

Abstract

Erik Langius (TNO), Serkan Kestin (TNO)

ENG:

Gaia-X and IPCEI CIS are two large-scale initiatives towards the establishment of an Open Cloud Ecosystem by means of Cloud Federation. In this session, an overview of current and future developments will be presented, as well as a concrete demonstration of a cloud federation testbed based on Liqo.io. The testbed federates Kubernetes clusters over multiple cloud providers based on different technology stacks, targeting the elimination of vendor lock-ins.

NL:

Deze sessie gaat over Gaia-X en IPCEI CIS, twee grootschalige initiatieven die een Open Cloud Ecosysteem opzetten met Cloud Federation. Je krijgt een overzicht van de huidige en toekomstige ontwikkelingen, en een concrete demonstratie van een proeftuin voor cloudfederatie op basis van Liqo.io. Deze proeftuin federeert Kubernetes-clusters over meerdere cloudleveranciers, op basis van verschillende technologiestacks, om vendor lock-ins te elimineren.

The Journey Towards a Federated European Cloud

SURF Cloudevent 2024

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07 February 2024



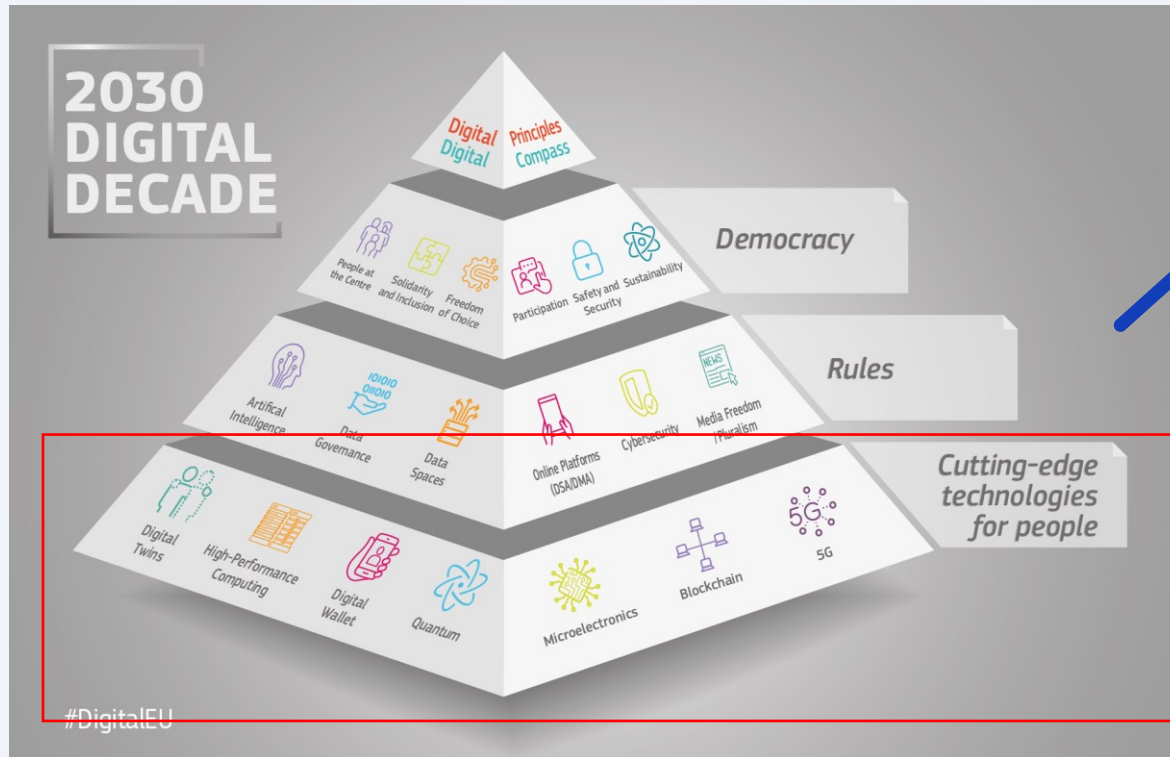
The Journey Towards a Federated European Cloud

Outline

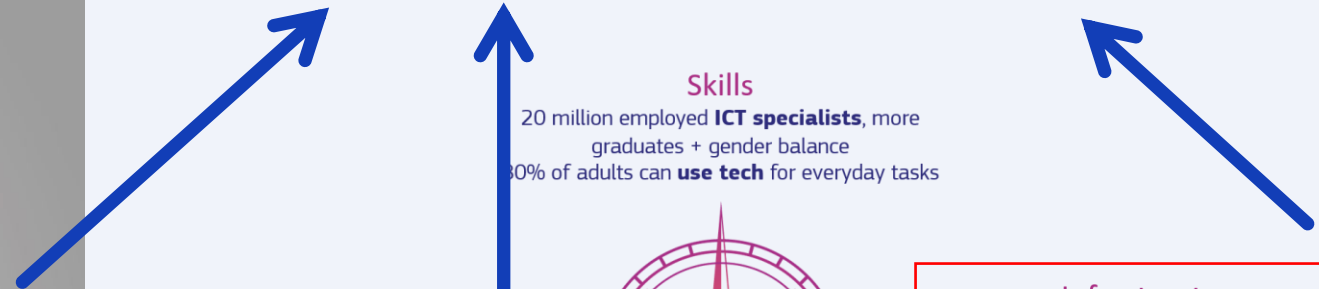
- Introduction to EU Cloud developments (Erik Langius)
 - Zoom in on IPCEI-CIS and Gaia-X with Lighthouse Structura-X
- Testbed Cloud federation: testbed based on Ligo.io (Serkan Keskin)
- Discussion and questions

The bigger picture: EU Digital Decade

Build the next generation digital infrastructure, including hyperscale cloud functionality



Approach for Cloud infrastructures:
Create hyper scale functionality without building a hyper scaler but by federating one



Government
Key Public Services - 100% online
Everyone can **access health records online**
Everyone can use **eID**

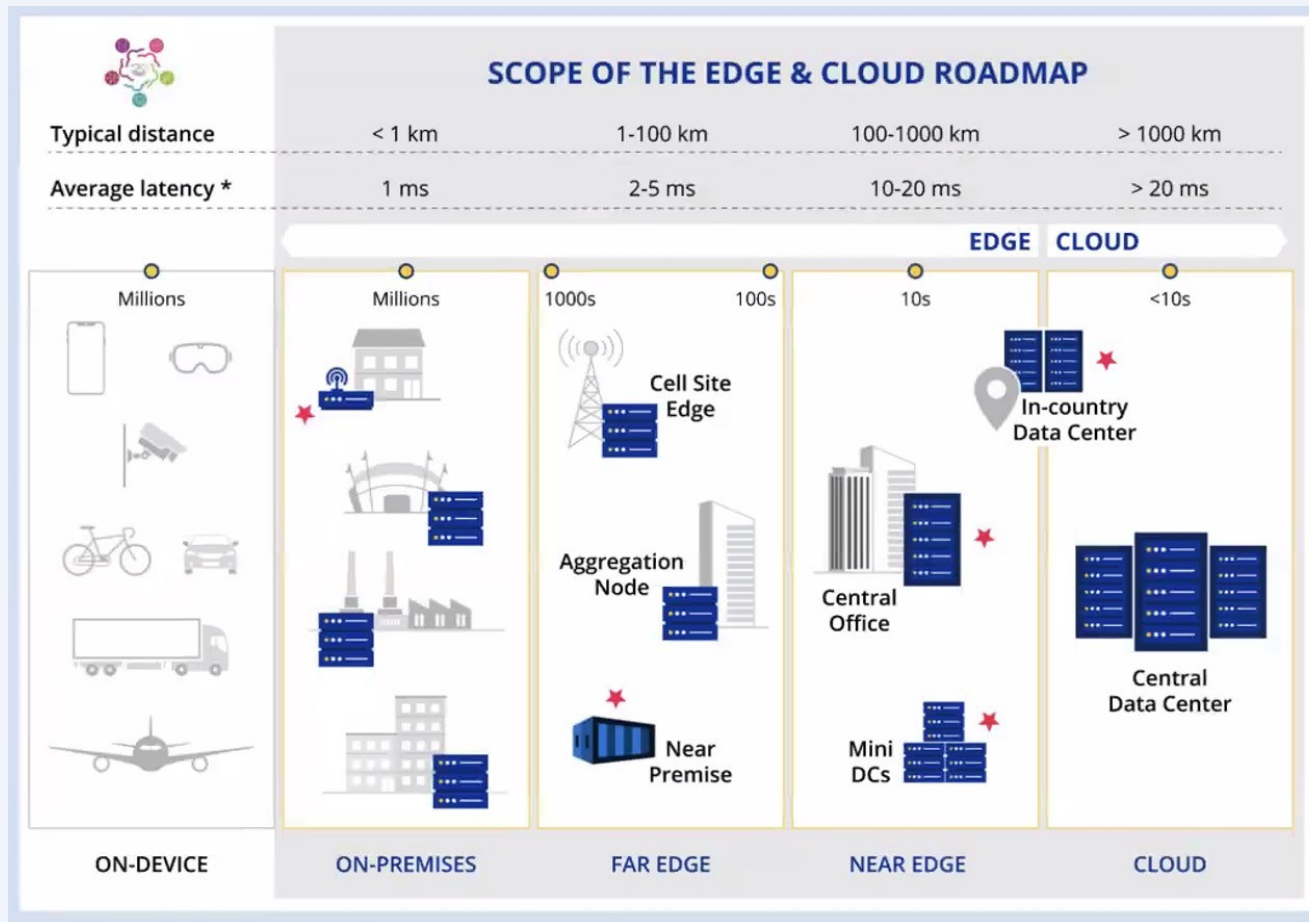
Skills
20 million employed **ICT specialists**, more graduates + gender balance
80% of adults can **use tech** for everyday tasks

