




# OpenNebula's Edge Innovation

## Building an Open Source Path towards an Edge-Cloud-HPC Continuum



# \$> whoami



 Lecce (Italy)



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# OpenNebula Systems

The Company behind OpenNebula—the European Open Source Cloud & Edge Computing Platform



- ✓ Founded in 2010 to develop and maintain the open source project OpenNebula.



- ✓ The **only European IaaS solution**, used as baseline technology in this Project.



- ✓ A success story that emerged from **EU innovation programs** (FP7 + H2020).



- ✓ 12 years of experience in R&D and innovation projects in cloud and edge computing.



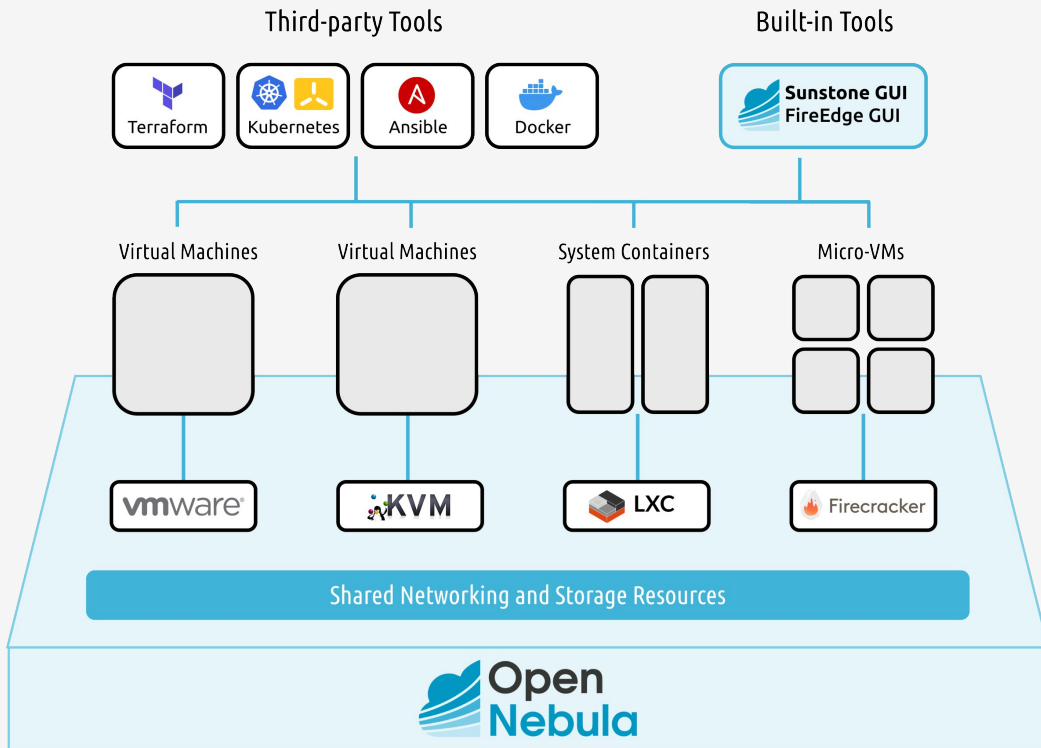
- ✓ Day-1 members of **GAIA-X**, members of the **European Open Science Cloud**, and chairing company of the Cloud/Edge WG – **EU Alliance for Industrial Data, Edge and Cloud**.

# 1. What is OpenNebula?



# What is OpenNebula?

The open source Cloud & Edge Computing Platform bringing real freedom to your Enterprise Cloud 🚀



- ✓ **Multi-Tenancy**
- ✓ **Self-Service**
- ✓ **Elasticity**
- ✓ **Multi-Tier Apps**
- ✓ **High Availability**
- ✓ **Federation**
- ✓ **Provisioning**
- ✓ **VMs + Containers**
- ✓ **Multi-Cloud**

# What is OpenNebula?

The open source Cloud & Edge Computing Platform bringing real freedom to your Enterprise Cloud 🚀

Virtual Machines



Application Containers



Kubernetes Clusters



Virtual Infrastructure Management, Cloud Management Provisioning & Cloud Federation



CORE DATA CENTER



PUBLIC CLOUD



EDGE

- ✓ Avoids “Vendor Lock-in”
- ✓ Minimizes complexity
- ✓ Reduces resource consumption
- ✓ Slashes operating costs

