

# Introduction to Cloud and Virtual Machines

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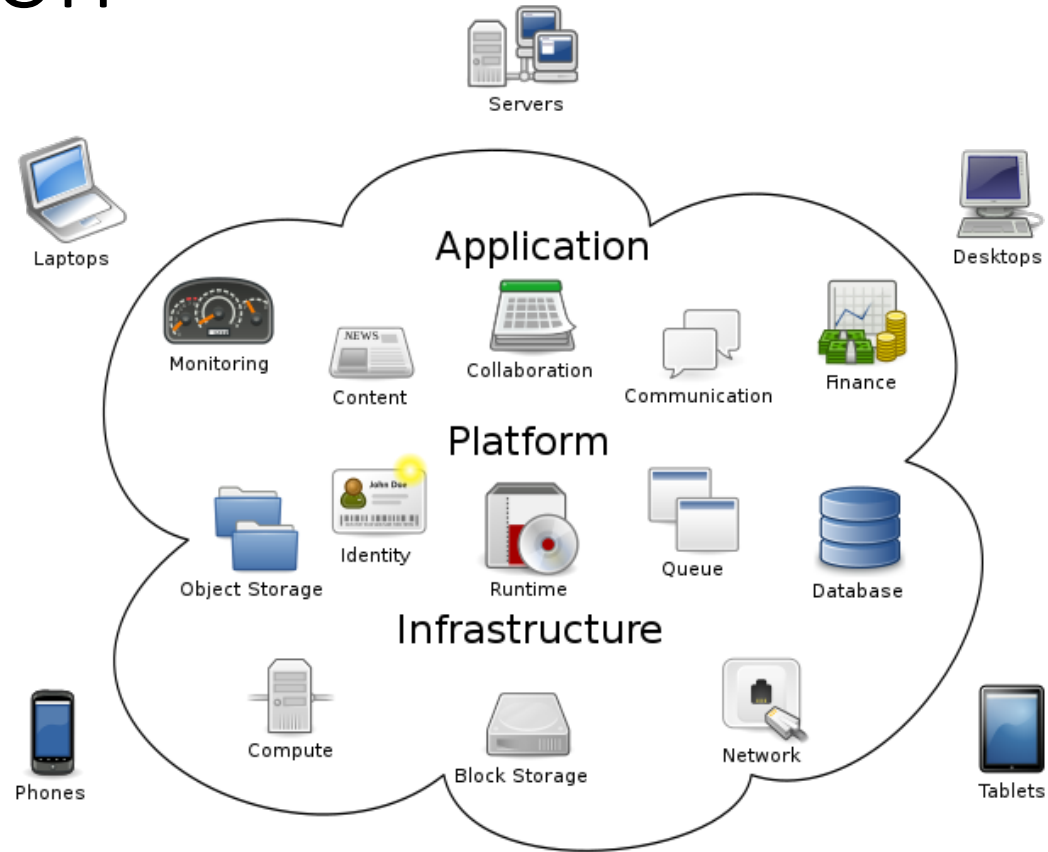
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# Introduction



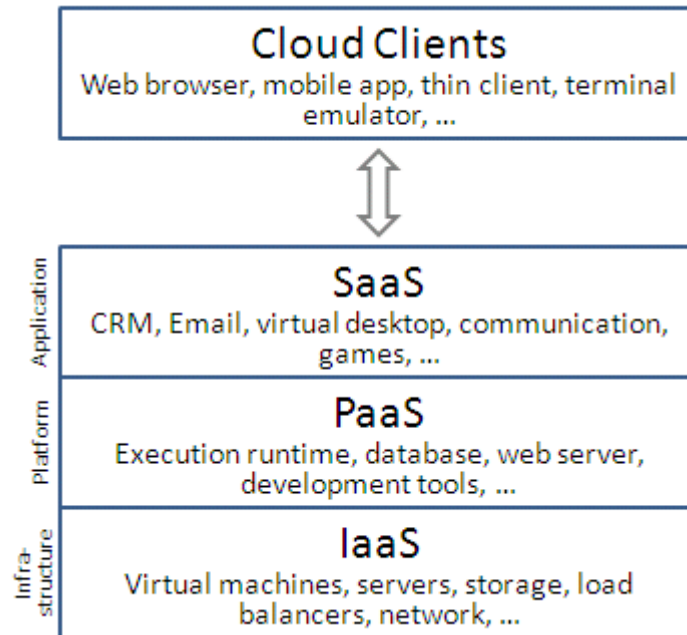
[https://commons.wikimedia.org/wiki/File:Cloud\\_computing.svg](https://commons.wikimedia.org/wiki/File:Cloud_computing.svg)

Author: Sam Johnston

# Introduction (cont.)

- Delivers high level services and access to system resources over the Internet.
- Services: collaboration (E-mail, calendaring, etc.), web, Dropbox-like file hosting, etc.
- System resources i.e. infrastructure: compute, disk, networking, load balancing, etc.

