# Cloud as resource for DIRAC


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*CPPM-IN2P3-CNRS, France,*

*20th Feb 2024,*

*Jennifer2 Workshop*

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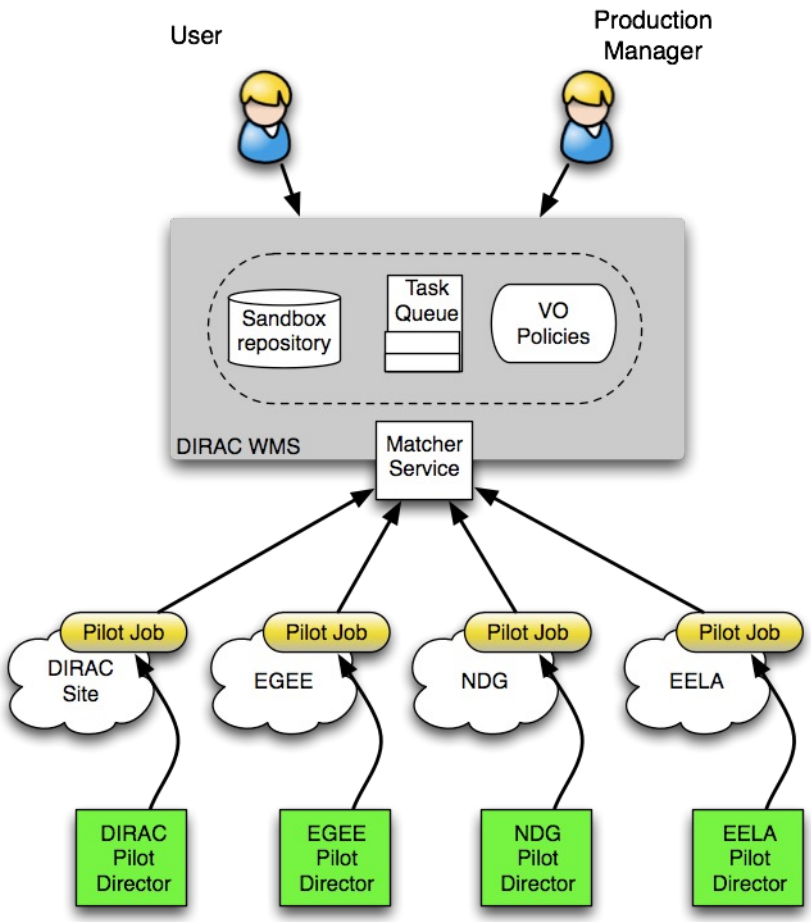
# Plan

- DIRAC WMS
- CloudComputingElement
- Pilots in VMs
- VM life cycle
- Conclusion

# Job scheduling

- Pilot jobs are submitted to computing resources by specialized Pilot Directors
- Pilots retrieve user jobs from the central Task Queue and steer their execution on the worker nodes including final data uploading
- Pilot based WMS advantages:
  - increases efficiency of the user job execution
  - allows to apply efficiently community policies at the Task Queue level
  - allows to integrate heterogeneous computing resources



# Computing Element

- DIRAC uses ComputingElement plugins to access different types of computing resources
  - Encapsulate access protocol (HTCondor, ARC, SSH)
  - Manages the pilot life cycle
- Recently CloudComputingElement was developed by the GridPP team (*Daniela, Simon*)
  - Access clouds in a similar way as other computing resources
  - Documentation:

    https://dirac.readthedocs.io/en/latest/CodeDocumentation/Resources/Computing/CloudComputingElement.html

