Direction	Ether Type	IP Protocol	Port Range	Remote IP Prefix	Remote Security Group	Actions
<input type="checkbox"/>	Egress	IPv4	Any	Any	0.0.0.0/0	-	Delete Rule
<input type="checkbox"/>	Egress	IPv4	TCP	4000	0.0.0.0/0	-	Delete Rule
<input type="checkbox"/>	Egress	IPv4	UDP	4001	0.0.0.0/0	-	Delete Rule
<input type="checkbox"/>	Egress	IPv6	Any	Any	::/0	-	Delete Rule
<input type="checkbox"/>	Ingress	IPv4	TCP	22 (SSH)	0.0.0.0/0	-	Delete Rule
<input type="checkbox"/>	Ingress	IPv4	TCP	4000	0.0.0.0/0	-	Delete Rule
<input type="checkbox"/>	Ingress	IPv4	UDP	4001	0.0.0.0/0	-	Delete Rule

Displaying 7 items

The OpenStack Client Tools

- Command-line client for OpenStack that brings the command set for Compute, Identity, Image, Object Storage and Block Storage APIs together in a single shell with a uniform command structure
- <https://docs.openstack.org/python-openstackclient>
- There are different ways of installing the tools
 - E.g., Ubuntu using apt as front end package manager

```
$ sudo apt install python3-openstackclient
```

The OpenStack Client Tools



The screenshot shows the OpenStack dashboard interface. On the right side, a user menu is open, showing options: Settings, Report Bug, Help, OpenStack RC File v3 (highlighted with a green box), and Sign Out. Two orange arrows point from the text 'Your user' and 'Your Profile file' to the user menu and the 'OpenStack RC File v3' option respectively.

Limit Summary

Resource	Used	Limit
Instances	Used 3 of 4	4
VCPUs	Used 42 of 160	160
RAM	Used 762,880 (No Limit)	762880
Floating IPs	Allocated 6 of 50	50
Security Groups	Used 8 of 10	10
Volumes	Used 10 of 10	10
Volume Storage	Used 365GB of 1TB	1TB

Usage Summary

Select a period of time to query its usage:
The date should be in YYYY-MM-DD format.

2019-10-03 to 2019-10-04

Active Instances: 3
Active RAM: 745GB
This Period's VCPU-Hours: 1345.89
This Period's GB-Hours: 1106.74
This Period's RAM-Hours: 25042024.24

Usage

Displaying 3 items

Instance Name	VCPUs	Disk	RAM	Time since created
test2	1	20GB	4.5GB	36 minutes
demo-isc	40	20GB	736GB	4 months, 3 weeks
test	1	20GB	4.5GB	2 hours, 41 minutes

← Your user

← Your Profile file

The OpenStack Client Tools

- Execute the downloaded file
 - e.g. in my case

```
$ . ./Download/di57sal-openrc.sh
```

The OpenStack Client Tools - Listing

```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — -zsh — 139x24
[→] openstack server list
+-----+-----+-----+-----+-----+-----+
| ID | Name | Status | Networks | Image | Flavor |
+-----+-----+-----+-----+-----+-----+
| 361246fc-ab91-4520-8c27-cf166cf7a50a | test2 | ACTIVE | internet=192.168.128.148 | | lrz.small |
| d7c17602-74d9-41b7-8e19-563b9f283b33 | test | ACTIVE | internet=192.168.128.96, 138.246.232.52 | | lrz.small |
| 6e23850f-9019-47af-b252-7e8897fae4a8 | demo-isc | SHELVED_OFFLOADED | internet=192.168.128.43, 138.246.232.37 | | nvidia-v100.2 |
+-----+-----+-----+-----+-----+-----+
[→] █
```