## 2. From the Edge to the Continuum

# Edge Computing Benefits

Opening up new business models



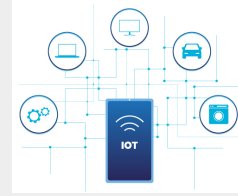
**Gaming**



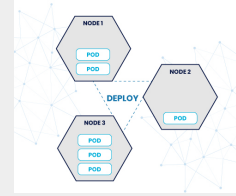
**OTT & Broadcasting**



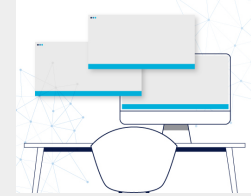
**5G Applications**



**Internet of Things**



**Smart Cities**



**Virtual Desktop**

Deploy (Ultra-) Low-Latency Applications

Improve User Experience

Expand Service Availability

Reduce Data Transfers and Security Risks

Reduce Energy Consumption

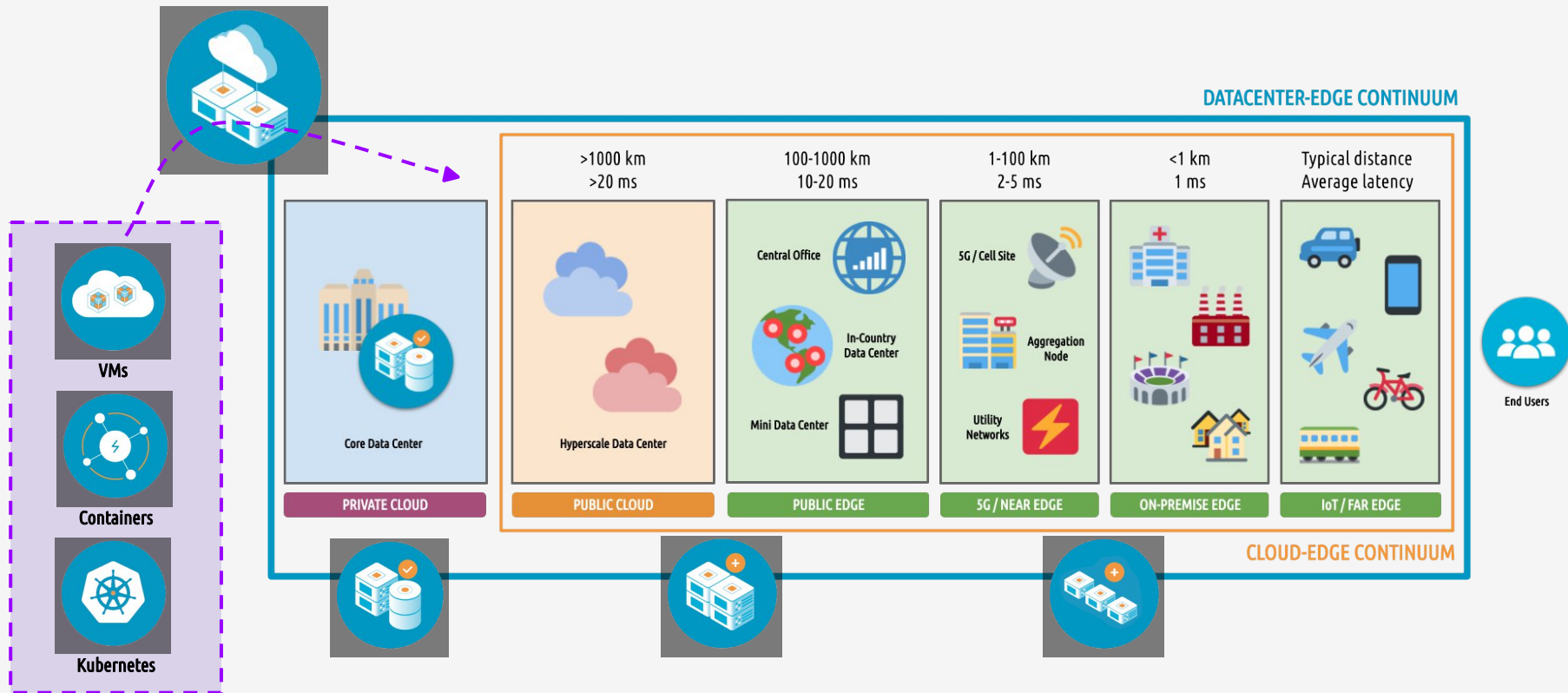
Minimize Vendor Dependency

Foster European Ecosystem of New Infrastructure Providers



# Edge Computing Innovation

Towards a meta-orchestrator for the Datacenter-Cloud-Edge-IoT continuum

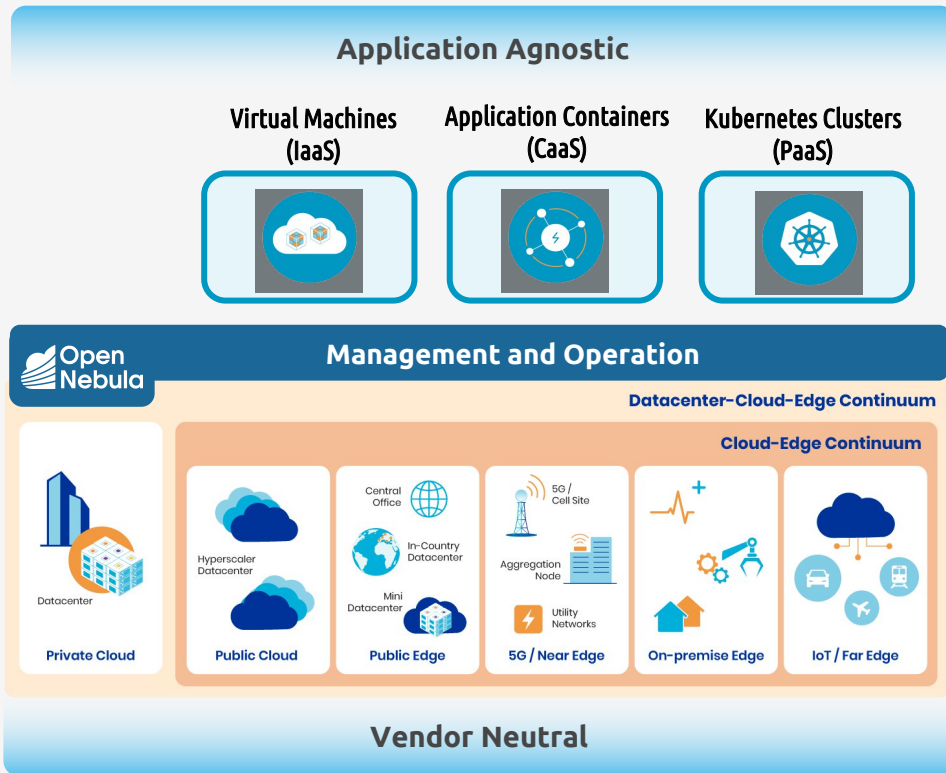


# Next Generation Cloud Computing

Management and Operation of Next-Generation Datacenter-Cloud-Edge Continuum

## Innovative Features

- ✓ Dynamic **provisioning**
- ✓ Application **portability**
- ✓ Multi-cloud **interoperability**
- ✓ AI-enabled **meta-orchestration**
- ✓ AI-enabled **federation**



## Innovative Capabilities

- ✓ **Energy** efficiency
- ✓ Distributed **security**
- ✓ Smart **orchestration**
- ✓ Smart **monitoring**
- ✓ **Observability**
- ✓ Smart **data processing**

# Expanding to the Edge

Automated Resource Provisioning and Applications Deployment at the Edge

## 3 Any Application

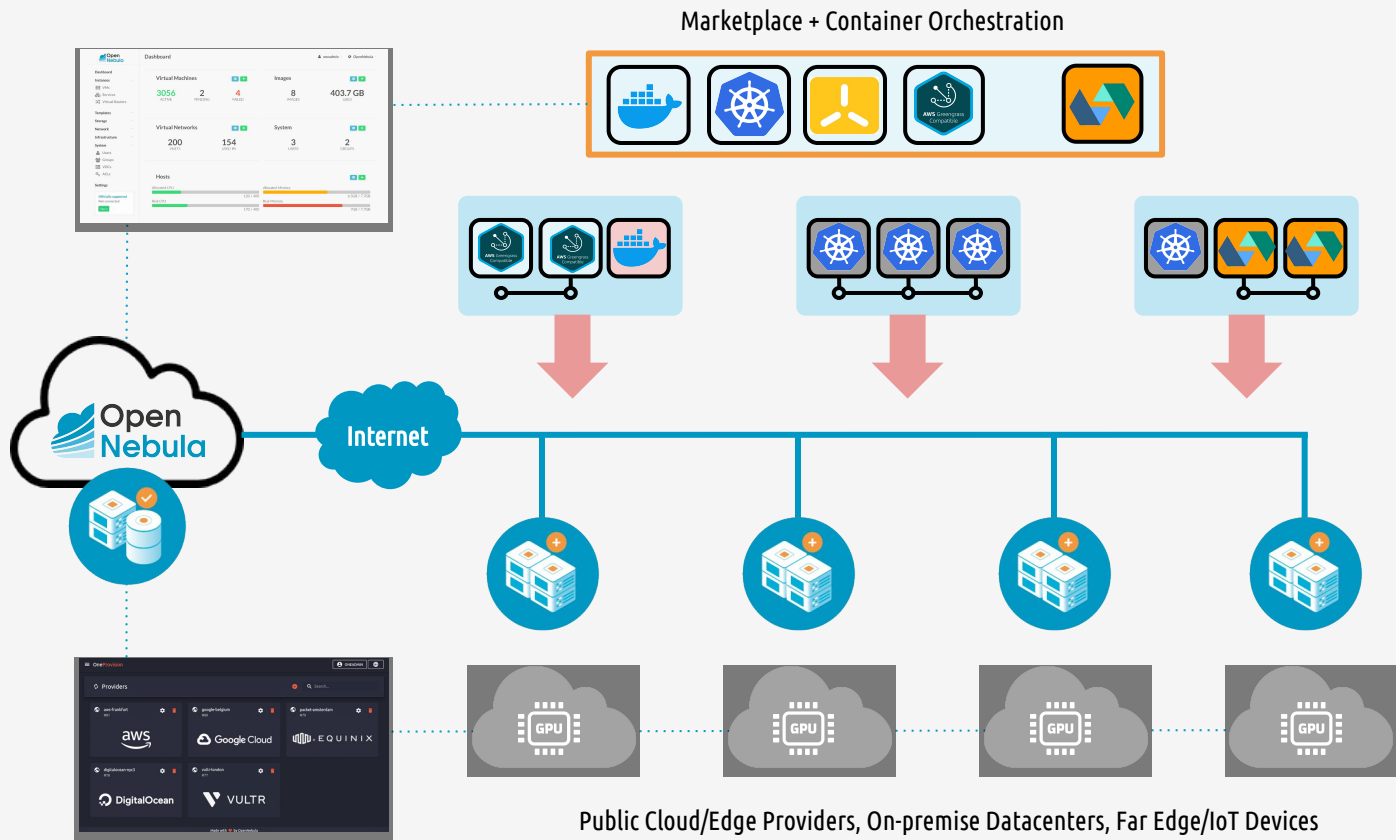
VMs, multi-VM services, containers, and K8s clusters on a shared environment