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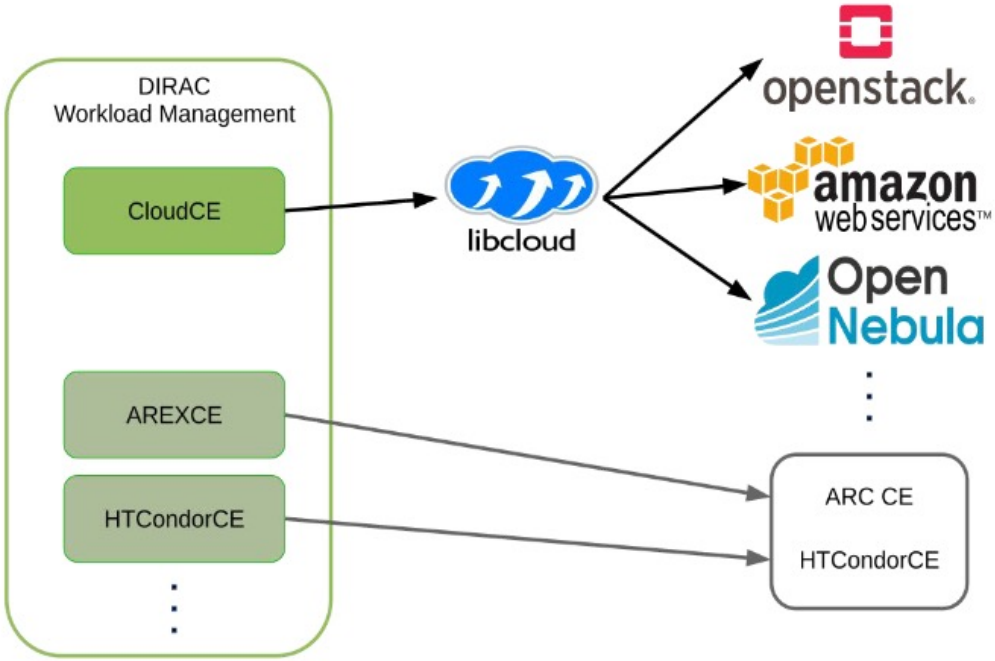
# CloudComputingElement

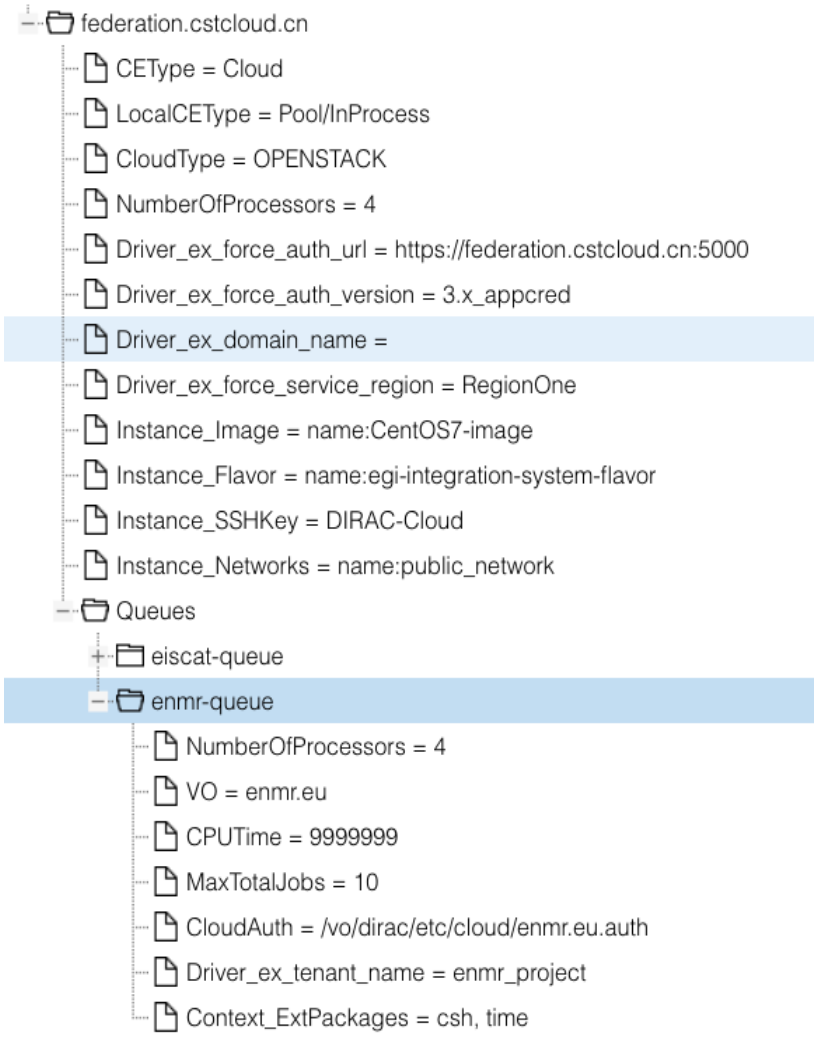
- CloudComputingElement is based on the Apache libcloud
  - https://libcloud.apache.org
- Apache libcloud is an open source collection of python based cloud interfaces, maintained by the Apache foundation
  - General cloud access functionality (computing and storage)
  - Driver plugins for (almost) all public and private clouds