The OpenStack Client Tools - Listing

```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — zsh — 139x34
[→] ~ openstack flavor list
+-----+-----+-----+-----+-----+-----+-----+
| ID | Name | RAM | Disk | Ephemeral | VCPUs | Is Public |
+-----+-----+-----+-----+-----+-----+-----+
| 5eaba3f9-2a26-4371-89f7-d1863702d6e3 | nvidia-v100.2 | 753664 | 20 | 0 | 40 | False |
| 6186e4c3-3f02-4ecf-bf68-2088ad10d11b | lrz.medium | 9216 | 20 | 0 | 2 | False |
| 690000bb-457a-479a-9f09-aa32f467b499 | tiny | 512 | 1 | 0 | 1 | False |
| 736b1189-1daf-46f1-ac2c-a9661f6f2b29 | lrz.large | 18432 | 20 | 0 | 4 | False |
| a7f8aa12-48a9-4abe-af82-642c381e74f0 | lrz.small | 4608 | 20 | 0 | 1 | False |
| e6cb5fc6-f0df-4970-ac8a-90d67f401808 | nvidia-v100.1 | 376832 | 20 | 0 | 20 | False |
| ff616544-723d-4eaf-81a5-1df1e86c4c3 | lrz.xlarge | 46080 | 20 | 0 | 10 | False |
+-----+-----+-----+-----+-----+-----+-----+
[→] ~ openstack image list
+-----+-----+-----+
| ID | Name | Status |
+-----+-----+-----+
| 5235e1d1-b2a2-46ed-abfd-c0d8b50c71ed | CentOS-6 | active |
| 63825d44-5312-4ace-b1a5-de7791a6bb43 | CentOS-7 | active |
| 24d28aa3-06d8-4f15-b211-a2428dba0112 | Debian-10-buster | active |
| 112a98db-e6e9-453c-840a-befbbf81a414 | Debian-8-jessie | active |
| c06b03df-4812-4324-8d95-8e47320acf8b | Debian-9-stretch | active |
| f469764e-822b-4177-92a3-83e2a421ae8e | Fedora-29 | active |
| 103cee77-a5b6-4ee6-aa59-0b11b8177f73 | Fedora-30 | active |
| eec6d450-b6b4-4560-8e3d-4945d819361b | FreeBSD-11.2 | active |
| 37ebe015-f481-4e65-8307-deca96359b42 | FreeBSD-12.0 | active |
| 956a7c2d-8d30-441e-891b-14081acac6fd | GPU-Ubuntu-18.04-LTS-bionic-(cuda/docker) | active |
| 0c231b3c-6445-4f66-aa2d-0e88f35c8338 | Ubuntu-16.04-LTS-xenial | active |
| 7e7e699a-dfab-4e10-ac23-696dee869580 | Ubuntu-18.04-LTS-bionic | active |
| 0ef79e2f-cea9-4418-97c7-6f05045bd38a | Ubuntu-19.04-disco | active |
| 41f4ed09-97f0-4aa1-9c14-f8597810e411 | cirros | active |
| 61109f36-0b03-4c14-8a8e-8934f74e85b8 | remote-visualization-ubuntu-18.04 | active |
+-----+-----+-----+
[→] ~
```


The OpenStack Client Tools - Listing

```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — -zsh — 139x24
[→] ~ openstack network list
openst+-----+-----+-----+
| ID | Name | Subnets |
+-----+-----+-----+
| 2da955ac-0ba6-4755-918d-9ae23565492c | test | 4abf2933-4e90-4280-a7f9-8cf63d71d05f |
| 3f1c6c34-2be9-44b3-9f21-c3e031ab8e5c | MWN | 16677895-8403-4f14-866b-62256404f0aa |
| 8f5b0e5e-e3bf-4b53-b680-30bc593213eb | internet | ef5b863e-3d4a-4947-95cf-83b311208894 |
| a3e4d020-c8b4-48b5-beb1-5f0d47d06ed7 | MWN_pool | 3e274178-88b9-4cde-8c37-04bb3a2b0911 |
| cca21b1f-03cd-410b-a80f-5cfce18afeec | internet_pool | 9851df97-49c5-4cb9-a385-6bf6fbfc46e9 |
+-----+-----+-----+
^R
[→] ~ openstack keypair list
+-----+-----+
| Name | Fingerprint |
+-----+-----+
| access_from_windows | 51:93:d4:5f:c1:6b:09:fd:da:11:19:e3:1e:34:ec:32 |
| lrz_durillo_key | c8:ea:48:d1:64:03:42:b5:bb:b9:0a:a4:4d:9f:41:e3 |
| test_machine_key | 66:68:b0:f3:a5:2b:1d:82:d3:25:b6:68:5d:76:03:70 |
+-----+-----+
[→] ~
```

The OpenStack Client Tools - Creating



```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — -zsh — 128x9  
→ openstack server create
```

- Simple unified API for all OpenStack Entities
- Access to the help of each command
 - Simply executing it with no additional arguments
 - Executing it with `-h` | `-- help` option

The OpenStack Client Tools – Creating a new server

- Depending on the version of the tools

```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — -zsh — 128x5  
→ openstack volume create --image Ubuntu-19.04-disco --bootable --size 25 volume_test
```

```
di57sal — di57sal@BADWLRZ-CM60333 — ~ — -zsh — 128x5  
→ openstack server create --volume volume_test --flavor lrz.small --key-name lrz_durillo_key --network internet --security-group ssh instance_test
```

Version
3.19.0

```
Downloads — ubuntu@test-keys: ~ — ssh ubuntu@138.246.232.52 -i createdUsingOpenStack.pem — 163x10  
ubuntu@test-keys:~$ openstack server create --image Ubuntu-19.04-disco --boot-from-volume 25 --flavor lrz.small --key-name lrz_durillo_key --network internet --security-group ssh test_version_4
```

Version
> 4.0.0

Hands on Session 2

- Tasks
 - Install the OpenstackClient tool in an Ubuntu machine
 - Create a new key pair
 - Create a new server
 - ssh into the new created server

Working with OpenStack

- Ansible modules
- Terraform
- REST API

Wrap-up

- Motivation of Cloud Computing?
- Introduction to Cloud Computing and OpenStack
- Hands-on session using the web interface
- Hands-on session using the OpenStack Client Tools

Course Evaluation

Please visit

<https://survey.lrz.de/index.php/453862?lang=en>

and rate this course.

Your feedback is highly
appreciated!

Thank you!