Business
75% of companies using **Cloud, AI or Big Data**
Double the number of **unicorn startups**
90% of **SMEs taking up tech**

Infrastructure
Gigabit connectivity for everyone, **high-speed mobile coverage** (at least 5G) everywhere
EU produces 20% of world's **semiconductors**
10 000 **cloud edge nodes** = fast data access
EU **quantum computing** by 2025

From Cloud to Edge to Device...

Technology roadmap of the EU alliance for Industrial Data, Edge and Cloud mentions “Orchestration and Federation of Distributed Edge Cloud”.



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European Alliance for Industrial Data, Edge and Cloud

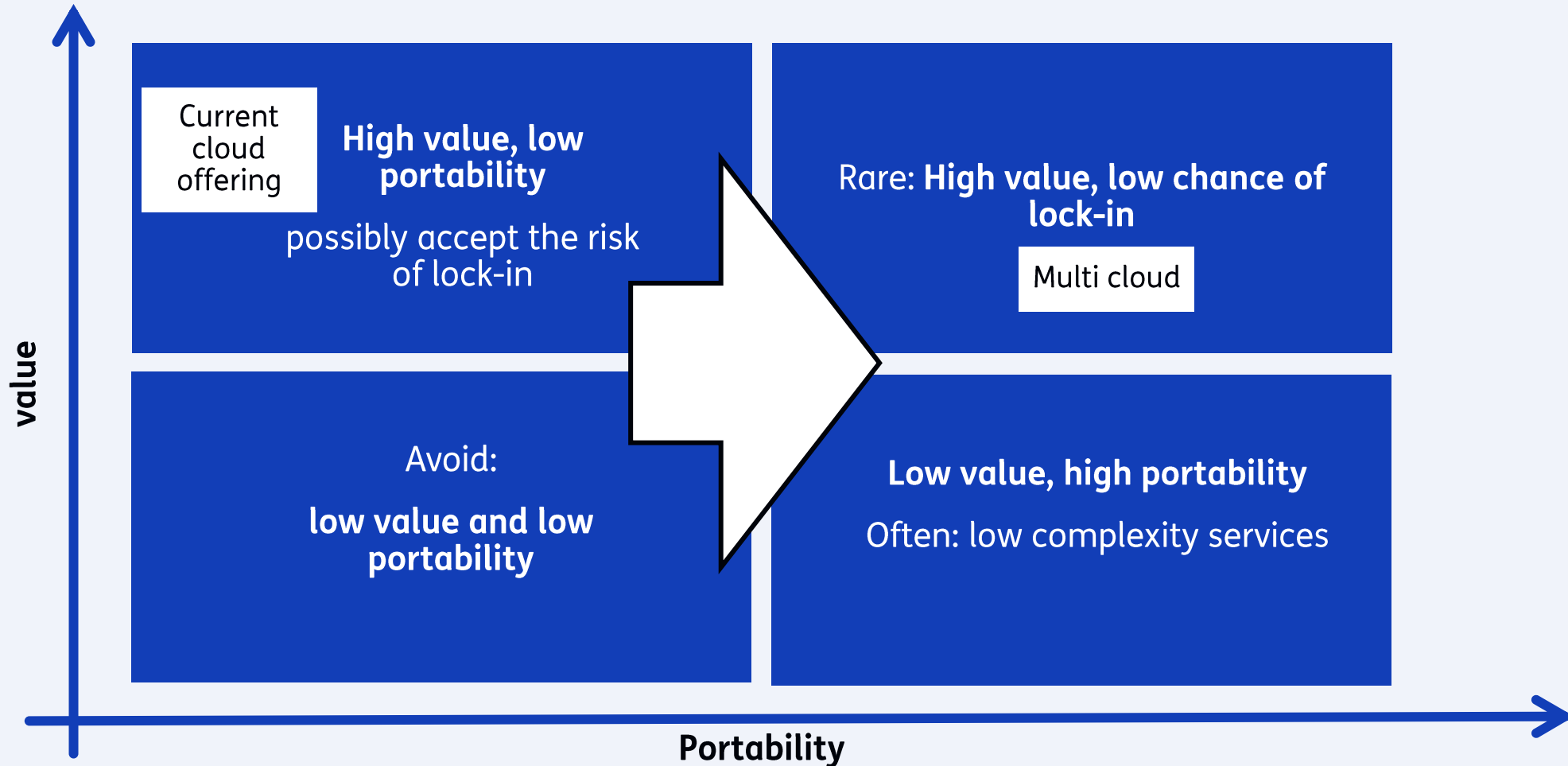
The European Alliance for Industrial Data, Edge and Cloud aims to foster the development and deployment of next generation edge and cloud technologies.

The Alliance brings together businesses, Member States representatives and relevant experts. It will strengthen the position of EU industry on cloud and edge technologies. It aims to serve the needs of EU businesses and public administrations that process sensitive categories of data, and has the objective to increase Europe's leadership position on industrial data.

Cloud and edge technologies are strategic innovation enablers for the uptake of emerging technologies, such as artificial intelligence, the Internet of Things, and 5G. They provide the infrastructure for highly innovative use cases. Europe needs to strengthen its position of EU industry on cloud and edge technologies.