## 2 Uniform Management

Homogeneous layer for user and workload management and operation

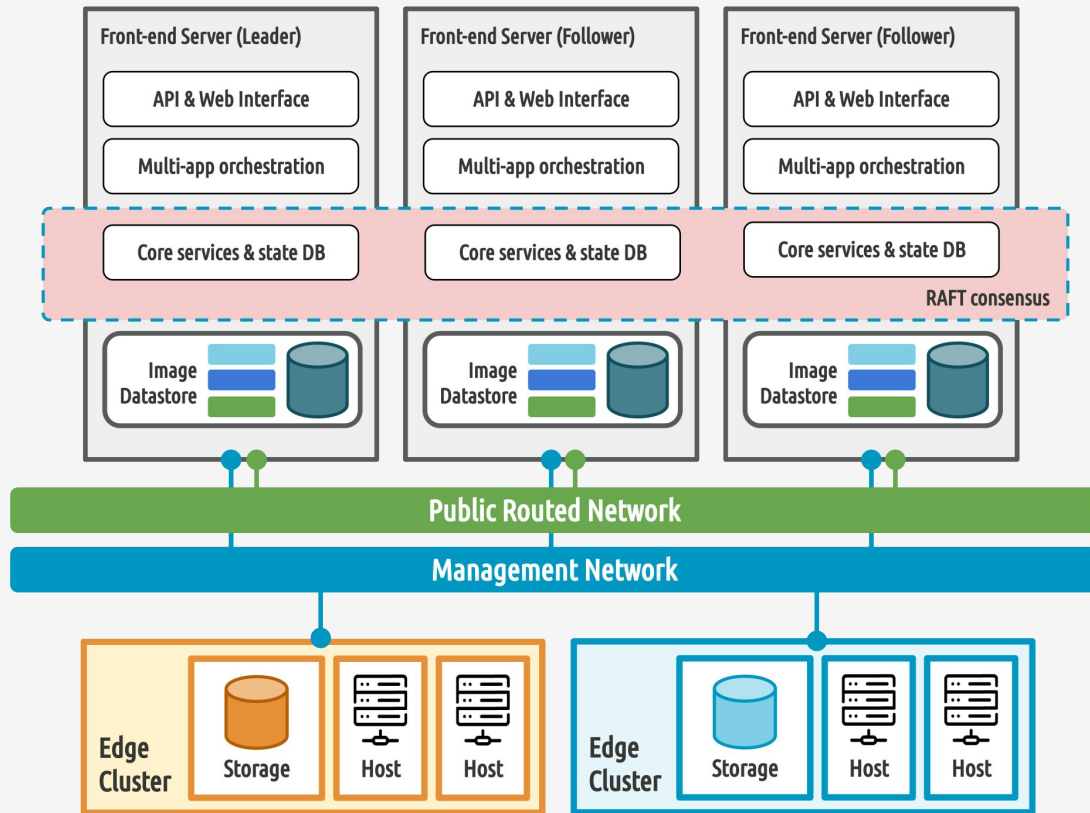
## 1 Any Infrastructure

Automatic provision of resources from public cloud/edge providers



# How does OpenNebula do it?

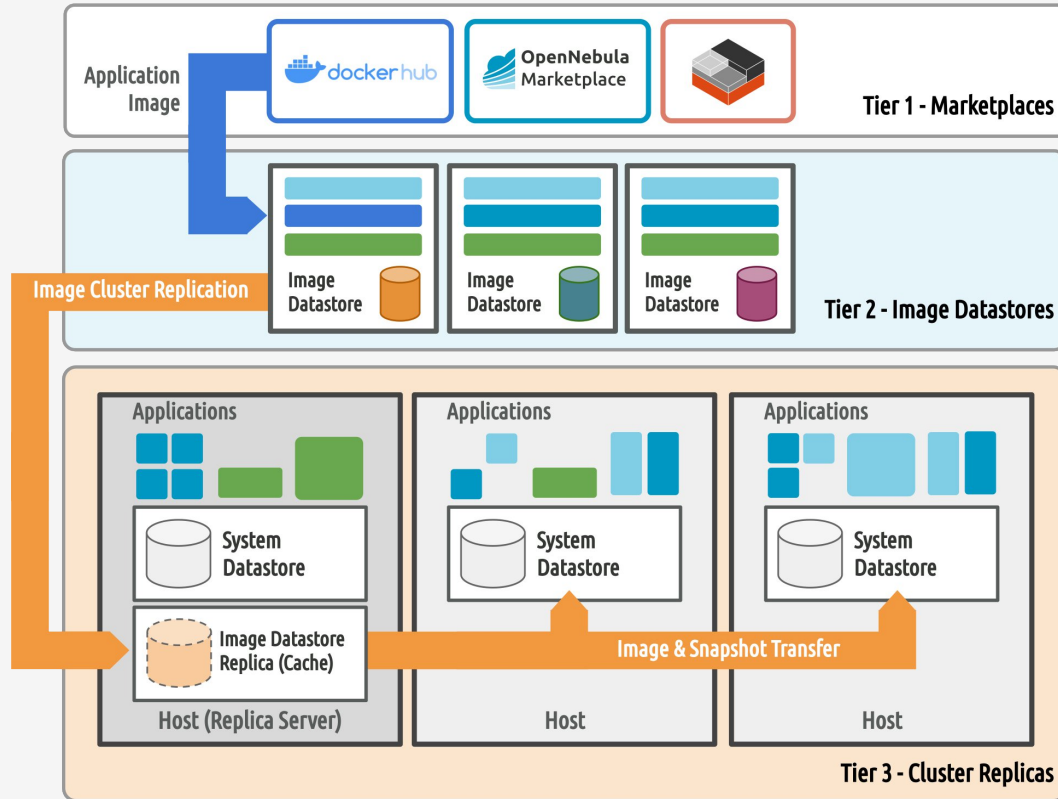
Say *hello* to our new Edge Cloud Architecture





# OneStor

Storage solution developed for the efficient management of disk images in OpenNebula cloud environments



# Real Use Cases

Applying Edge Computing in Key Industries

## Low-latency Gaming

Fully automated deployment of gaming servers  
on 17 edge locations in 25 minutes



<https://opennebula.io/opennebula-a-lightning-fast-video-gaming-edge-use-case-2/>

## OTT & Live Broadcasting

Build live and on-demand video workflows on a geo-distributed cloud to meet latency, bandwidth and regulation needs.



<https://opennebula.io/an-elastic-private-cloud-opennebulas-solution-for-media-services/>

## Internet of Things

Leverage the IoT features of "AWS IoT Greengrass" to  
create a distributed Greengrass Edge Cloud



<https://opennebula.io/automatic-deployment-of-aws-iot-greengrass-at-the-edge/>

## Desktop Virtualization

Deploy a pay-as-you-go VDI solution that is  
compliant with local data protection regulations.

