NebulOuS - A Meta Operating System for Brokering
Hyper-Distributed Applications on Cloud Computing Continuums

Have your head in the clouds while keeping your feet firmly on the ground

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Agenda

- What is the cloud continuum and why do we need it?

- How do the various related concepts fit together?

- What is a meta operating system?

- NebulOuS intro and details

- A sneak peek into the NebulOuS's architecture

- Summary

Cloud Continuum definition

Sergio Moreschini et al. (2022; IEEE Access) provide the following definition:

*Cloud Continuum is an **extension** of the traditional **Cloud towards multiple entities** (e.g., Edge, Fog, IoT) that provide analysis, processing, storage, and <u>data</u> generation capabilities.*

Why Cloud Continuum?

- Apps know no boundaries (and need flexible scalability/bursting).

- Cloud might not cater to all app requirements.
  - Technical constraints:
    - Network-related: latency, bandwidth
    - Need for specialised hardware
    - IoT
  - Non-technical constraints:
    - Compliance with GDPR, CCPA, PCI DSS, HIPAA
    - Internal business compliance

- Some companies **still have not migrated** to the cloud and are looking for a streamlined solution to do it, keeping their existing non-cloud investment relevant.

- Some other companies **are leaving** the cloud due to the cost explosion and wish to optimise their solutions.

Why Cloud Continuum? Because **data**

- The need for computation is all about data. The data is:
  - Generated / obtained (-> data provenance)
    - From humans, from devices (sensors)...
  - Stored
    - Transiently (usually in working memory), persistently
  - Transferred (in transit)
  - Processed / analysed (being computed on)
    - Human-driven, automation-driven

- Adopting cloud continuum allows to act upon data in the most optimal way and thus achieve the best utilisation of available resources.

Where might the continuum live?

- **(Public) Cloud(s)**

- Fog / Datacenters (DC) / Private Clouds

- Edge (Sites) / Multi-Access Edge Computing (MEC) / Micro Datacenters (MDC)

- *IoT*

Cloud Continuum and friends

- Multi-cloud = 2 or more (public) clouds

- Hybrid-cloud = (public) cloud and not a (public) cloud

- Cloud Continuum = mix and match as you wish

Meta Operating System

Operating System definition by Wikipedia (2023-01-16):

*An operating system (OS) is system software that **manages computer hardware**, **software resources**, and **provides common services for computer programs.***

While the *meta-* prefix is defined as follows:

Meta (from the Greek μετά, meta, meaning "after" or "beyond") is a prefix meaning "more comprehensive" or "transcending".

Thus, an (ad-hoc) definition of a Meta Operating System:

*A meta operating system (MOS) is system software that **manages sets of computer resources** and **provides common services for computer programs running on them**.*

NebulOuS intro

- NebulOuS = A Meta Operating System for Brokering Hyper-Distributed Applications on Cloud Computing Continuums

- A consortial project funded by the European Union.

- The consortium consists of 16 organizations (both academia and business). There are both tool providers and consumers (use cases).

