Programming Languages to Runtime Execution: A Continuum

Red Hat Research Day Europe
15/09/2022

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Clément Escoffier°

* University of Lyon, INSA Lyon, Inria
° Red Hat

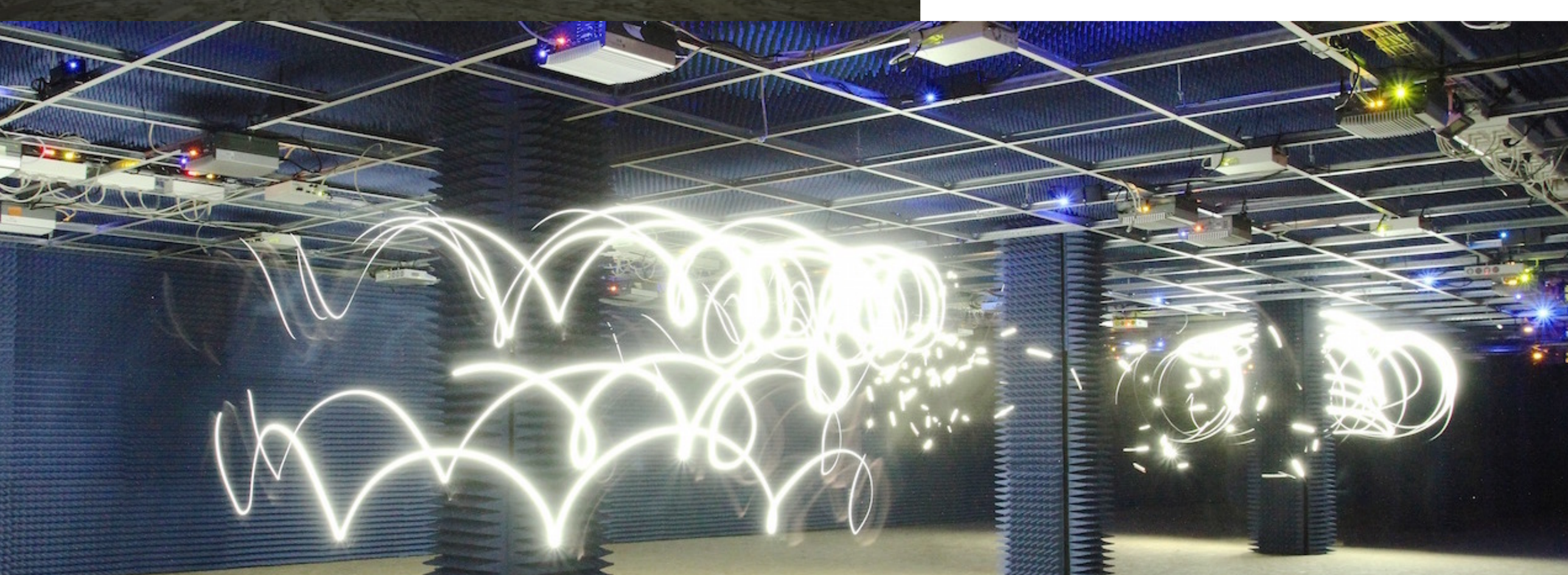
Lyon, France ?

- 2h from Paris by train
- 1.4M inhabitants
- 2nd economical region in France
- Region, famous for:
  - Gastronomy
  - Metallurgy sector
  - Chemical sector
  - Healthcare, pharmaceutic sector
  - Electric, electronic sector
  - IT services sector