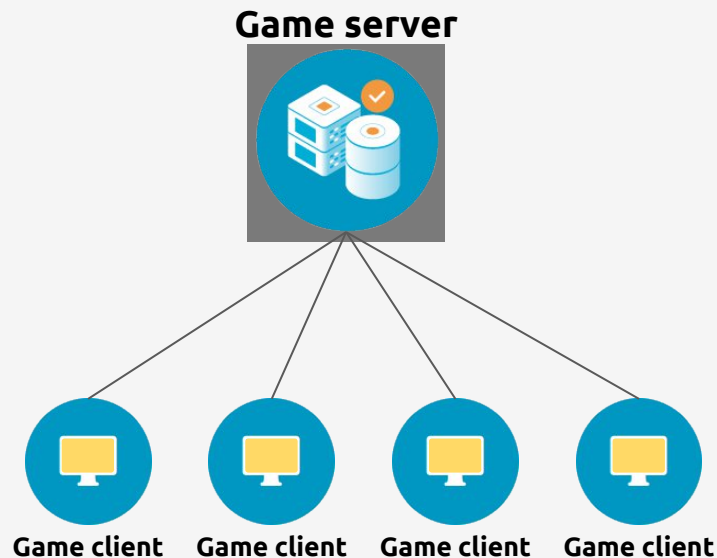


<https://opennebula.io/opennebula-for-vdi-at-the-edge/>

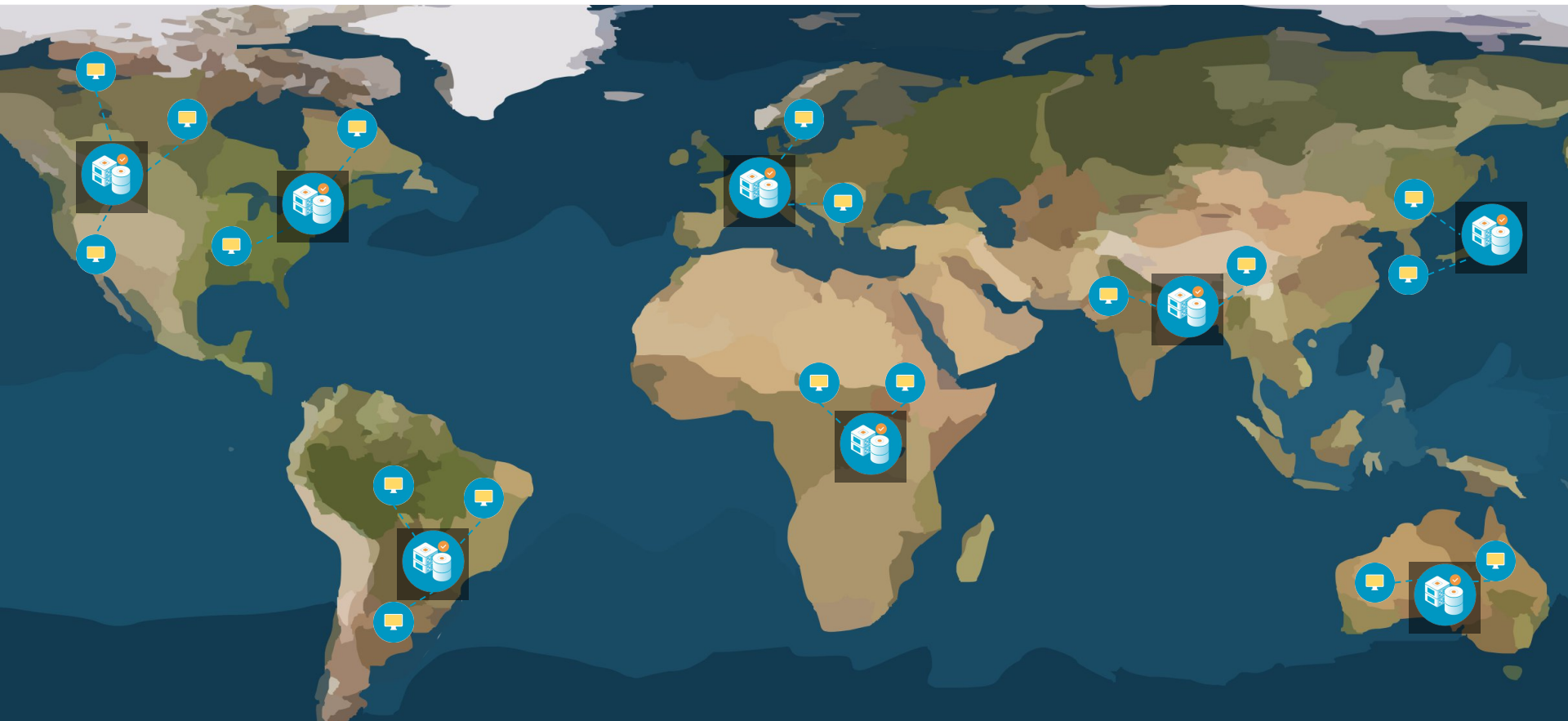
# Multiplayer Online Gaming

Fast-paced, realtime, multiplayer games where **latency and performances** are **critical** parts of the games

First Person Shooters (FPS)  
Multiplayer Online Battle Arena (MOBA)  
Battle Royale



# Edge Computing for Multiplayer Gaming





# Deploying Game Servers at the Edge

## 4 Deploy game server

Deploy and manage Xonotic Game Servers with Agones.

## 3 Agones installation

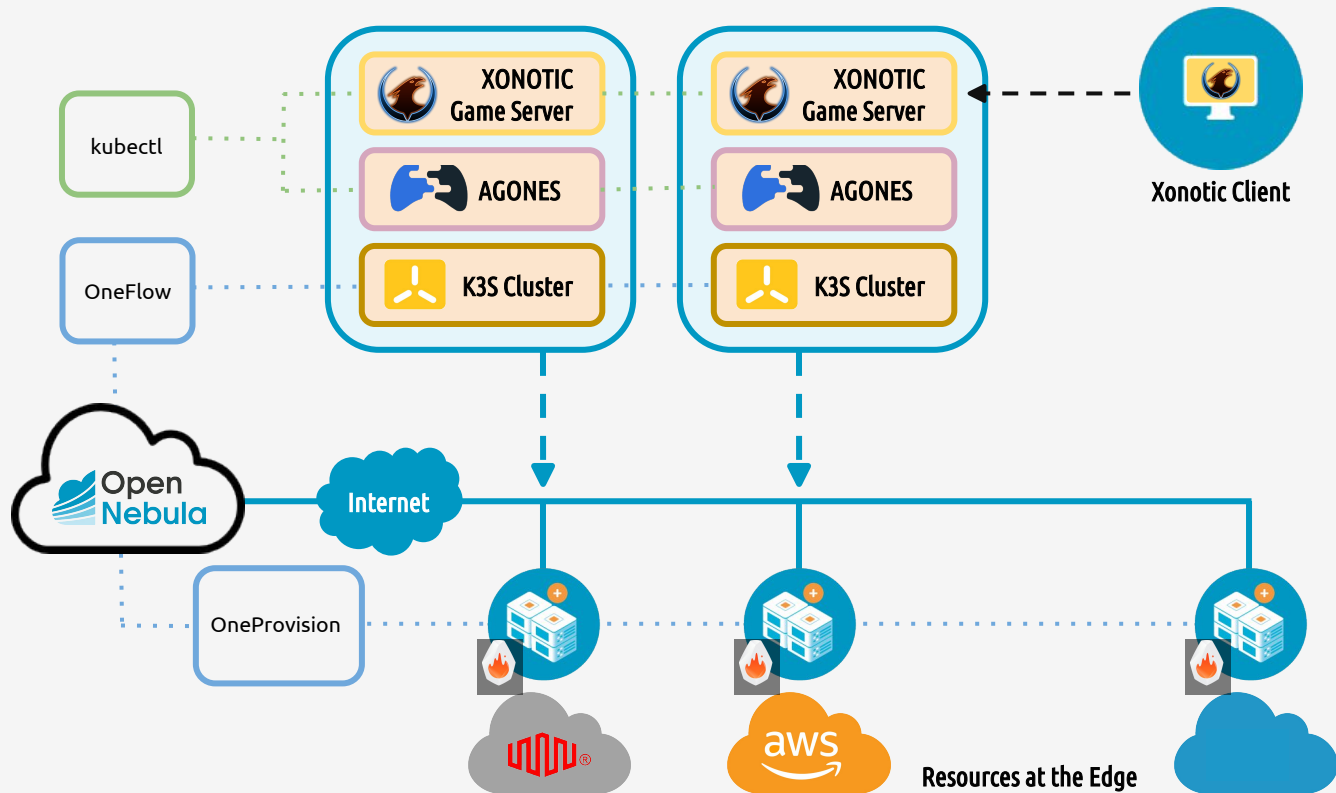
Install Agones on K3s clusters using kubectl

## 2 Deploy K3s clusters

Launch K3s Docker images as Firecracker microVMs using OneFlow

## 1 Provisioning

Edge resources provisioning from public cloud providers using OneProvision



# 3. Towards an Edge-Cloud-HPC Continuum

# HPC in the Continuum

Needs and challenges in the edge-to-exascale

## NEEDS



Running advanced computational problems and simulations

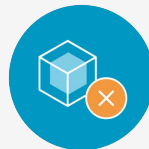


Multiple tasks running simultaneously for processing massive amounts of data at scale



Using Artificial intelligence (AI) and high performance data analytics (HPDA) for analysis of massive data

## CHALLENGES



Automated provisioning of HPC clusters



Agnostic HPC applications deployments



Automated tools for HPC workflows

# HPC Usage

OpenNebula Providing the Framework for Private HPC Cloud Use Case

## Americas

- Harvard University
- Fermilab
- Rice University
- USC
- NASA
- UCLA
- UC Santa Barbara
- Tufts University
- Dartmouth University
- Hofstra Univ.