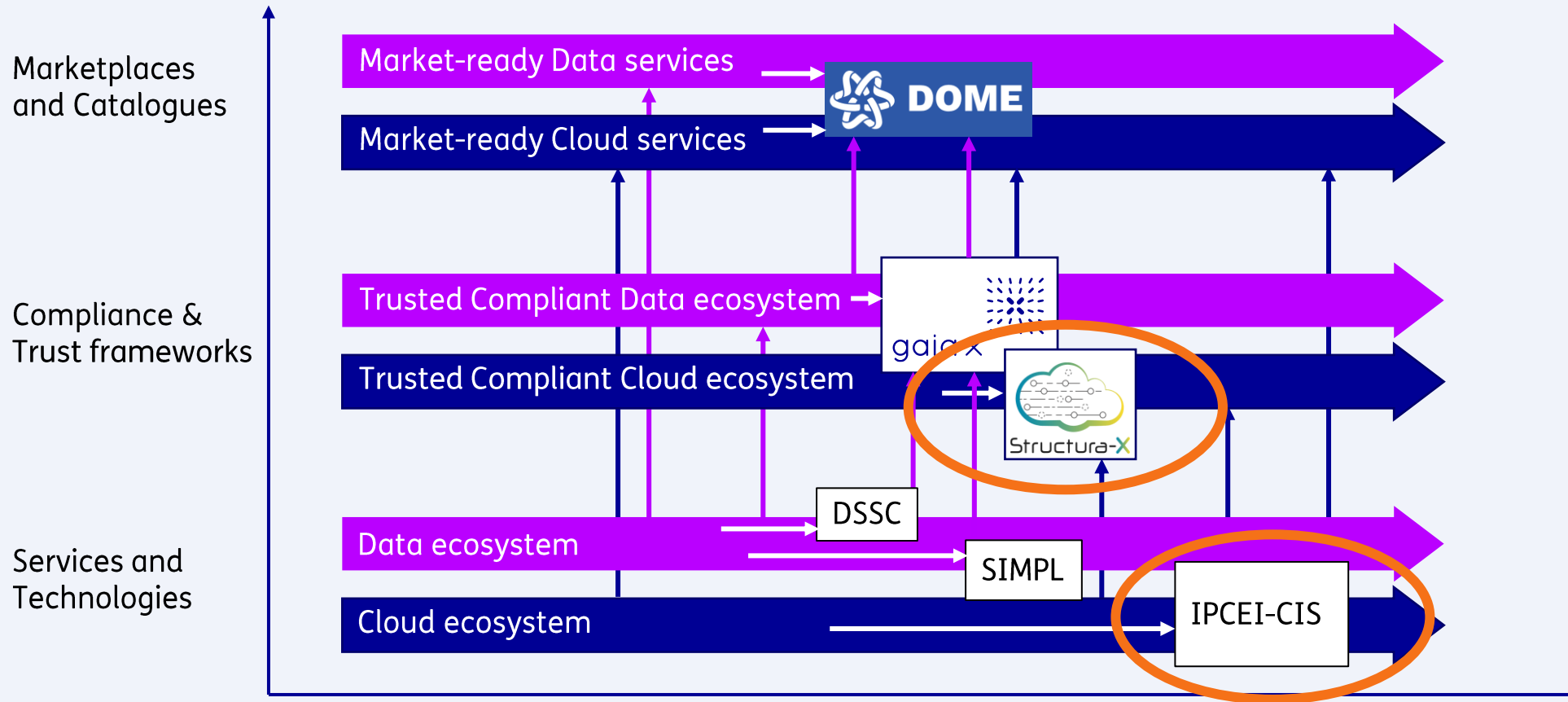
Cloud and edge technologies are key enablers for Europe's digital transformation. The Alliance aims to bring together relevant stakeholders from the private and public sector to jointly define strategic

Current cloud offerings: balance between *value* and *portability*



Modified from: [Managing technical lock-in in the cloud - GOV.UK \(www.gov.uk\)](http://www.gov.uk)

Developments in cloud: middleware, trust and marketplace



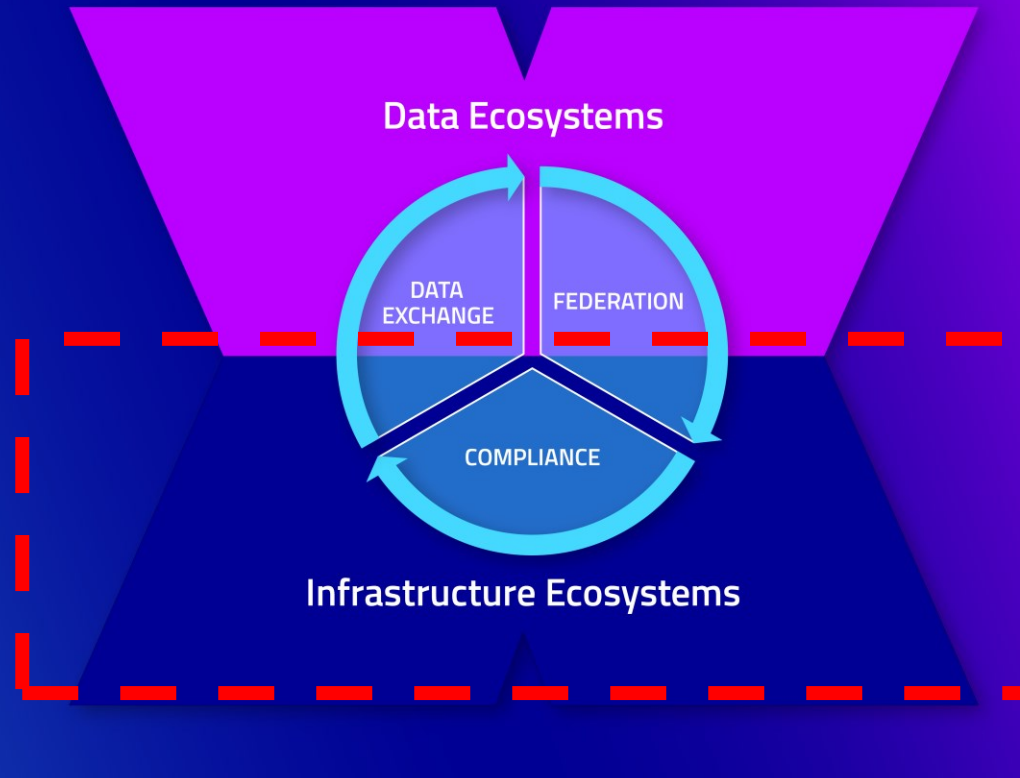
What is Gaia-X

Our X-Model

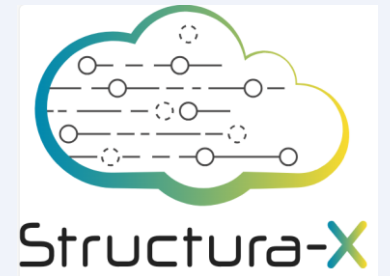
Connecting Data & Infrastructure Ecosystems



- Advanced Services**
New (Cross-) Sector Innovations / Applications build from service composition.
- Data Spaces / Federations**
Interoperable & portable (Cross-) Sector data-sets and services.
- Data Exchange**
Anchored contract rules for access and data usage.
- Gaia-X Compliance**
Decentralized services to enable objective and measurable trust.
- Label framework**
Gaia-X and ecosystem specific Labels to ease market adoption through autonomy and self-determination.



Structura-X is a lighthouse within Gaia-X



What is IPCEI-CIS?

IPCEI Next generation Cloud Infrastructures and Services

Europe on the path to the cloud infrastructure of the future



© BMWK

- IPCEI = Important Project of Common European Interest
- CIS = Cloud Infrastructures and Services
- In EU more than 100 organizations from 12 member states contributing with projects into one total integrated project.
- Government funding of > 1,2 billion euro. Private funding comes in addition to this for a total of 2,6 billion euro.
- The Netherlands is funding 70 million euro in three projects:



- MISD: Modular Integrated Sustainable Datacenter.
- ECOFED: European Cloud services in an Open FEDerated ecosystem.



- European Cloud Campus: Development of European Cloud Infrastructure and Services.



IPCEI CIS officially stated at Dec 5, 2023

PRESS RELEASE | 5 December 2023 | Brussels

Commission approves up to €1.2 billion of State aid by seven Member States for an Important Project of Common European Interest in cloud and edge computing technologies



€2.6bn for IPCEI projects on European cloud technologies

Technology News | December 5, 2023

By Nick Flaherty

Technology

EU clears up to 1.2 bln euros of aid for cloud computing

Reuters

December 5, 2023 11:41 AM GMT+1 · Updated 2 months ago



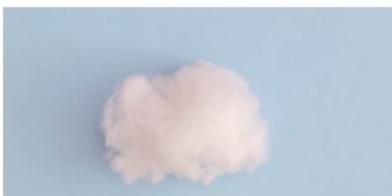
Dutch IT Channel

Info Support, i3D.net, BIT, AMS-IX en TNO bouwen federatieve Europese cloud

Een Nederlands consortium, bestaande uit Info Support, i3D.net, BIT, AMS-IX en TNO, start met het bouwen van een federatieve Europese cloud. Het project "European cloud services in an open federated ecosystem" (ECOFED) wordt mede gefinancierd door de Nederlandse overheid, na goedkeuring van de Europese Commissie.