# Introduction (cont.)



[https://commons.wikimedia.org/wiki/File:Cloud\\_computing\\_layers.png](https://commons.wikimedia.org/wiki/File:Cloud_computing_layers.png)

# Digital Research Alliance of Canada (The Alliance) Cloud

Arbutus cloud ([arbutus.cloud.computecanada.ca](https://arbutus.cloud.computecanada.ca))

| Node count ↕ | CPU ↕                          | Memory (GB) ↕ | Local (ephemeral) storage ↕                 | Interconnect ↕ | GPU ↕                         | Total CPUs ↕ | Total vCPUs ↕ |
|--------------|--------------------------------|---------------|---|----------------|-------------------------------|--------------|---------------|
| 156          | 2 x <a href="#">Gold 6248</a>  | 384           | 2 x 1.92TB SSD in <a href="#">RAID0</a>     | 1 x 25GbE      | N/A                           | 6,240        | 12,480        |
| 8            | 2 x <a href="#">Gold 6248</a>  | 1024          | 2 x 1.92TB SSD in <a href="#">RAID1</a>     | 1 x 25GbE      | N/A                           | 320          | 6,400         |
| 26           | 2 x <a href="#">Gold 6248</a>  | 384           | 2 x 1.6TB SSD in <a href="#">RAID0</a>      | 1 x 25GbE      | 4 x <a href="#">V100 32GB</a> | 1,040        | 2,080         |
| 32           | 2 x <a href="#">Gold 6130</a>  | 256           | 6 x 900GB 10k SAS in <a href="#">RAID10</a> | 1 x 10GbE      | N/A                           | 1,024        | 2,048         |
| 4            | 2 x <a href="#">Gold 6130</a>  | 768           | 6 x 900GB 10k SAS in <a href="#">RAID10</a> | 2 x 10GbE      | N/A                           | 128          | 2,560         |
| 8            | 2 x <a href="#">Gold 6130</a>  | 256           | 4 x 1.92TB SSD in <a href="#">RAID5</a>     | 1 x 10GbE      | N/A                           | 256          | 512           |
| 240          | 2 x <a href="#">E5-2680 v4</a> | 256           | 4 x 900GB 10k SAS in <a href="#">RAID5</a>  | 1 x 10GbE      | N/A                           | 6,720        | 13,440        |
| 8            | 2 x E5-2680 v4                 | 512           | 4 x 900GB 10k SAS in RAID5                  | 2 x 10GbE      | N/A                           | 224          | 4,480         |
| 2            | 2 x E5-2680 v4                 | 128           | 4 x 900GB 10k SAS in RAID5                  | 1 x 10GbE      | 2 x <a href="#">Tesla K80</a> | 56           | 112           |

Location: University of Victoria

Total CPUs: 16,008 (484 nodes)

Total vCPUs: 44,112

Total GPUs: 108 (28 nodes)

Total RAM: 157,184 GB

5.3 PB of Volume and Snapshot [Ceph](#) storage.

12 PB of Object/Shared Filesystem [Ceph](#) storage.

# The Alliance Cloud (cont.)

## Cedar cloud ([cedar.cloud.computecanada.ca](https://cedar.cloud.computecanada.ca))

| Node count | CPU                            | Memory (GB) | Local (ephemeral) storage              | Interconnect | GPU | Total CPUs | Total vCPUs |
|------------|--------------------------------|-------------|--|--------------|-----|------------|-------------|
| 28         | 2 x <a href="#">E5-2683 v4</a> | 256         | 2 x 480GB SSD in <a href="#">RAID1</a> | 1 x 10GbE    | N/A | 896        | 1,792       |
| 4          | 2 x <a href="#">E5-2683 v4</a> | 256         | 2 x 480GB SSD in <a href="#">RAID1</a> | 1 x 10GbE    | N/A | 128        | 2,560       |