## Europe

- SurfSara
- CSUC
- EURAC Research
- ETH Zürich
- Fraunhofer SCAI
- Barcelona Supercomputing Center
- ESAC (European Space Agency)
- Universitat Politècnica de Catalunya
- Teide HPC
- University Catholique of Louvain
- University of Padua

## Asia / Other

- National Institute of Advanced Industrial Science and Technology (AIST) - (Japan)
- HPCI (Japan)
- Moscow State University of Technology STANKIN
- Deakin University
- Universiti Teknologi MARA



# HPC in the Continuum

OpenNebula Vision for edge-to-exascale

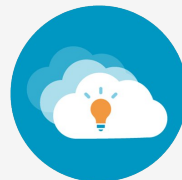
## OpenNebula for Private HPC Cloud



- ✓ CPU pinning and NUMA-aware scheduler
- ✓ PCI-Passthrough for GPUs
- ✓ SR-IOV Driver for HPC networks, i.e. Mellanox Infiniband
- ✓ System Containers Virtualization (LXC)

## OpenNebula for HPC in the Continuum

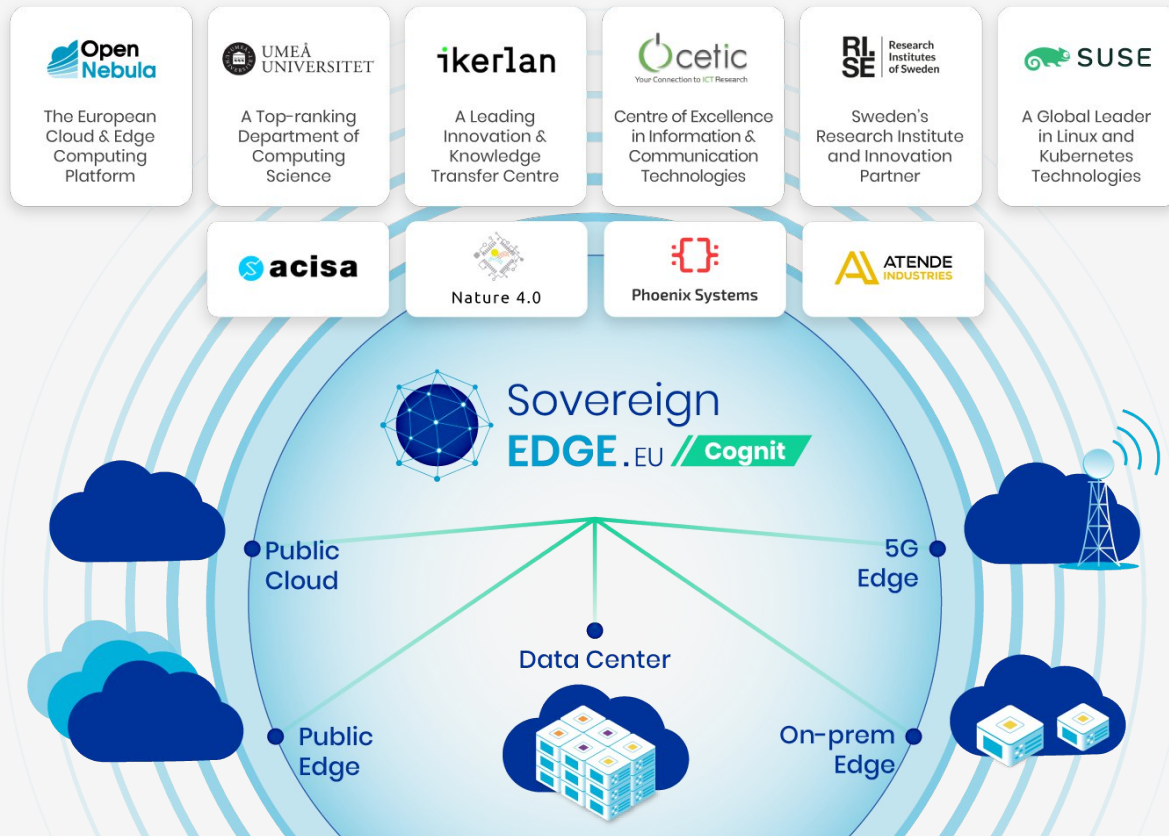
- ✓ Automated Provisioning of HPC clusters
- ✓ Seamless deployment of HPC workflows/applications
- ✓ HPC as a Service Model



# EU SovereignEdge/Cognit

A Cognitive Serverless Framework for the Cloud-Edge Continuum

Budget: 5.7 M€



# EU IPCEI Cloud Infra & Services

## Cloud-Edge Capabilities (WS2)

Chair: Telecom Italia  
Co-chairs: SAP & OpenNebula

**Budget: 2,000+ M€**



12 EU Member States, led by Germany and France, and with the support of the European Commission, have just submitted a formal proposal for an **Important Project of Common European Interest (IPCEI)** on Next Generation Cloud Infrastructure & Services:

The main objectives of this initiative include:

- Enable Multi-Provider **Cloud-Edge Continuum**.
- Strengthening of EU digital industry.
- Development of European open source technologies.



# 4. Try Yourself!

# OpenNebula Edge Cloud



## OpenNebula's Approach to Edge Computing

*WHITE PAPER*



## Edge Cloud Reference Architecture

*WHITE PAPER*



## Enterprise Kubernetes Made Simple

*WHITE PAPER*

miniONE

Install a single-node KVM/LXC/FC Cloud  
[minione.opennebula.io](https://minione.opennebula.io)

OpenNebula 6.4.

Try "Archeon", our latest release!  
[opennebula.io/archeon](https://opennebula.io/archeon)

Edgify

Edgify - Hosted OpenNebula  
[www.edgify.io](https://www.edgify.io)