Cloud Infrastructuur

Nederlands project van start om keuzevrijheid cloudbuikers te bevorderen



10 januari 2024 – Een Nederlands consortium, bestaande uit Info Support, i3D.net, BIT, AMS-IX en TNO, start met het bouwen van een federatieve Europese cloud. Het project "European cloud services in an open federated ecosystem" (ECOFED) wordt mede gefinancierd door de Nederlandse overheid, na goedkeuring van de Europese Commissie.



Goedkeuring voor €70 miljoen kabinetssteun aan Nederlandse cloudinnovaties

Nieuwsbericht | 05-12-2023 | 20:00

Meer dan honderd ondernemingen en kennisinstellingen uit twaalf EU-landen gaan samenwerken aan het opzetten van nieuwe en innovatieve cloudoplossingen voor (industriële) bedrijven. Dat moet leiden tot minder technologische afhankelijkheden en minder marktverstoring. Maar ook tot een betere toepasbaarheid en onderlinge deelbaarheid van data waardoor ook de concurrentiepositie van Nederlandse bedrijven verbetert. De Europese Commissie heeft vandaag ook verschillende initiatieven vanuit 13 Nederlandse bedrijven en kennisinstellingen goedgekeurd. Het kabinet draagt zelf 70 miljoen euro bij aan het ontwikkelen van deze cloudinnovaties in dit zogenoemde Important Project of Common European Interest (IPCEI).

On the legislation side

Switchability in The Data Act

CHAPTER VI

SWITCHING BETWEEN DATA PROCESSING SERVICES

Article 23

Removing obstacles to effective switching between providers of data processing services

Article 24

Contractual terms concerning switching between providers of data processing services

Article 25

Gradual withdrawal of switching charges

Article 26

Technical aspects of switching



Article 29

Interoperability for data processing services

Open interoperability specifications and European standards for the interoperability of data processing services shall address:

- (a) the cloud interoperability aspects of transport interoperability, syntactic interoperability, semantic data interoperability, behavioural interoperability and policy interoperability;
- (b) the cloud data portability aspects of data syntactic portability, data semantic portability and data policy portability;
- (c) the cloud application aspects of application syntactic portability, application instruction portability, application metadata portability, application behaviour portability and application policy portability.

Getting Federation started... Cloud Federation Testbed

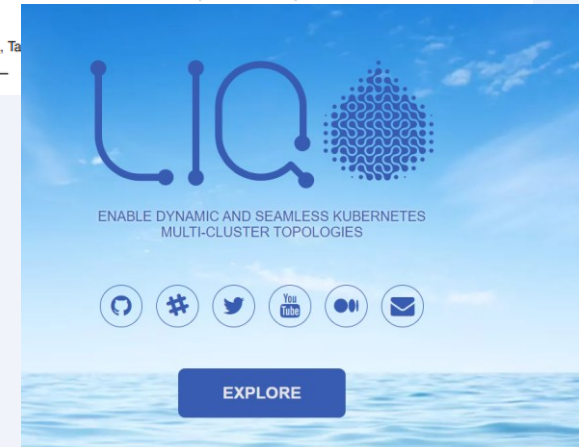
- Gaia-X lighthouse – Structura-X
- Experimenting with multi-CSP cloud federation
- Use Ligo open source technology
- Foundation for technical cloud federation use cases
- Gain practical experience
- Contribute to open source development

Computing Without Borders: The Way Towards Liquid Computing

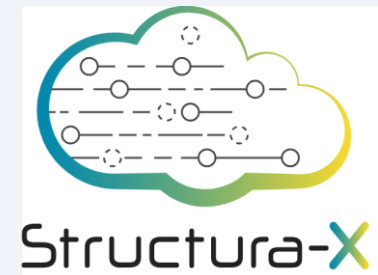
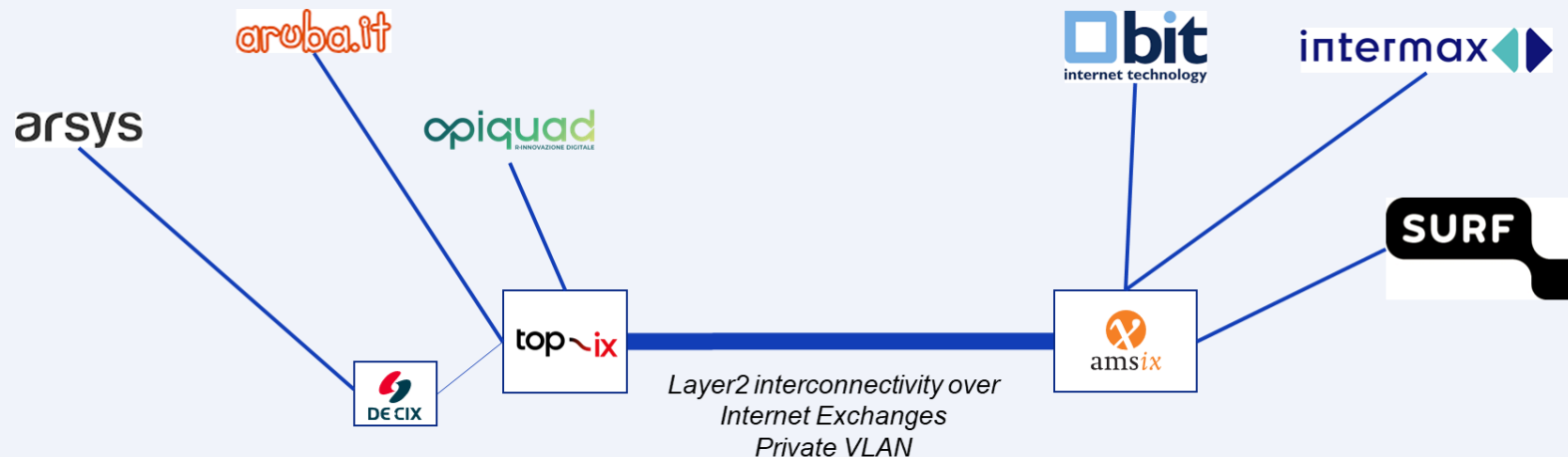
Marco Iorio, Fulvio Rizzo, Alex Palesandro, Leonardo Camiciotti, and Antonio Manzalini

Abstract—Despite the de-facto technological uniformity fostered by the cloud and edge computing paradigms, resource fragmentation across isolated clusters hinders the dynamism in application placement, leading to suboptimal performance and operational complexity. Building upon and extending these paradigms, we propose a novel approach envisioning a transparent continuum of resources and services on top of the underlying fragmented infrastructure, called *liquid computing*. Fully decentralized, multi-ownership-oriented and intent-driven, it enables an overarching abstraction for improved applications execution, while at the same time opening up for new scenarios, including resource sharing and brokering. Following the above vision, we present *liqo*, an open-source project that materializes this approach through the creation of dynamic and seamless Kubernetes multi-cluster topologies. Extensive experimental evaluations have shown its effectiveness in different contexts, both in terms of Kubernetes overhead and compared to other open-source alternatives.

Index Terms—Computing Continuum, Cloud/Edge Computing, Ta

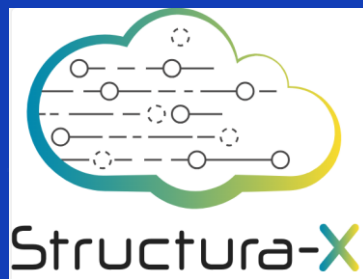


Federated Cloud Resources with Ligo



Proof of the pudding...

Testbed Cloud Federation



TNO innovation
for life

bit
internet technology

aruba.it

SURF

intermax

*info*Support
Solid Innovator

amsix
amsterdam internet exchange

top-ix

arsys

DE CIX

opiquad
D-INNOVAZIONE DIGITALE

gaia-x

 Hub Netherlands

Practical need for Cloud Federation

- Limited resources on clusters
- Sharing the excess / consolidation
- Geographical constraints / optimisation
- Legislative constraints
- Preventing vendor and technology lock-ins

- Basically what we want is achieving hyperscaler functionality with multi-cloud
- Cloud service scope is wide, we started with the containers!
- What about supporting different stacks? And also expanding a cluster over a public internet?