# CloudComputingElement

- Inherits the DIRAC ComputingElement interface
  - Works with the standard pilot factory (SiteDirector)
- The pilot payload script and data are added as instance metadata in **cloud-init** format
- Any VM image containing **cloud-init** to decode and start the DIRAC pilot bootstrap scripts.



# CloudCE Configuration




- Access point
- Auth method
  - Password, Application Credentials
- Project/Tenant
- VM parameters
  - Image, flavor
- Max number of VMs to create
- Extra software to install
  - CVMFS is always installed

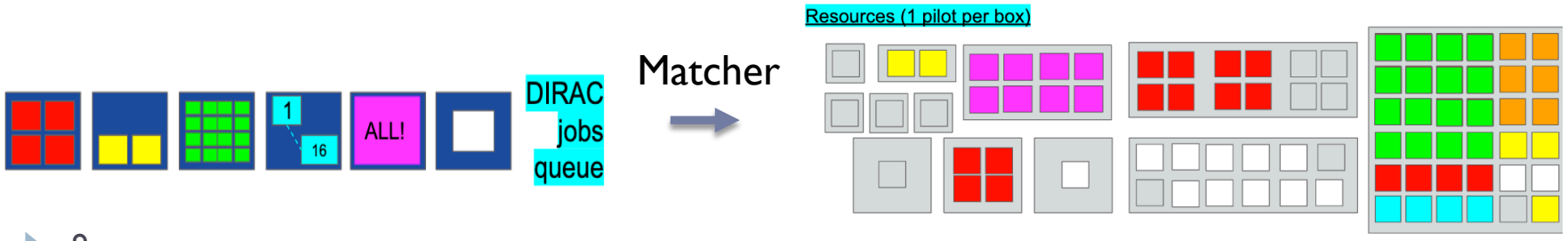
# Authentication to clouds

- Openstack authentication
  - Login/password
  - Certificates
  - Application Credentials

- Accessing clouds with tokens recipe
  - Login to the cloud dashboard with a token
  - Choose the proper project
  - Set up Application Credentials
  - Store the AppCred ID and secret in the pilot factory configuration

# Multi-core VMs

- Pilots exploit multi-core VMs using **PoolCE** "inner" Computing Element
  - On-WN batch system
  - Flexible strategy with prioritized job requests to the Matcher, e.g.:
    - First, ask for jobs requiring WholeNode tag
    - If none, ask for jobs requesting as many cores as available
    - If none, ask for jobs with MultiProcessor requirement
    - If none, ask for single-core jobs
  - The goal is to fill the nodes with payloads fully exploiting there multi-core capacity



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# Pilots in VM

- User payloads execution options (configurable)
  - Execution by a pilot user process
    - **InProcessCE** « inner » Computing Element
    - No barriers between parallel user jobs
    - No barriers between the user job and the pilot
  - Execution in separate **Singularity** containers
    - Good payloads separation