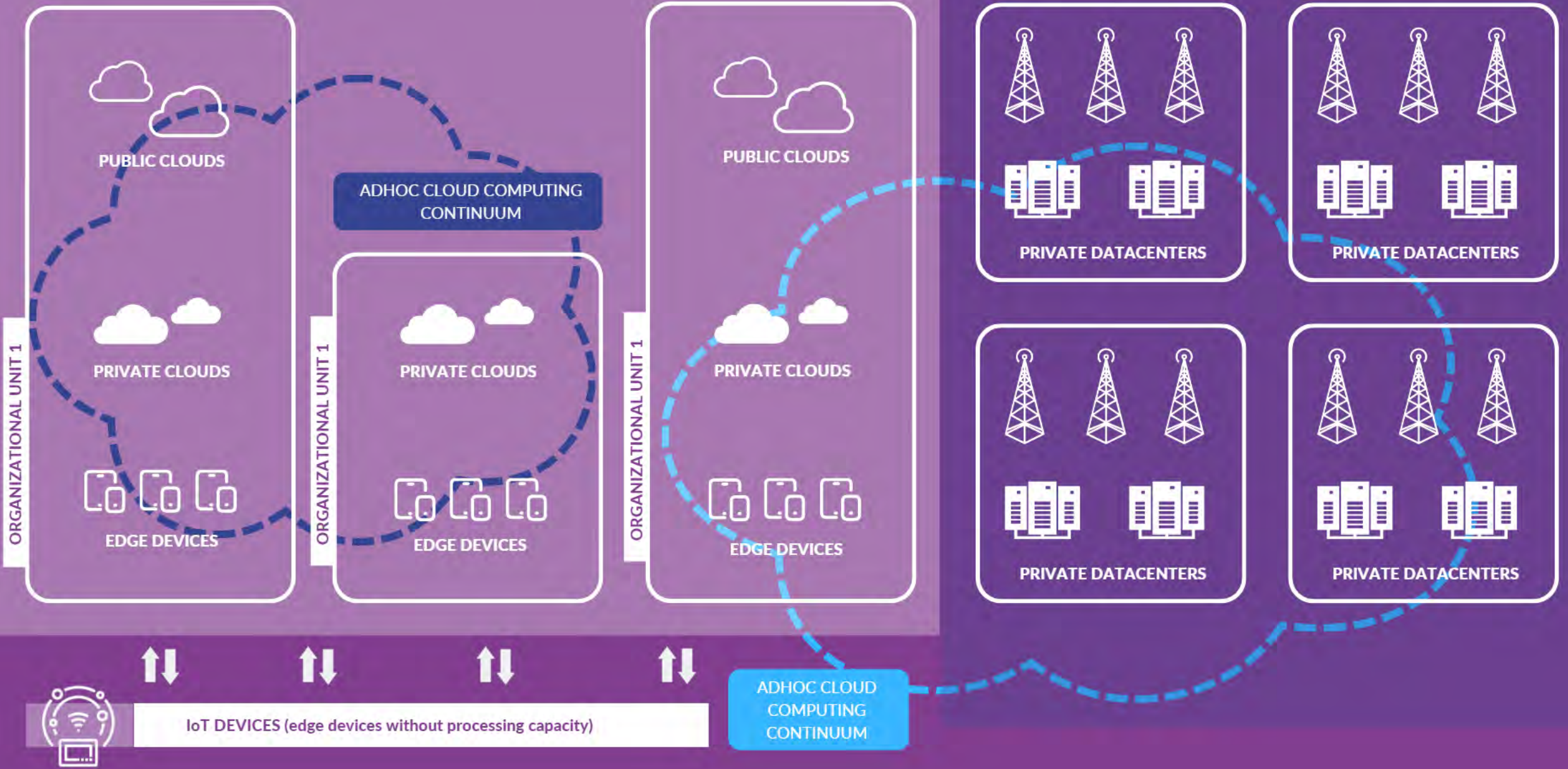- Schedule: September 2022 – August 2025

- https://nebulouscloud.eu

NebulOuS Consortium

NebulOuS development and source

- NebulOuS software components will be developed in the open and offered as an open source software under the Mozilla Public License (MPL) 2.0.

- The development platform is yet to be decided as of the time of this writing but it should be established by the end of January so get in touch if you are interested!

NebulOuS is not only about producing software

NebulOuS project will offer more than software:

- Open Access Research
- Cloud Continuum Culture Dissemination
- Training
- Open call

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NebulOuS directions of work

- Development of appropriate modelling methods and tools for describing the cloud-fog-edge computing continuum, application requirements, and data streams; these methods and tools will be used for assuring the QoS of the provisioned services.

- Efficient comparison of available offerings, using appropriate multi-criteria decision-making methods that are able to consider all dimensions of consumer requirements.

- Addressing the security aspects emerging in the cloud-fog-edge computing continuum.

- Conducting and monitoring smart contracts-based service level agreements.

NebulOuS open call

NebulOuS has a 1.35 Million EUR fund available for 9 grants.

The project will launch its first round of Open Calls in **2024**.

Those 9 teams will be given the opportunity to discover NebulOuS when a mature release will be available. They will test it, by providing a use-case where an IoT to Edge to Cloud infrastructure is needed.

https://www.nebulouscloud.eu/open-calls/

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NebulOuS platform architecture assumptions

- Support the scope of the project.

- Support the use cases of NebulOuS.

- Reuse existing open source software as much as possible:
  - Open-source components of multi-cloud platforms: Melodic, Functionizer, Morphemic (WIP)
  - Open-source container and * orchestration and more: Kubernetes

- Allow user-friendly, declarative, reproducible and GitOps-friendly app modelling in YAML, inspired and based on Kubernetes Custom Resource Definitions (CRDs) with custom controllers.