**contact@opennebula.io**



### **OpenNebula Headquarters**

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#### **Phone**

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+1 617 453 3829



#### **Website**

**OpenNebula.io**  
OneEdge.io

# Thanks!

# BACKUP



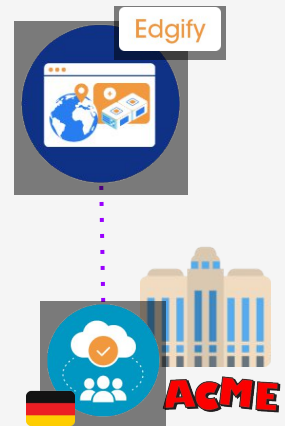
# Demo: Edgify Service

A View From the Eagle's Eye



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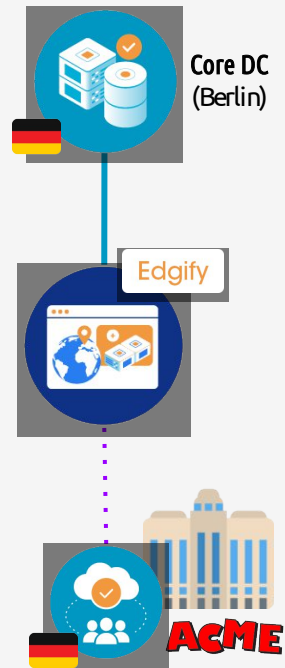
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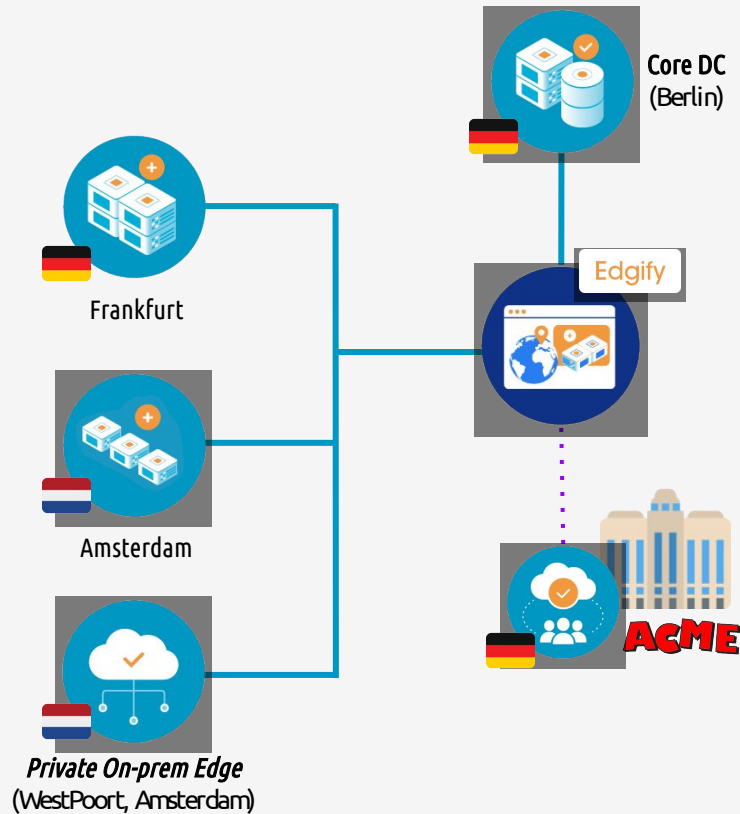
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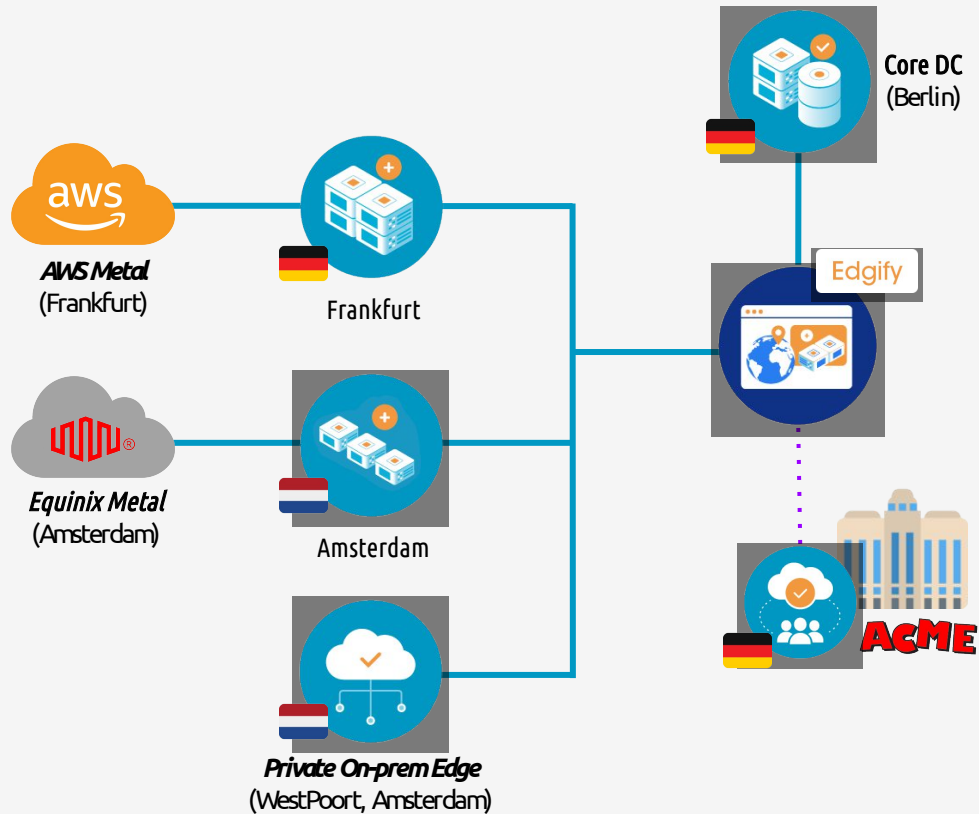
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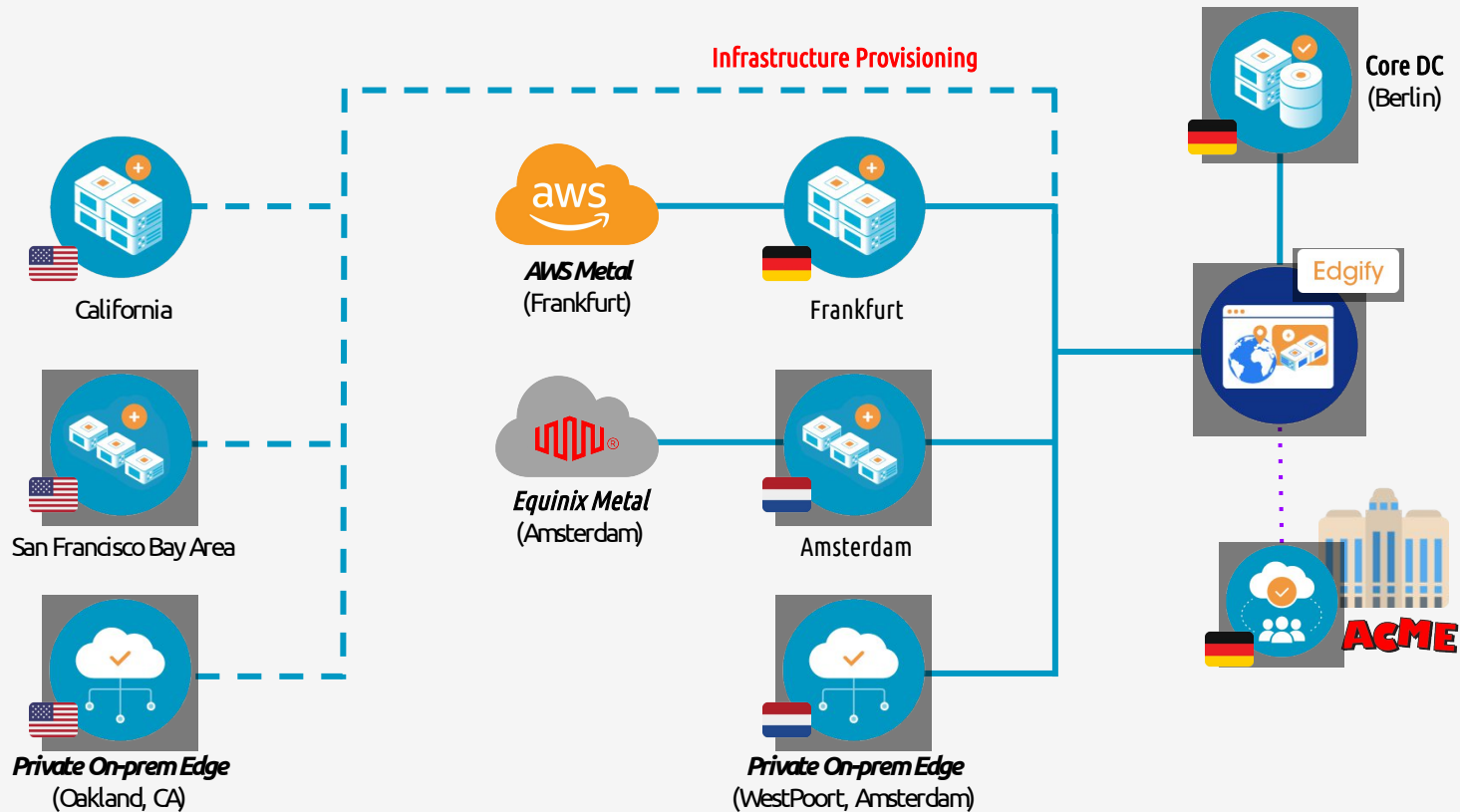
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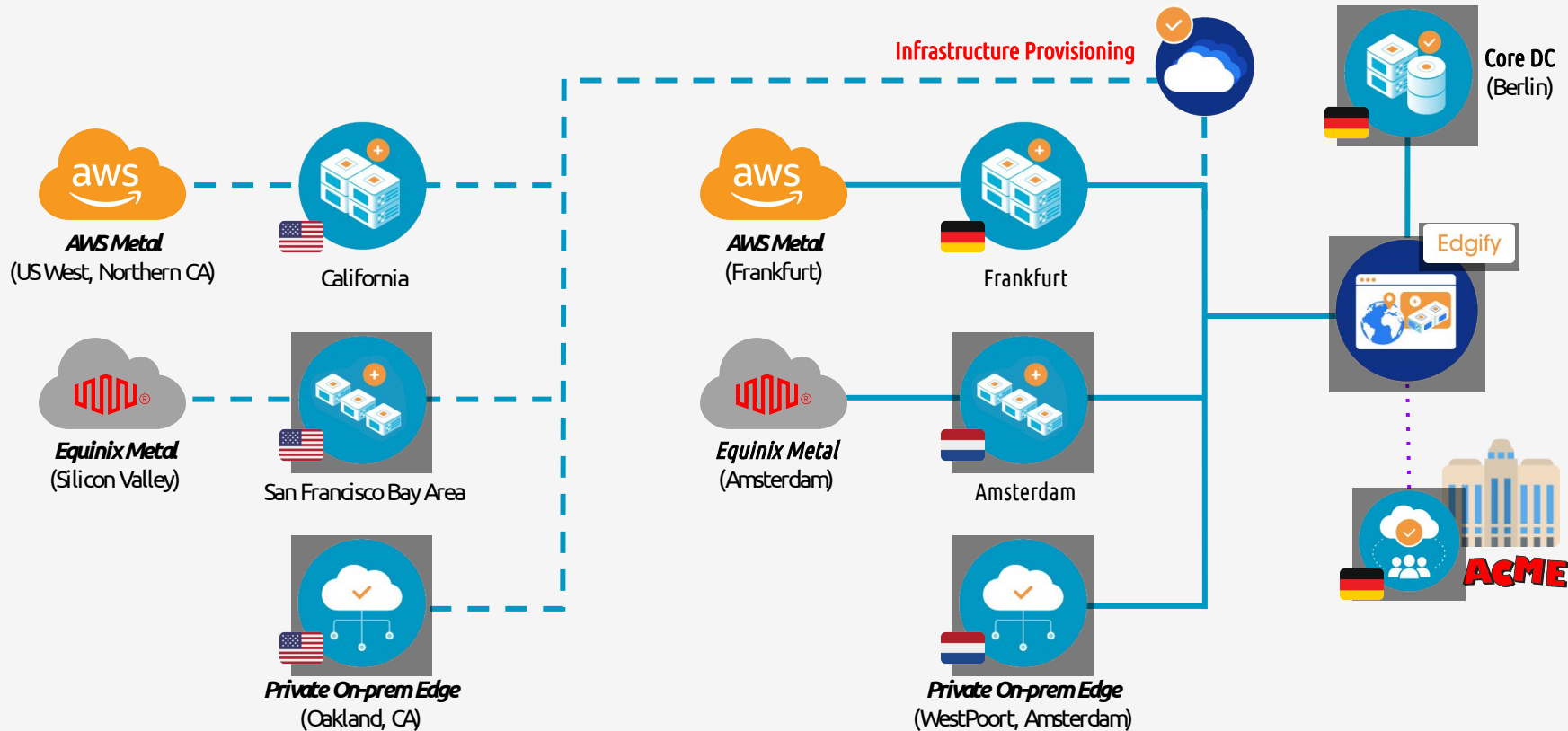
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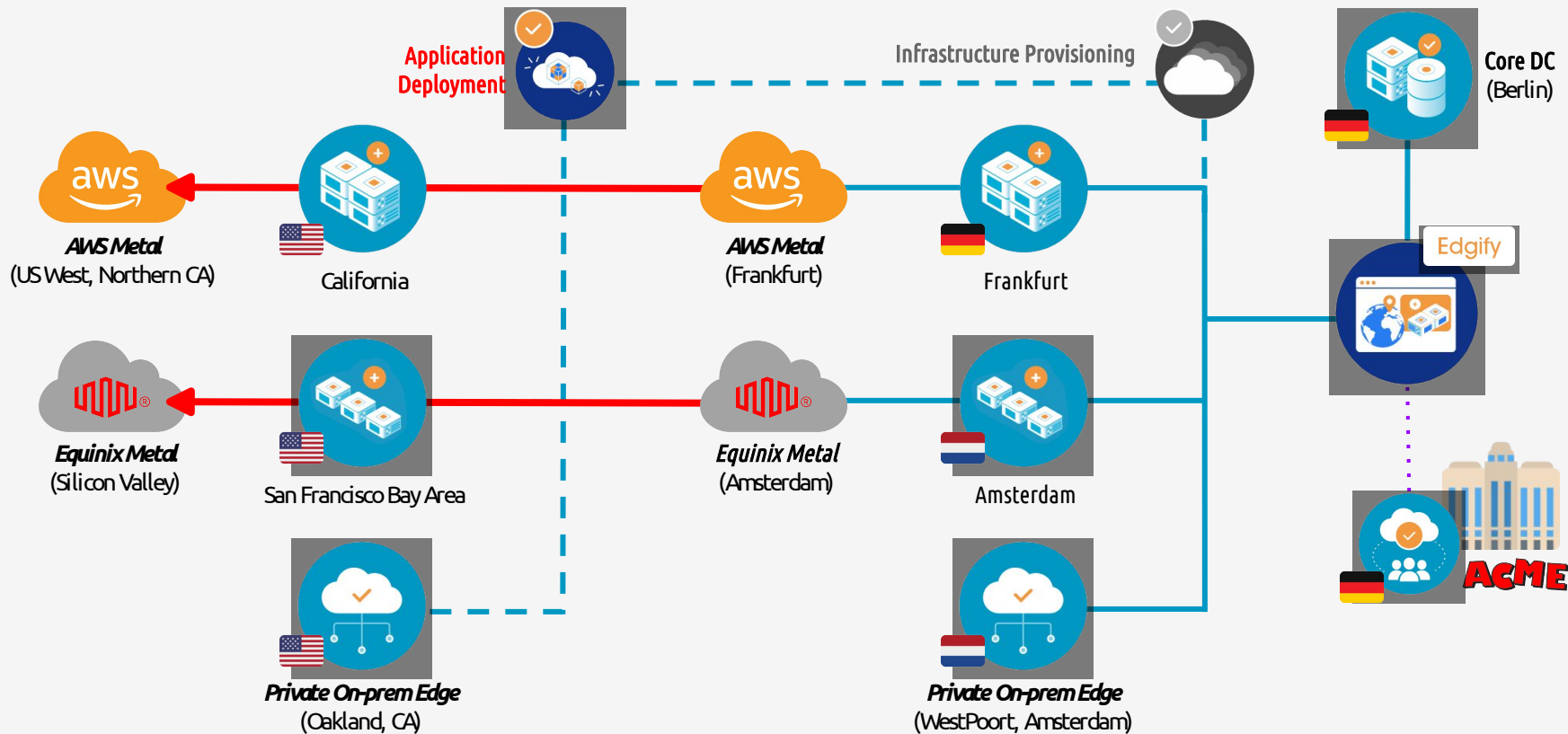
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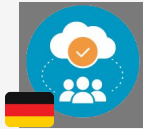
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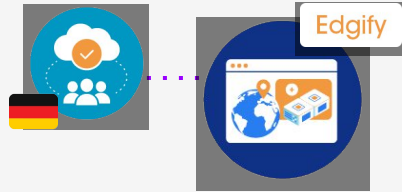
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An **on-demand, vendor-neutral & application-agnostic** solution for the Edge