Location: Simon Fraser University

Total CPUs: 1,024

Total vCPUs: 4,352

Total RAM: 7,680 GB

500 TB of persistent [Ceph](#) storage.

# The Alliance Cloud (cont.)

Graham cloud ([graham.cloud.computecanada.ca](http://graham.cloud.computecanada.ca))

| Node count | CPU                       | Memory (GB) | Local (ephemeral) storage | Interconnect | GPU | Total CPUs | Total vCPUS |
|------------|---------------------------|-------------|---------------------------|--------------|-----|------------|-------------|
| 6          | 2 x E5-2683 v4            | 256         | 2x 500GB SSD in RAID0     | 1 x 10GbE    | N/A | 192        |             |
| 2          | 2 x E5-2683 v4            | 512         | 2x 500GB SSD in RAID0     | 1 x 10GbE    | N/A | 64         |             |
| 8          | 2 x E5-2637 v4            | 128         | 2x 500GB SSD in RAID0     | 1 x 10GbE    | N/A | 256        |             |
| 8          | 2 x Xeon(R) Gold 6130 CPU | 256         | 2x 500GB SSD in RAID0     | 1 x 10GbE    | N/A | 256        |             |
| 3          | 2 x E5-2640 v4            | 256         | 2x 500GB SSD in RAID0     | 1 x 10GbE    | N/A | 120        |             |
| 12         | 2 x Xeon(R) Gold 6248 CPU | 768         | 2x 1TB SSD in RAID0       | 1 x 10GbE    | N/A | 480        |             |

Location: University of Waterloo

Total CPUs: 1,368

Total vCPUs:

Total RAM: 15,616 GB

84 TB of persistent [Ceph](#) storage.



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# The Alliance Cloud (cont.)

## Béluga cloud ([beluga.cloud.computecanada.ca](https://beluga.cloud.computecanada.ca))

| Node count | CPU                      | Memory (GB) | Local (ephemeral) storage      | Interconnect | GPU | Total CPUs | Total vCPUs |
|------------|--------------------------|-------------|--------------------------------|--------------|-----|------------|-------------|
| 96         | 2 x Intel Xeon Gold 5218 | 256         | N/A, ephemeral storage in ceph | 1 x 25GbE    | N/A | 3,072      | 6,144       |
| 16         | 2 x Intel Xeon Gold 5218 | 768         | N/A, ephemeral storage in ceph | 1 x 25GbE    | N/A | 512        | 10,240      |

Location: École de Technologie Supérieure

Total CPUs: 3,584

Total vCPUs: 16,384

Total RAM: 36,864 GiB

200 TiB of replicated persistent SSD [Ceph](#) storage.

1.7 PiB of erasure coded persistent HDD [Ceph](#) storage.





# The Alliance Cloud (cont.)

- There is also the NextCloud service which provides 50GB of backed up Dropbox-like storage (<https://docs.alliancecan.ca/wiki/Nextcloud>).

# The Alliance Cloud (cont.)

- The IaaS clouds are built on OpenStack.
- OpenStack is an open-source software platform for deploying clouds i.e. build your own cloud environment.
- Can work with a variety of hardware, network switches, hypervisors.

# The Alliance Cloud (cont.)

- Various commercial vendors provide OpenStack:
  - SUSE
  - Redhat
  - Ubuntu
  - Mirantis
- Also exists a free implementation called OpenStack-Ansible which is in use by The Alliance:
  - <https://github.com/openstack/openstack-ansible>

# Cloud Resources

| Attributes                                    | Compute Cloud <sup>[1]</sup>                   | Persistent Cloud <sup>[1]</sup>   |
|---|--|-----------------------------------|
| Who can request                               | PIs only                                       | PIs only                          |
| VCPUs (see <a href="#">VM flavours</a> )      | 80   | 25                                |
| Instances <sup>[2]</sup>                      | 20   | 10                                |
| Volumes <sup>[2]</sup>                        | 2  | 10                                |
| Volume snapshots <sup>[2]</sup>               | 2  | 10                                |
| RAM (GB)                                      | 300  | 50                                |
| Floating IP                                   | 2  | 2                                 |
| Persistent storage (TB)                       | 10   |                                   |
| Object storage (TB) <sup>[3]</sup>            | 10   |                                   |
| Shared filesystem storage (TB) <sup>[3]</sup> | 10   |                                   |
| Default duration                              | 1 year <sup>[4]</sup> , with 1 month wall-time | 1 year (renewable) <sup>[4]</sup> |
| Default renewal                               | April <sup>[4]</sup>                           | April <sup>[4]</sup>              |