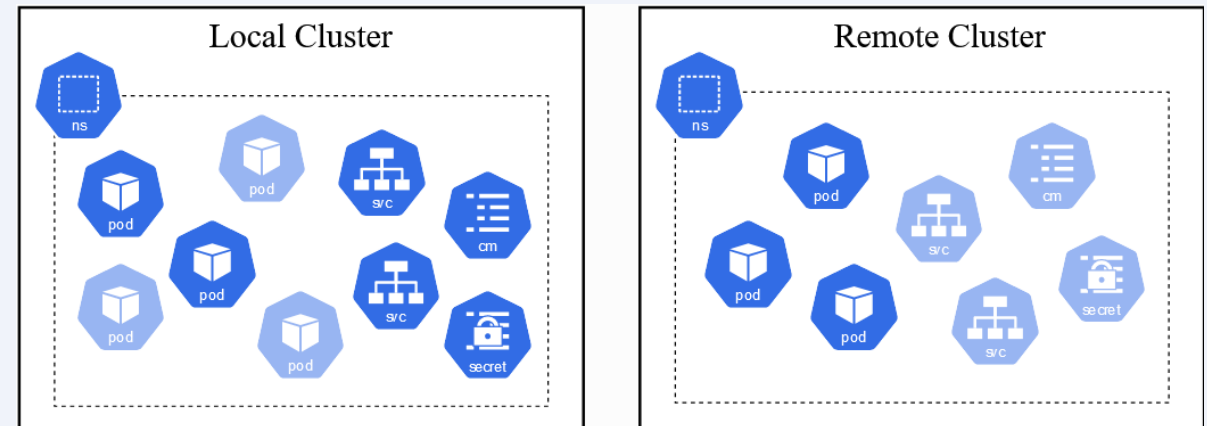
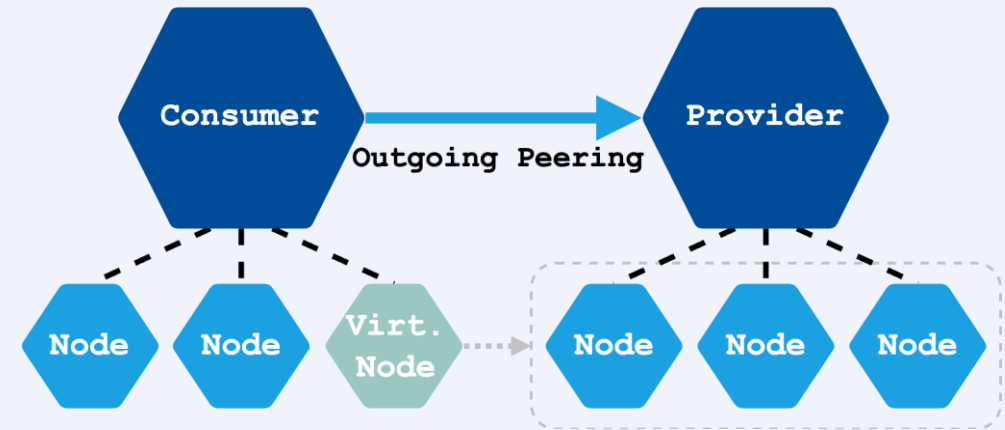
What is available (for Kubernetes)?

- GitOps tools: ArgoCD, Fleet, FluxCD
 - Apps are templated with a target cluster, so it is static
- Service Meshes, CNIs and other network interconnection tools: Istio, Linkerd, CiliumMesh, Submariner, Skupper
 - Usually requires modification on app for using a specific API
 - Does not move resources
- Hierarchical: Kubefed, Karmada, Open Cluster Management, Kubermatic
 - Requires a manager, single point of failure
 - Not ideal for ad-hoc setups
- Virtual Kubelet based solutions: Admiralty, Liqo, Tensile
 - Expands Kubernetes by adding new types of kubelets (and nodes) backed by X



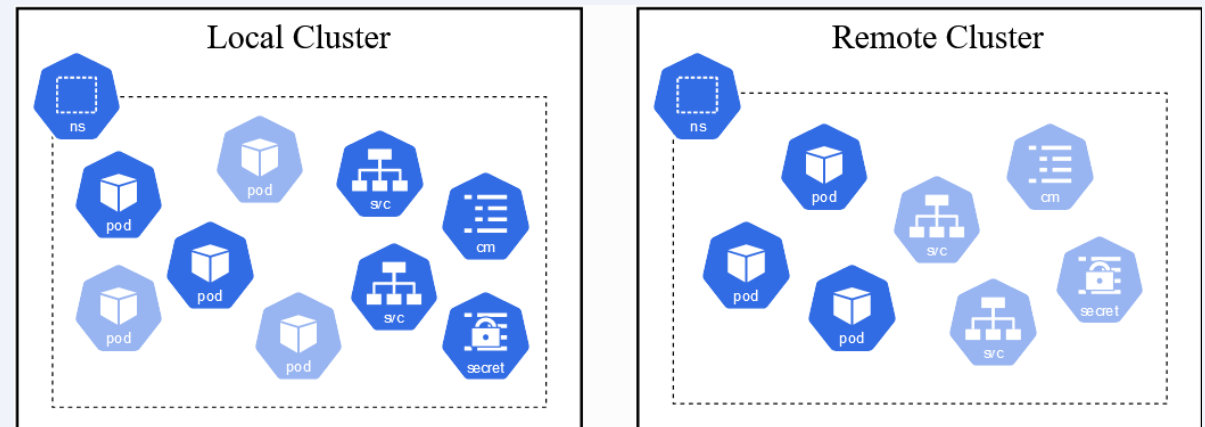
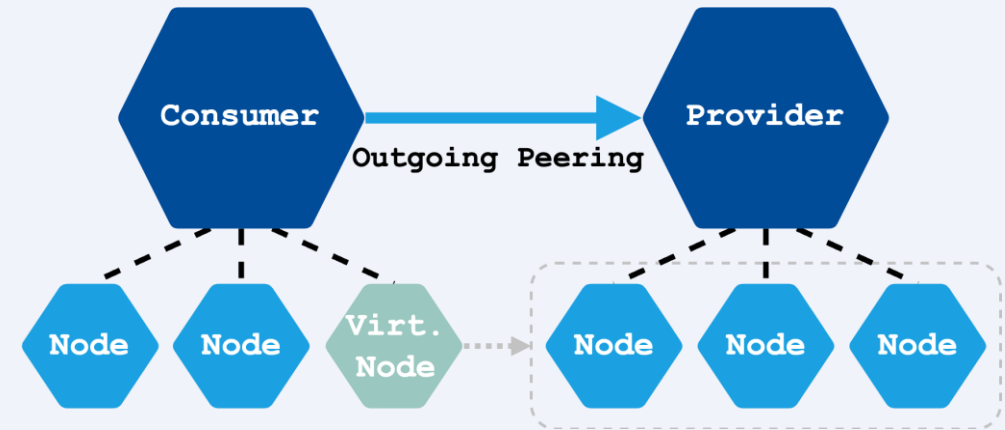
Liqo – What is it?