CITI Lab

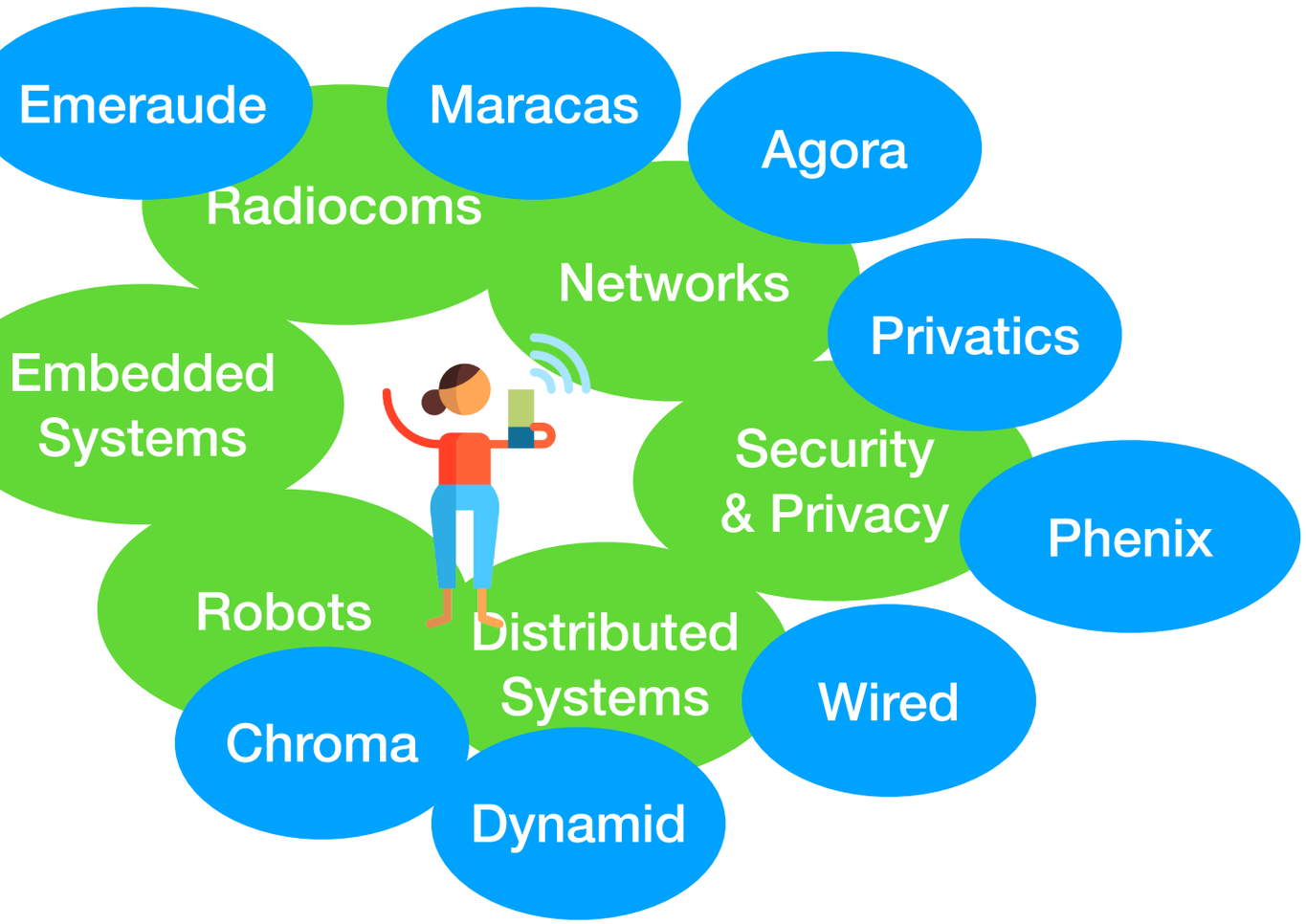
- Topic: Telecommunications
- ~130 members (~40 professors), 8 teams
- Common Labs: Nokia Bell, Orange - Chair: SPIE ICS
- 12 plateforms : EquipEx FIT/CorteXLab, EquipEx+ TIRREX
- 3 spinoff startups
- 9.6M€ turnover, 4.3M€ revenue generated in 2022