# Cloud Resources (cont.)

- You can request resources via the Rapid Access Service (RAS) or Resource Allocation Competition (RAC):
- <https://alliancecan.ca/en/services/advanced-research-computing/research-portal/accessing-resources>

# Other Free Services

- <https://www.infoworld.com/article/3179785/aws-vs-azure-vs-google-cloud-which-free-tier-is-best.html>
- Amazon Web Services: <https://aws.amazon.com/free/>; 1-2 VCPU free for 12 months (t2.micro or t3.micro instances depending on region).
- Data egress is typically charged.

# Hands-On

Project ▼

API Access

Compute ▼

**Overview**

Instances

Images

Key Pairs

Server Groups

Volumes >

Network >

Orchestration >

Share >

Identity >

Project / Compute / Overview

## Overview

### Limit Summary

#### Compute

|                           |                        |                             |
|---------------------------|------------------------|-----------------------------|
|                           |                        |                             |
| Instances<br>Used 0 of 50 | VCPUs<br>Used 0 of 200 | RAM<br>Used 0Bytes of 300GB |

#### Volume

|                          |                                  |                                       |
|--------------------------|----------------------------------|---------------------------------------|
|                          |                                  |                                       |
| Volumes<br>Used 13 of 50 | Volume Snapshots<br>Used 0 of 50 | Volume Storage<br>Used 103GB of 9.8TB |

# Create SSH Key Pair and Download Private Key

Project ▼

API Access

Compute ▼

Overview

Instances

Images

**Key Pairs**

Server Groups

Project / Compute / Key Pairs

## Key Pairs

Click here for filters or full text search. × + Create Key Pair 📄 Import Public Key 🗑 Delete Key Pairs

Displaying 1 item

| <input type="checkbox"/> | Name <span>▲</span>           | Type                               |
|--------------------------|-------------------------------|------------------------------------|
| <input type="checkbox"/> | <a href="#">mobaxterm key</a> | ssh <span>🗑 Delete Key Pair</span> |



## Create Key Pair



Key Pairs are how you login to your instance after it is launched. Choose a key pair name you will recognize. Names may only include alphanumeric characters, spaces, or dashes.

**Key Pair Name \***

**Key Type \***



Create Keypair

Copy Private Key to Clipboard

Done

# Launch Instance of a Virtual Machine

Project ▼

API Access

Compute ▼

Overview

**Instances**

Images

Key Pairs

Project / Compute / Instances

## Instances

Instance ID =  Filter [Launch Instance](#)

| Instance Name        | Image Name | IP Address | Flavor | Key Pair | Status | Availability Zone | Task | Power State | Age | Actions |
|----------------------|------------|------------|--------|----------|--------|-------------------|------|-------------|-----|---------|
| No items to display. |            |            |        |          |        |                   |      |             |     |         |

# Launch Instance



## Details

Source \*

Flavor \*

Networks

Network Ports

Security Groups

Key Pair

Configuration

Please provide the initial hostname for the instance, the availability zone where it will be deployed, and the instance count. Increase the Count to create multiple instances with the same settings.

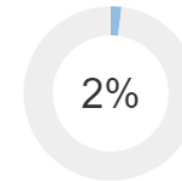
**Instance Name \***

**Description**

**Availability Zone**

**Count \***

Total Instances  
(50 Max)



- 0 Current Usage
- 1 Added
- 49 Remaining

## Launch Instance



Details

Source

Flavor \*

Networks

Network Ports

Security Groups

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

### Create New Volume

### Allocated

| Name                   | Updated         | Size      | Type  | Visibility |   |
|------------------------|-----------------|-----------|-------|------------|---|
| > CentOS-7-x64-2020-11 | 5/26/21 4:01 PM | 847.81 MB | qcow2 | Public     | ↓ |

## Launch Instance



Details

Source

Flavor

Networks

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 |   |
|------------|-------|--------|------------|-----------|----------------|--------|---|
| > p1-1.5gb | 1     | 1.5 GB | 20 GB      | 20 GB     | 0 GB           | No     | ↓ |

# Launch Instance



Details

A key pair allows you to SSH into your newly created instance. You may select an existing key pair, import a key pair, or generate a new key pair.