- Cloud federation with Liqo:
 - *“dynamic and seamless Kubernetes multi-cluster topologies, supporting heterogeneous on-premise, cloud and edge infrastructures”*
- Main original use-case is **resource expansion**: one cluster can consume resources of another.
- The act of connecting clusters and determining the relation is called **“peering”**.
- This is a **directed relation**:
 - A consumes resources of B
 - B consumes resources of A
 - A and B may consume each other's resources



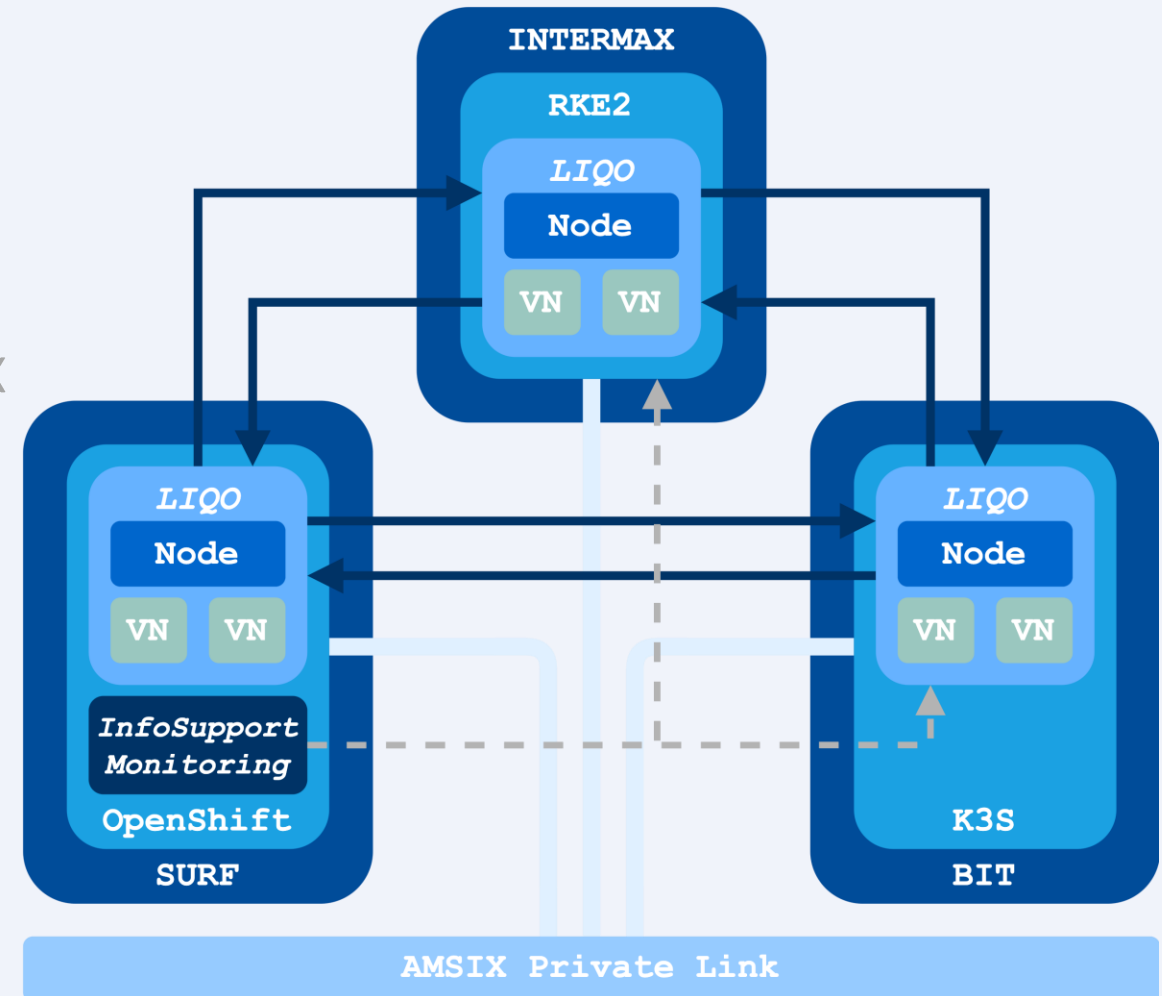
Liqo in a nutshell

- Installed on top of Kubernetes, leverages CRDs
- A directional pair of Kubernetes clusters create a “peering”
- Total capacity of the providing cluster is represented as a “**virtual node**” in the consuming cluster.
- User creates a namespace and offloads it.
- Resources created within the namespace can be offloaded **dynamically**.
- Scheduling is handled by remote cluster’s own scheduler
- Controlled offloading using labels and taints



Our Setup

- Proof-of-concept (PoC) for cloud federation with Liqo, connected by a private link
- PoC 1: Dutch partners connected via AMS-IX (this demo)
- PoC 2: Extend cross-border to Italy with TOP-IX (currently we are working on it)
- Innovative perspectives:
 - Private link
 - Heterogenous K8s stacks
 - No new API's are needed
 - You don't need to modify your app