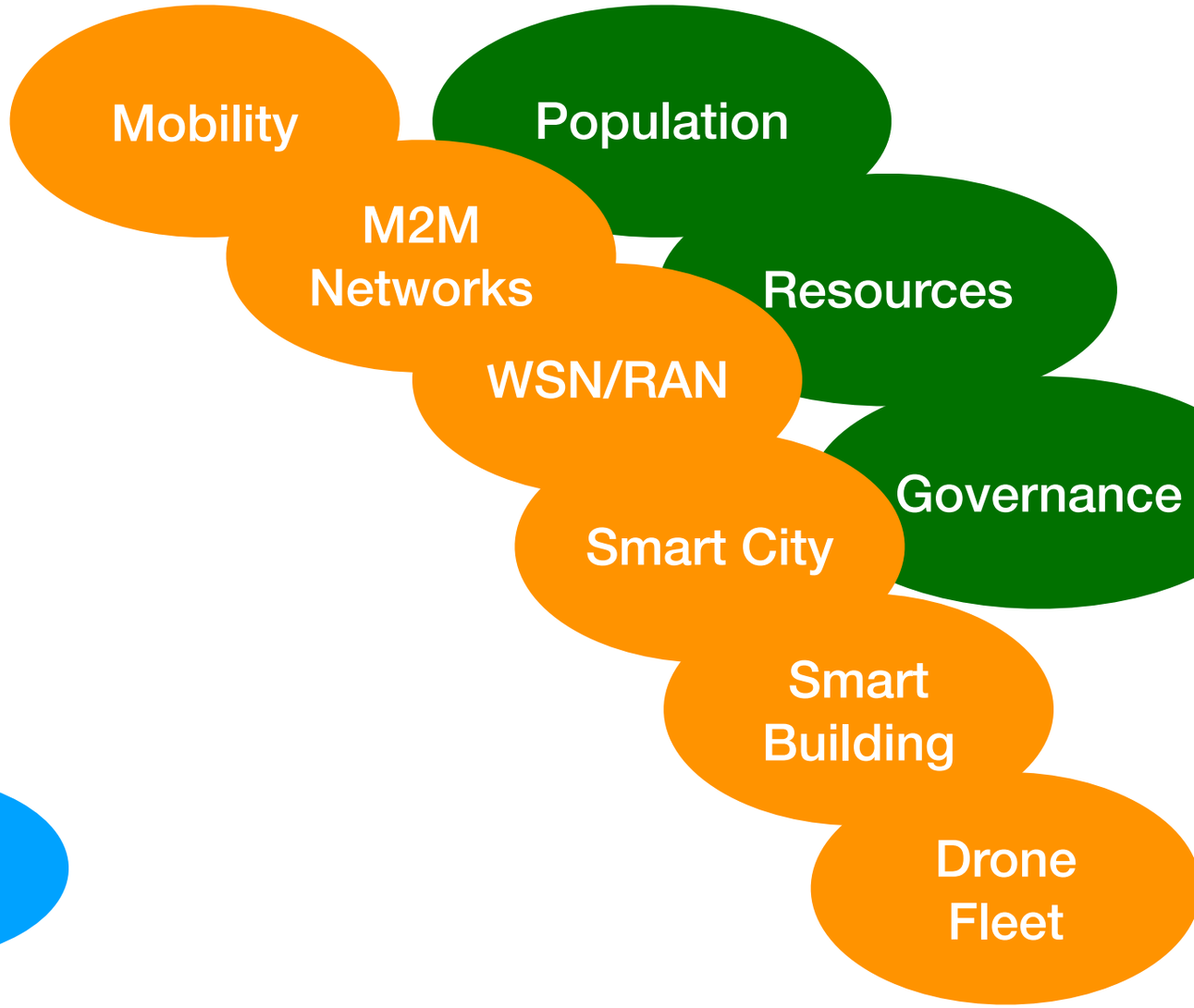
CorteXLab Platform



Scientific project
« Reconnected Society »

citi lab





Scientific project « Reconnected Society »

citi lab

Population

Mobility

M2M Networks

Resources

WSN/RAN

Governance

Smart City

Smart Building

Drone Fleet

Complex Systems Modelling

Large-scale Systems

Collaborative Systems

Emeraude

Maracas

Agora

Radiocoms

Networks

Privatics

Embedded Systems

Security & Privacy

Phenix

Robots

Distributed Systems

Wired

Chroma

Dynamid

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CPE LYON

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Frédéric Le Mouël

- Professor, head of CITI Lab
- Chair in Internet of Things
- Chair in Edge AI
- Topics: Distributed Systems, Edge/Fog Computing
- Industrial use cases: IT sector (SPIE ICS, Red Hat), Automotive sector (VALEO, Stellantis)
- Twitter: @flemouel