Sneak peek into NebulOuS's architecture
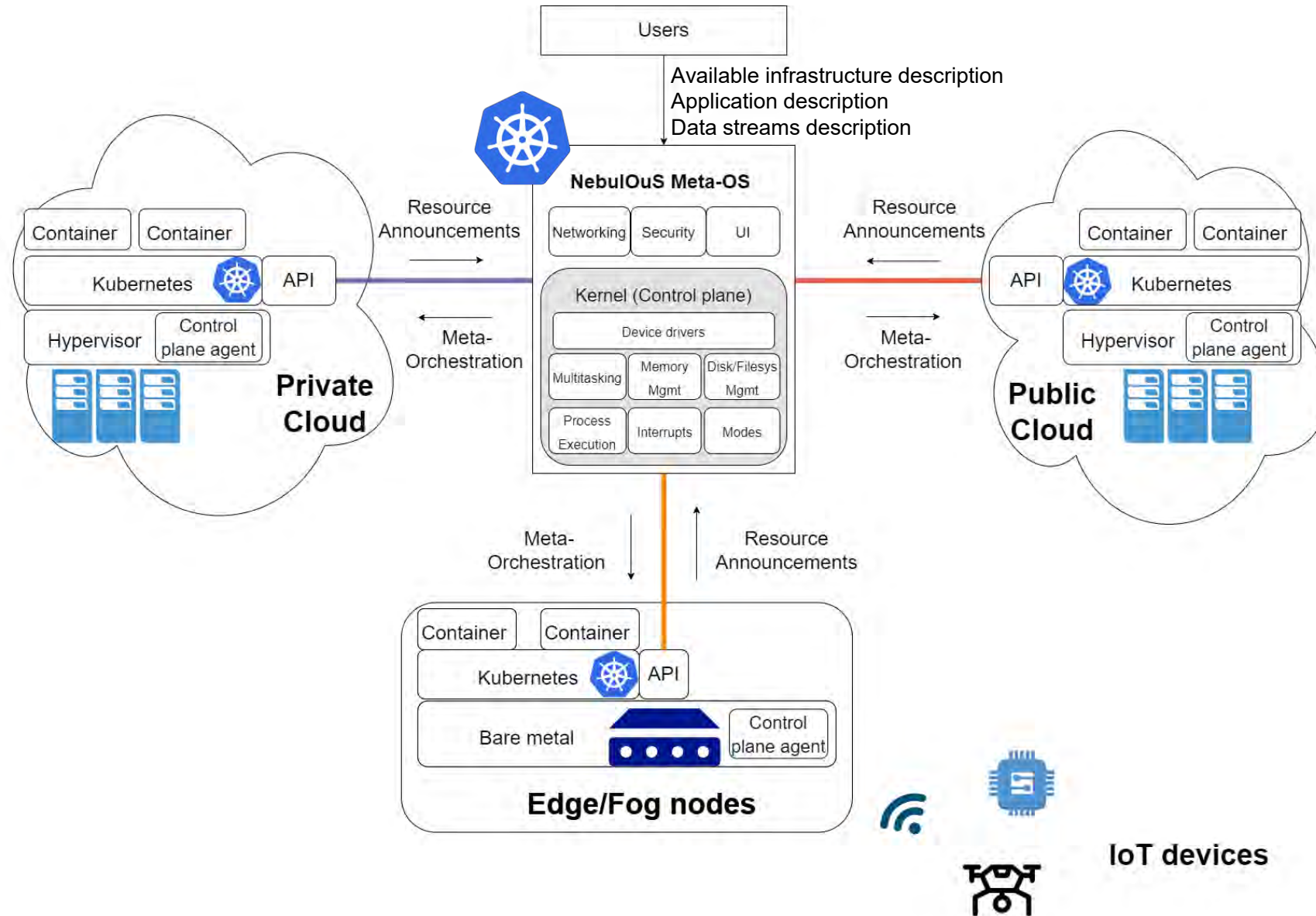
Summary

- Cloud Continuum support is crucial to handle current and upcoming computing challenges.

- Data is what drives the need for computing.

- Meta operating system (MOS) is an operating system for multiple computers at once.

- NebulOuS is a fresh project comprehensively building a MOS for Cloud Continuum.

- NebulOuS software is open-source, MPL2.0-licensed.

- NebulOuS has an open call for usage grants starting in 2024.

- Kubernetes is an important building block for a Cloud Continuum MOS such as NebulOuS.

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And that's all.
Thank you!

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