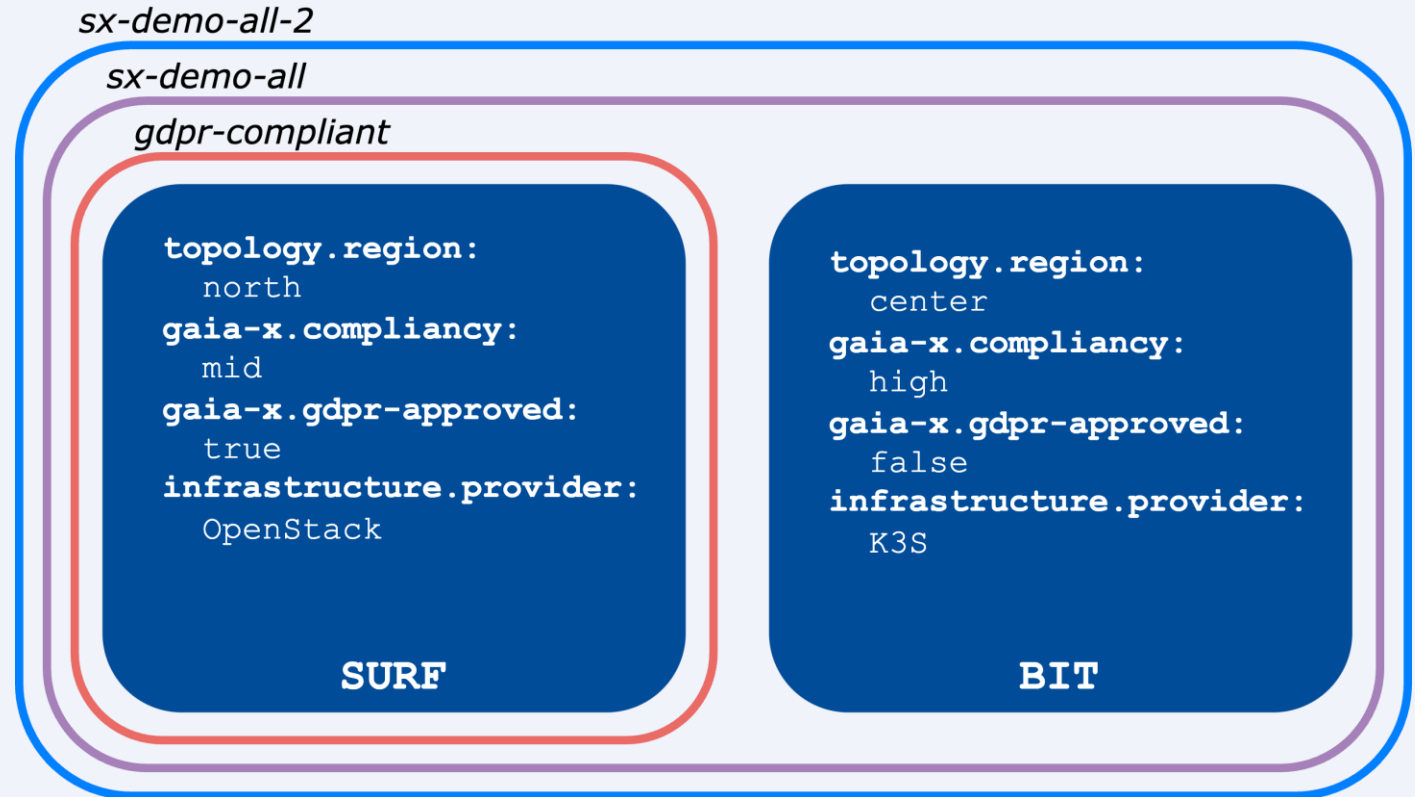
Demo

- Google's microservice demo
- Digital storefront
- Runtime constraints

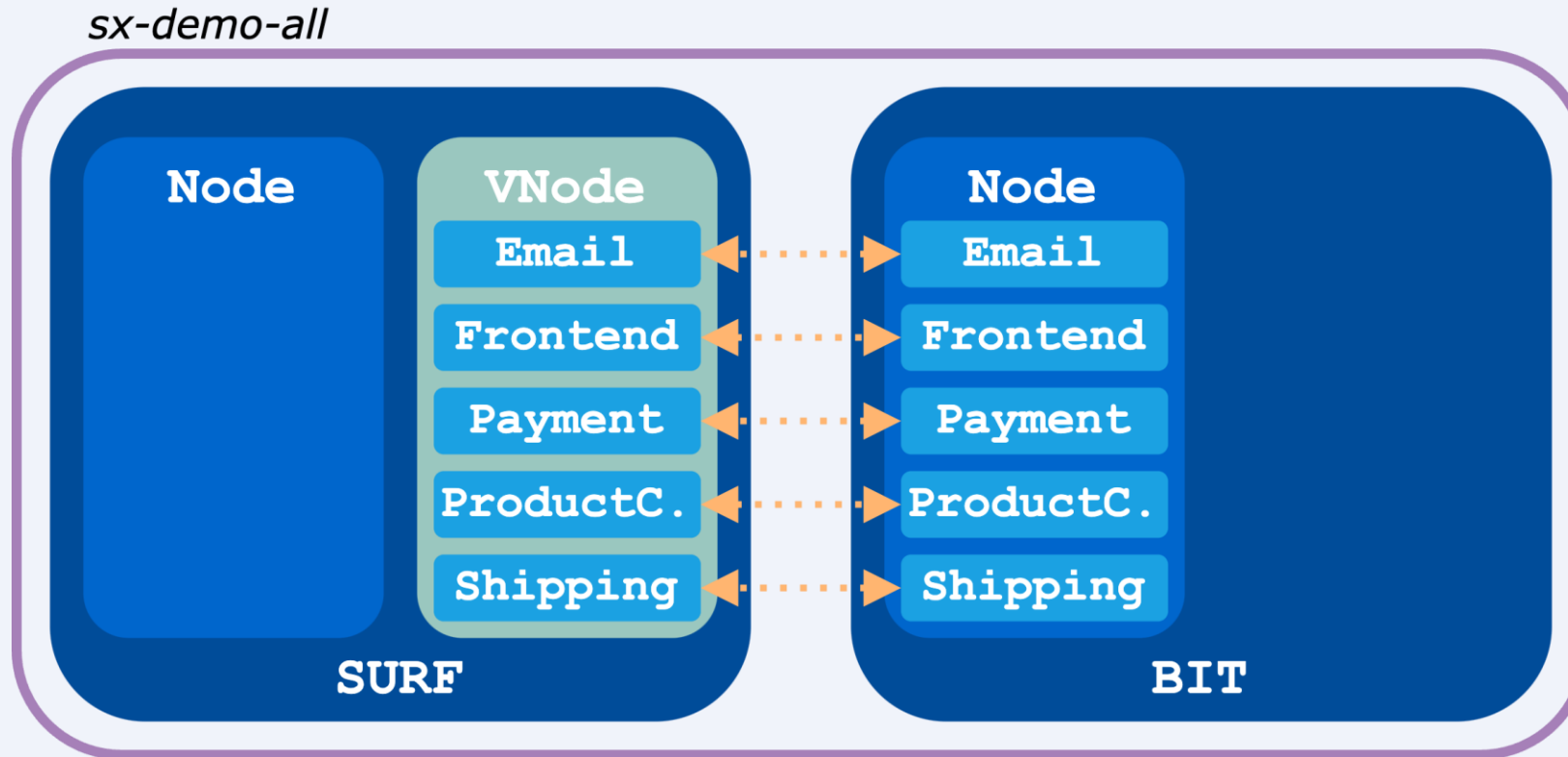


Demo

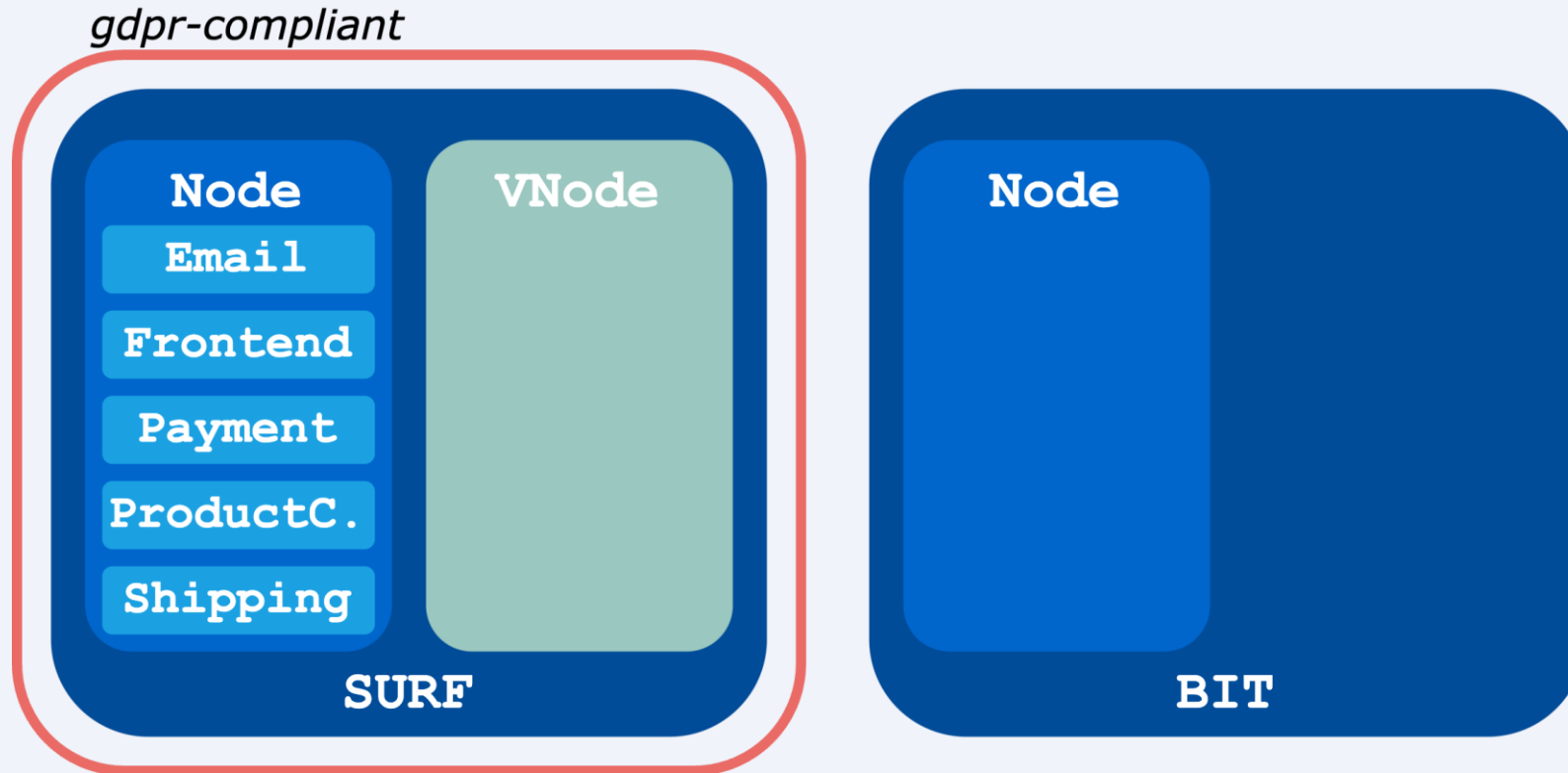
- Cluster labels
- Namespace offloading
- Constraints
 - Node affinity
- Taints



Scenario #1: Anything Goes



Scenario #2: LIQO Namespace Offloading



Scenario #3: Constraints

sx-demo-all-2

sx-demo-all

gdpr-compliant

```

topology.region:
  north
gaia-x.compliance:
  mid
gaia-x.gdpr-approved:
  true
infrastructure.provider:
  OpenStack
    
```

SURF

```

topology.region:
  center
gaia-x.compliance:
  high
gaia-x.gdpr-approved:
  false
infrastructure.provider:
  K3S
    
```

BIT

```

gdpr-approved:
  true
    
```

Shipping

```

topology.region:
  center
    
```

ProductCatalog

```

gdpr-approved:
  true
    
```

Email

```

may-run-on-vnode:
  false
    
```

Frontend

```

gaia-x.compliance:
  high
    
```

Payment

sx-demo-all-2

Node

Email

Frontend

Shipping

VNode

Payment

ProductC.