Source \*

+ Create Key Pair

Import Key Pair

Flavor \*

## Allocated

Displaying 1 item

| Name            | Type |   |
|-----------------|------|---|
| > mobaxterm key | ssh  | ↓ |

Networks

Network Ports

Security Groups

Key Pair

Displaying 1 item

Available 0

Select one



Click here for filters or full text search.



Configuration

Server Groups

Displaying 0 items



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# Launch the Instance

- Click Launch Instance to launch the virtual machine. Make sure to note the name of your instance.
- OpenStack will boot the VM and insert the SSH key into it.
- Once the VM is booted, we can try to access it remotely.
- But need to configure security and public networking first.

# Configuring Remote Access

Project ▼

API Access

Compute ▼

Overview

**Instances**

Images

Key Pairs

Server Groups

Volumes >

Network >

Project / Compute / Instances

## Instances

Instance ID =  Filter 🔗 Launch Instance 🗑 Delete Instances More Actions ▼

Displaying 1 item

| <input type="checkbox"/> | Instance Name              | Image Name           | IP Address      | Flavor   | Key Pair  | Status | Availability Zone | Task | Power State | Age       | Actions                        |
|--------------------------|----------------------------|----------------------|-----------------|----------|-----------|--------|-------------------|------|-------------|-----------|--------------------------------|
| <input type="checkbox"/> | <a href="#">myinstance</a> | CentOS-7-x64-2020-11 | 192.168.181.218 | p1-1.5gb | coursekey | Active | Persistent_01     | None | Running     | 0 minutes | <span>Create Snapshot</span> ▼ |

Displaying 1 item



| <input type="checkbox"/> | Instance Name | Image Name           | IP Address      | Flavor   | Key Pair  | Status |  | Availability Zone | Task | Power State | Age       | Actions  |
|--------------------------|---------------|----------------------|-----------------|----------|-----------|--------|--|-------------------|------|-------------|-----------|--|
| <input type="checkbox"/> | myinstance    | CentOS-7-x64-2020-11 | 192.168.181.218 | p1-1.5gb | coursekey | Active |  | Persistent_01     | None | Running     | 0 minutes | <input type="button" value="Create Snapshot"/> |

Displaying 1 item

- Associate Floating IP
- Attach Interface
- Detach Interface
- Edit Instance
- Attach Volume
- Detach Volume
- Update Metadata
- Retrieve Password
- Edit Security Groups
- Edit Port Security Groups

# Manage Floating IP Associations




**IP Address \***

Select the IP address you wish to associate with the selected instance or port.

**Port to be associated \***

Cancel

Associate

- Project ▼
- API Access
- Compute >
- Volumes >
- Network ▼
  - Network Topology
  - Networks
  - Routers

Project / Network / Security Groups

## Security Groups

Displaying 1 item

| <input type="checkbox"/> | Name    | Security Group ID                    | Description            | Actions                                     |
|--------------------------|---------|--------------------------------------|------------------------|---|
| <input type="checkbox"/> | default | 18a91f32-0989-4855-93ec-71c978fc562e | Default security group | <input type="button" value="Manage Rules"/> |

Displaying 1 item

Security Groups

This can be ignored, it has already been pre-configured but is here for informational purposes

## Add Rule



Rule \*

SSH

Remote \* ?

CIDR

CIDR ?

0.0.0.0/0

### Description:

Rules define which traffic is allowed to instances assigned to the security group. A security group rule consists of three main parts:

**Rule:** You can specify the desired rule template or use custom rules, the options are Custom TCP Rule, Custom UDP Rule, or Custom ICMP Rule.

**Open Port/Port Range:** For TCP and UDP rules you may choose to open either a single port or a range of ports. Selecting the "Port Range" option will provide you with space to provide both the starting and ending ports for the range. For ICMP rules you instead specify an ICMP type and code in the spaces provided.

**Remote:** You must specify the source of the traffic to be allowed via this rule. You may do so either in the form of an IP address block (CIDR) or via a source group (Security Group). Selecting a security group as the source will allow any other instance in that security group access to any other instance via this rule.