# Pilots in VM

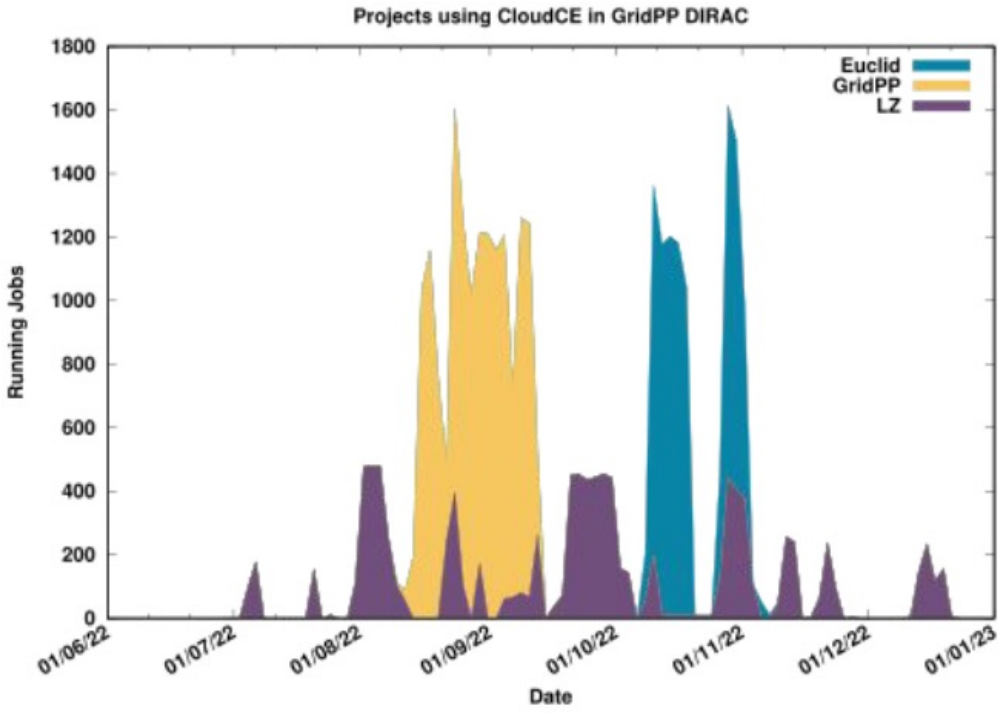
- The pilot life cycle finishes when
  - The limit of the number of user jobs is reached
  - The limit of fruitless attempts to get user jobs is reached
    - Typically 10 attempts within 20 minutes
  - The hard time limit for the VM is reached
    - 2 weeks by default
    - Stuck VM will be cleaned when reaching this limit
- Pilot logs are not easily available right now
  - No inbound connectivity to VMs from the DIRAC services
  - One has to log in to the running VM for debugging
  - Work in progress on the system to push pilot log messages to a central service

# Pilots credentials

- Pilots use credentials to connect to the DIRAC central service
  - X.509 proxy certificates
- No mechanism for the pilot proxy renewal
  - Pilots are instrumented with proxies as long as the VM time limit, e.g. 2 weeks
- The user payload proxies are renewed by pilots as needed

# CloudCE usage

- Used quite intensively in GridPP




- Few cloud sites in EGI
  - 15 configured, ~6 actually used
  - Not so many resources available through clouds
  - Available sites are quite stable

*See Daniela's presentation at the DIRAC&Rucio Workshop, KEK, 2023*
*https://indico.cern.ch/event/1252369/*

# Outlook

- CloudComputingElement works well for Openstack clouds
  - With Application Credentials set up for each cloud
- OpenNebula cloud access is being tested
  - Other clouds can be tried out as soon as this will be requested by users
- Centralized pilot logging is in the certification phase
  - Will help all the pilots, not only those in the clouds