SURF

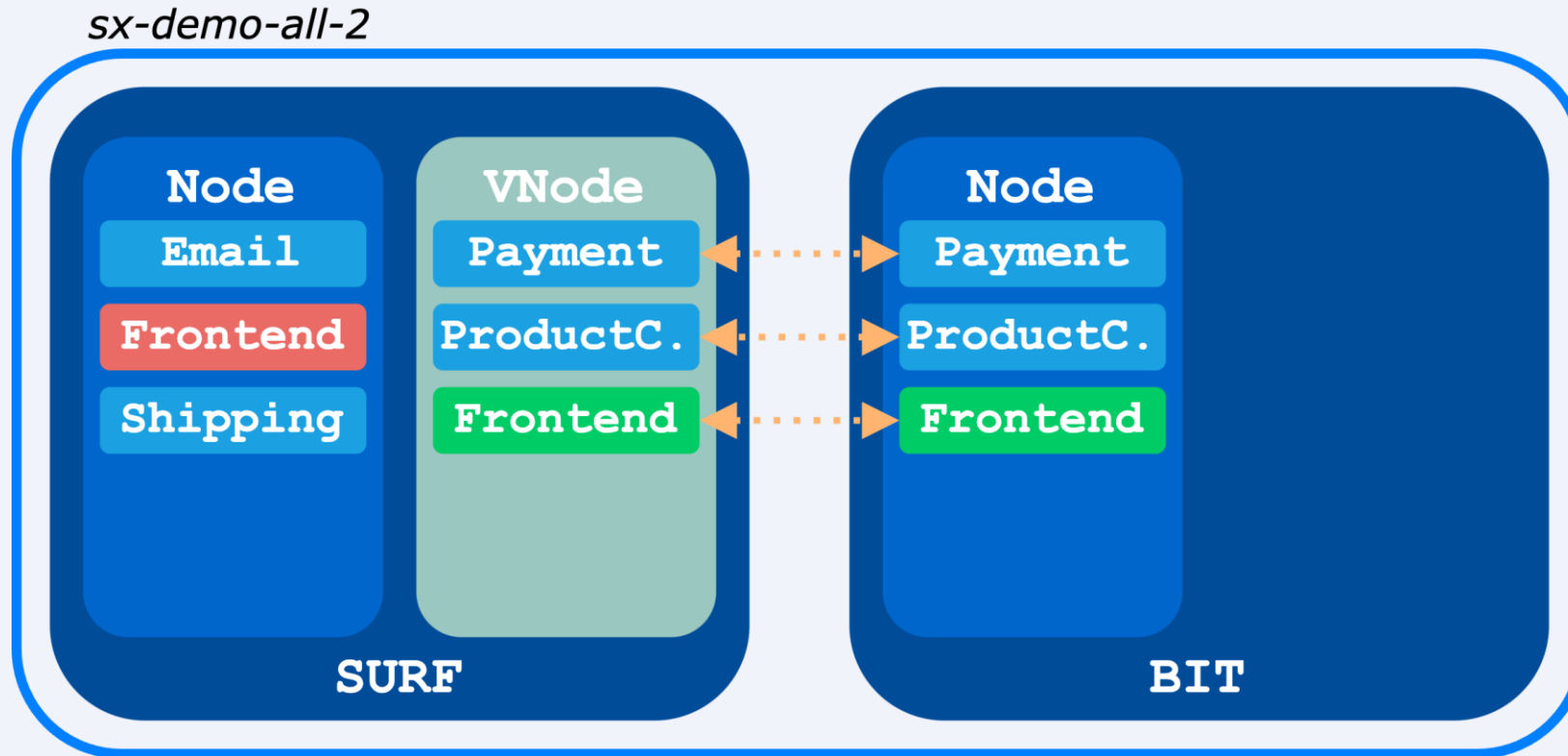
Node

Payment

ProductC.

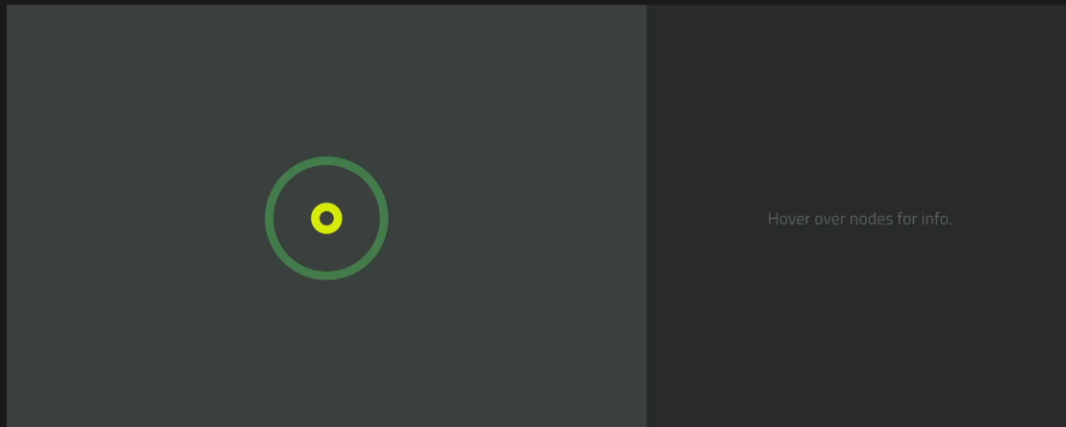
BIT

Scenario #3b



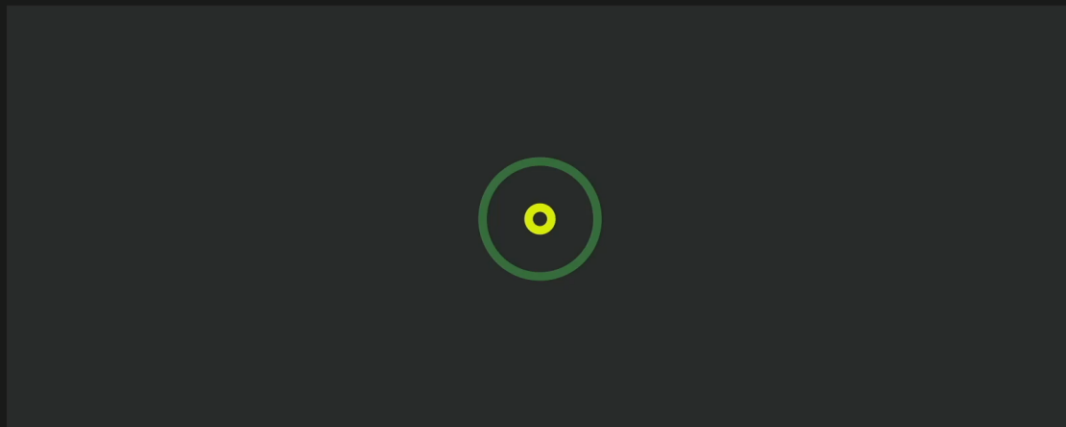
Network view

Cluster view Node view



Timeline view of Pods

Start time mins ago 5



Challenges

- Communication and Coordination with multiple parties
- Manual network configuration before peering
- Supporting system heterogeneity (e.g. Rancher, OpenShift, K3S)
- Early-adopters tax
- Hard to debug: Opaque errors due to many layers of complexity
- Private link, BGP, Firewalls, Kubernetes, LIQO installation, User



Future

- We need to work on:
 - Network automation with IX-API
 - Better Multi-tenancy
 - Better CNI-agnostic network fabric
 - IPv6 support
 - New way of representing resources
- How is billing model going to work?



Thank you for your attention!

Questions?



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