Add

This can be ignored, it has already been pre-configured but is here for informational purposes

Network ▼

Network Topology

Networks

Routers

**Security Groups**

Floating IPs

Orchestration ➤

Share ➤

Identity ➤

+ Add Rule 🗑 Delete Rules

Displaying 7 items

| <input type="checkbox"/> | Direction | Ether Type | IP Protocol | Port Range  | Remote IP Prefix | Remote Security Group | Description | Actions     |
|--------------------------|-----------|------------|-------------|-------------|------------------|-----------------------|-------------|-------------|
| <input type="checkbox"/> | Egress    | IPv4       | Any         | Any         | 0.0.0.0/0        | -                     | -           | Delete Rule |
| <input type="checkbox"/> | Egress    | IPv6       | Any         | Any         | ::/0             | -                     | -           | Delete Rule |
| <input type="checkbox"/> | Ingress   | IPv4       | Any         | Any         | -                | default               | -           | Delete Rule |
| <input type="checkbox"/> | Ingress   | IPv4       | TCP         | 22 (SSH)    | 0.0.0.0/0        | -                     | -           | Delete Rule |
| <input type="checkbox"/> | Ingress   | IPv4       | TCP         | 80 (HTTP)   | 0.0.0.0/0        | -                     | -           | Delete Rule |
| <input type="checkbox"/> | Ingress   | IPv4       | TCP         | 443 (HTTPS) | 0.0.0.0/0        | -                     | -           | Delete Rule |
| <input type="checkbox"/> | Ingress   | IPv6       | Any         | Any         | -                | default               | -           | Delete Rule |

Displaying 7 items

This can be ignored, it has already been pre-configured but is here for informational purposes

# Connect to the Instance via SSH

```
ssh -i <key>.pem centos@<public ip>
```

If using MobaXTerm, see:

[https://docs.alliancecan.ca/wiki/Connecting\\_with\\_MobaXTerm#Using\\_a\\_Key\\_Pair](https://docs.alliancecan.ca/wiki/Connecting_with_MobaXTerm#Using_a_Key_Pair)

If using Windows Subsystem for Linux, you may need to do:

```
chmod 600 <name of private key file>
```

# Installing RStudio

```
sudo yum install epel-release -y
```

```
sudo yum install R -y
```

```
<< will take a while >>
```

```
sudo yum install wget -y
```

```
wget https://download2.rstudio.org/server/centos7/x86_64/rstudio-server-rhel-1.4.1717-x86_64.rpm
```

```
sudo yum install rstudio-server-rhel-1.4.1717-x86_64.rpm -y
```

```
sudo systemctl status rstudio-server.service
```

```
sudo systemctl enable rstudio-server.service
```

# Add Security Rule

**Rule \***  
Custom TCP Rule ▼

**Description ?**

**Direction**  
Ingress ▼

**Open Port \***  
Port ▼

**Port\* ?**  
8787

**Remote\* ?**  
CIDR ▼

**CIDR ?**  
0.0.0.0/0

This can be ignored, it has already been pre-configured but is here for informational purposes

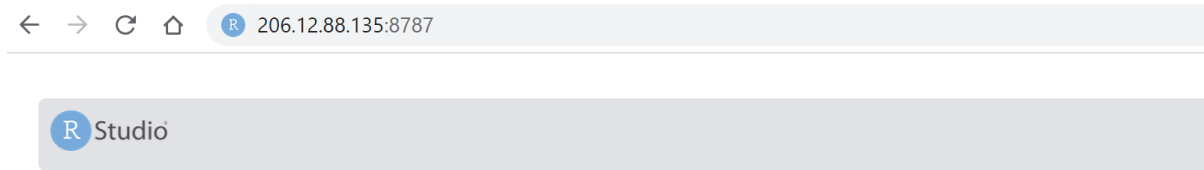


# Add User

```
sudo useradd rstudiouser
```

```
sudo passwd rstudiouser
```

# Done



Sign in to RStudio

Username:

Password:

Stay signed in when browser closes

You will automatically be signed out after 60 minutes of inactivity.

[Sign In](#)

# Maintaining Your Instance

- Install updates to the OS, e.g. for CentOS do “yum -y update”.
- Install application updates regularly for RStudio and other applications.

# Resources

- The Alliance Cloud
  - [https://docs.alliancecan.ca/wiki/Cloud\\_RAS\\_Allocations](https://docs.alliancecan.ca/wiki/Cloud_RAS_Allocations)
  - [https://docs.alliancecan.ca/wiki/Cloud\\_Quick\\_Start](https://docs.alliancecan.ca/wiki/Cloud_Quick_Start)
- UBC Advanced Research Computing
  - <https://www.arc.ubc.ca>