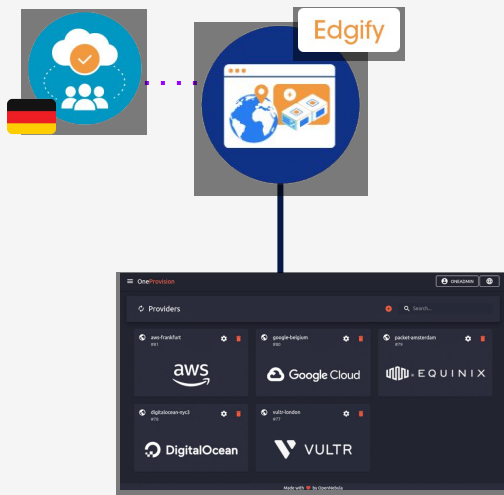
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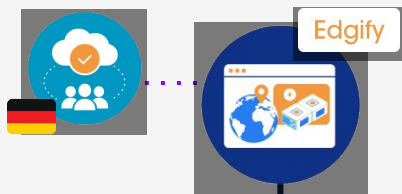
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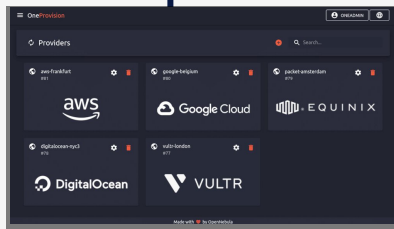
An **on-demand, vendor-neutral & application-agnostic** solution for the Edge



1

## Provider Catalog

Add **AWS** and **Equinix Metal** as new public cloud/edge infra providers in the US.



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An **on-demand, vendor-neutral & application-agnostic** solution for the Edge

2

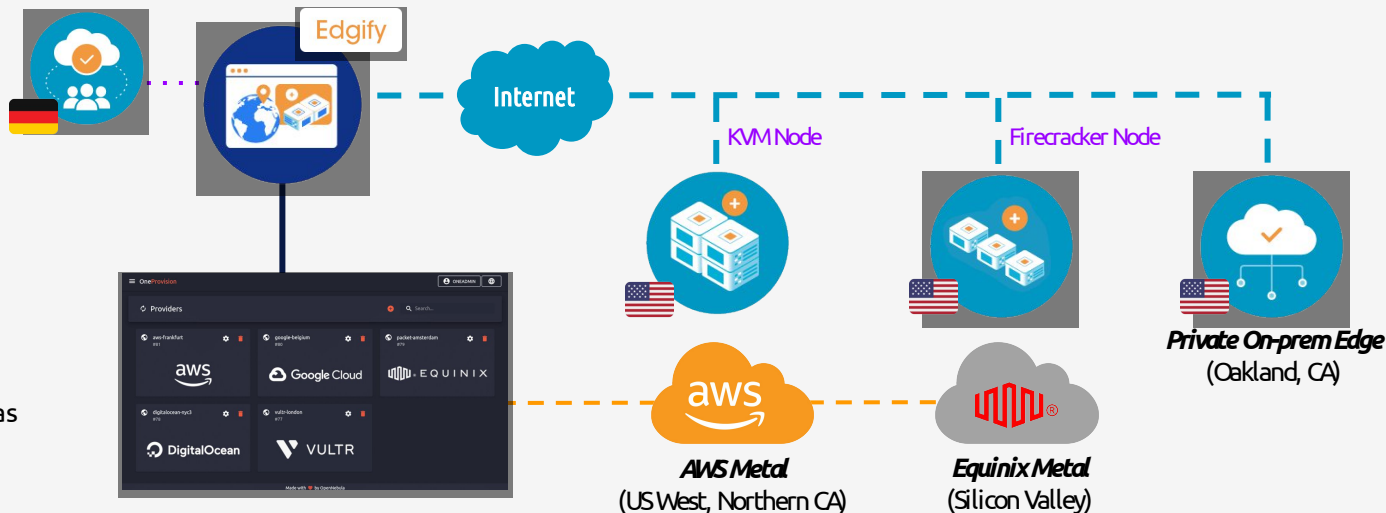
## Automatic provision

Provision OpenNebula Edge Clusters on the bare-metal locations of choice.

1

## Provider Catalog

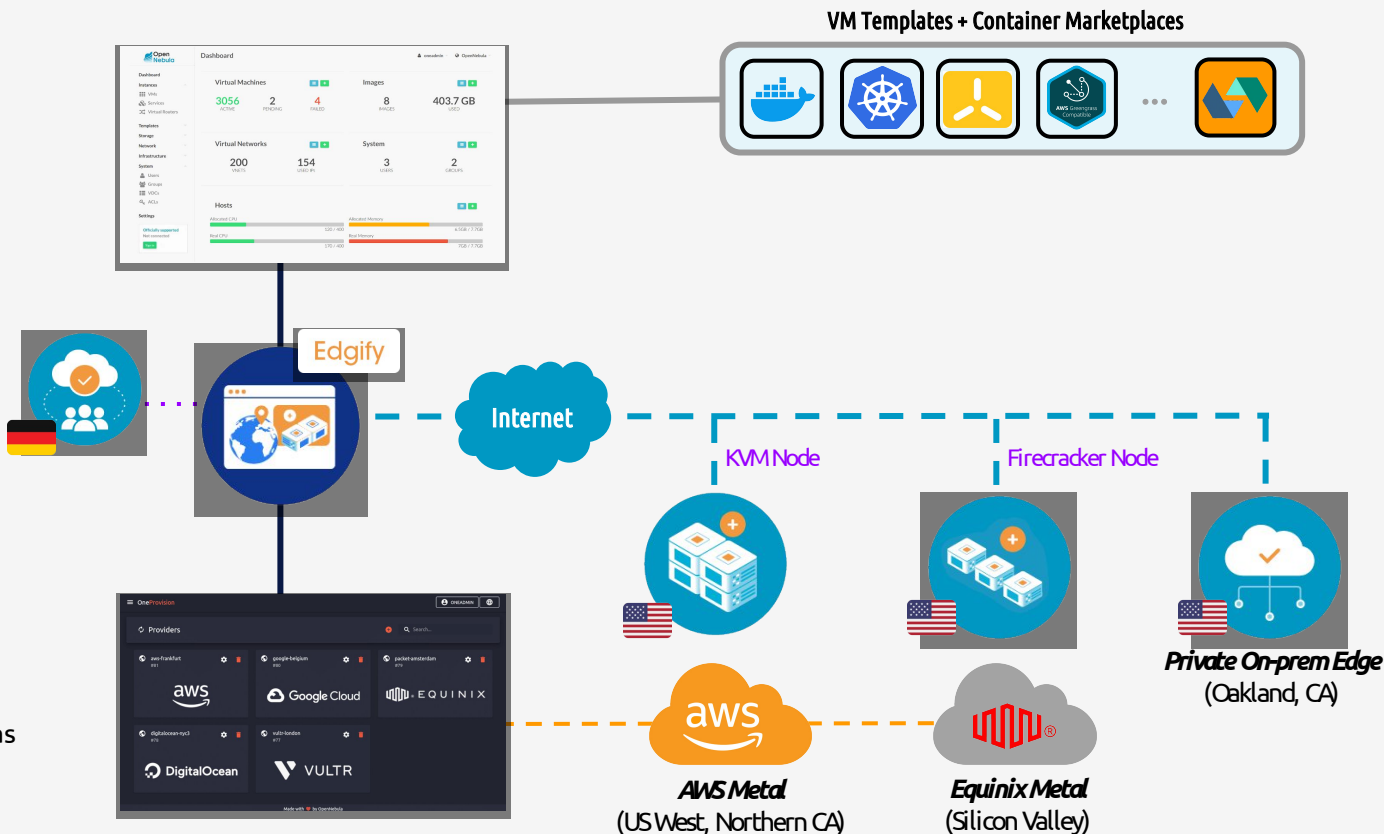
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# Demo: Edgify Service

An **on-demand, vendor-neutral & application-agnostic** solution for the Edge

- 3 Access Marketplace**  
 Download the VM templates or Docker images for the services to deploy.
- 2 Automatic provision**  
 Provision OpenNebula Edge Clusters on the bare-metal locations of choice.
- 1 Provider Catalog**  
 Add **AWS** and **Equinix Metal** as new public cloud/edge infra providers in the US.





# Demo: Edgify Service

An **on-demand, vendor-neutral & application-agnostic** solution for the Edge

## 4 Deploy Applications

Instantiate new VMs or Firecracker microVMs in the remote cloud/edge locations.

## 3 Access Marketplace

Download the VM templates or Docker images for the services to deploy.

## 2 Automatic provision

Provision OpenNebula Edge Clusters on the bare-metal locations of choice.

## 1 Provider Catalog

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