Home Automation

Mobile Cloud Computing

Green Buildings

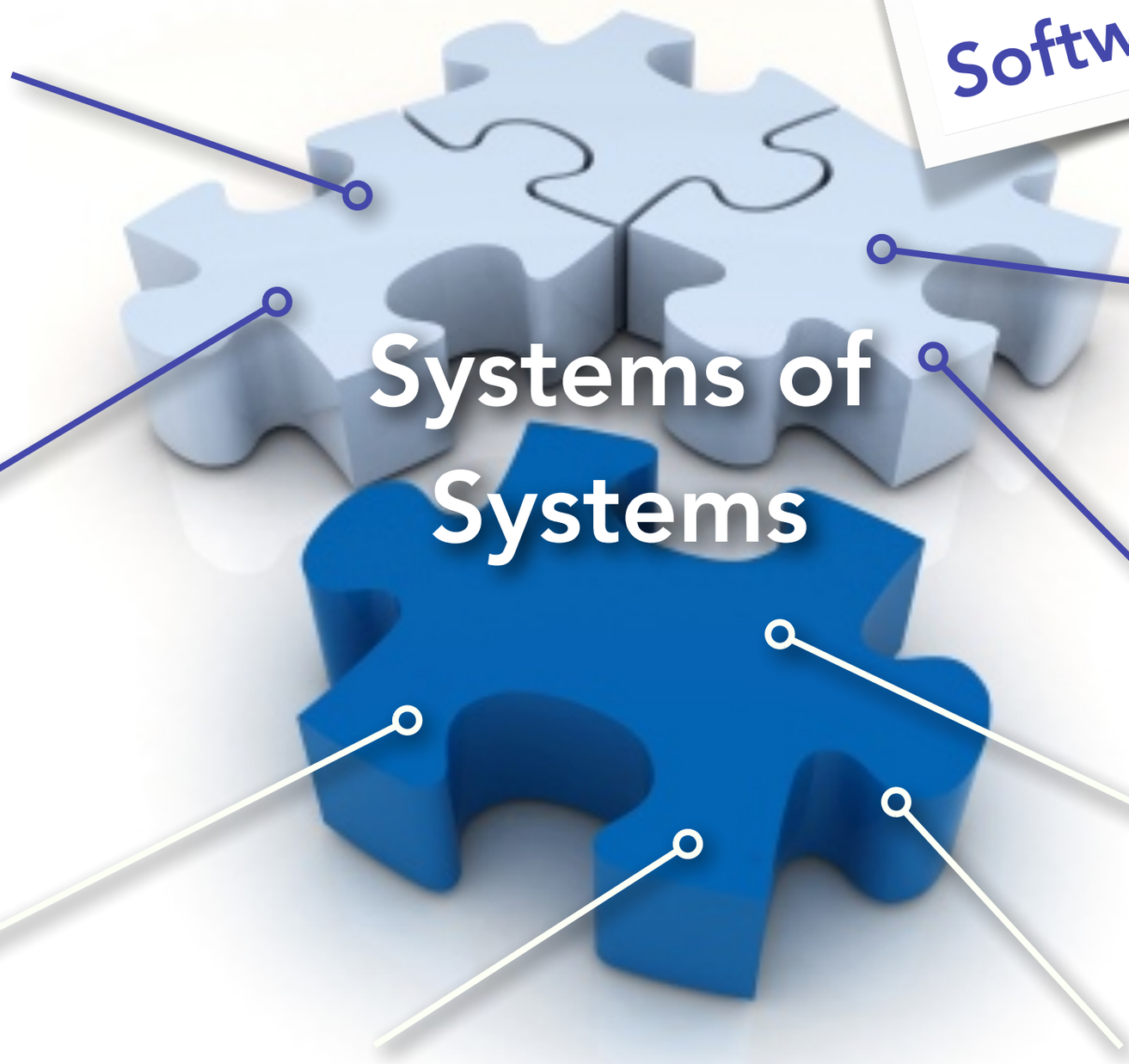
Autonomous Robotics

Smart Cities

Smart Cars

Internet/Web of Things

Integrated Software Systems



Multi-agents Systems

Distributed Systems

Operating Systems

Embedded Mobile Code

Middleware & Platforms

Algorithms

Optimization A.I.

Programming Languages, DSL

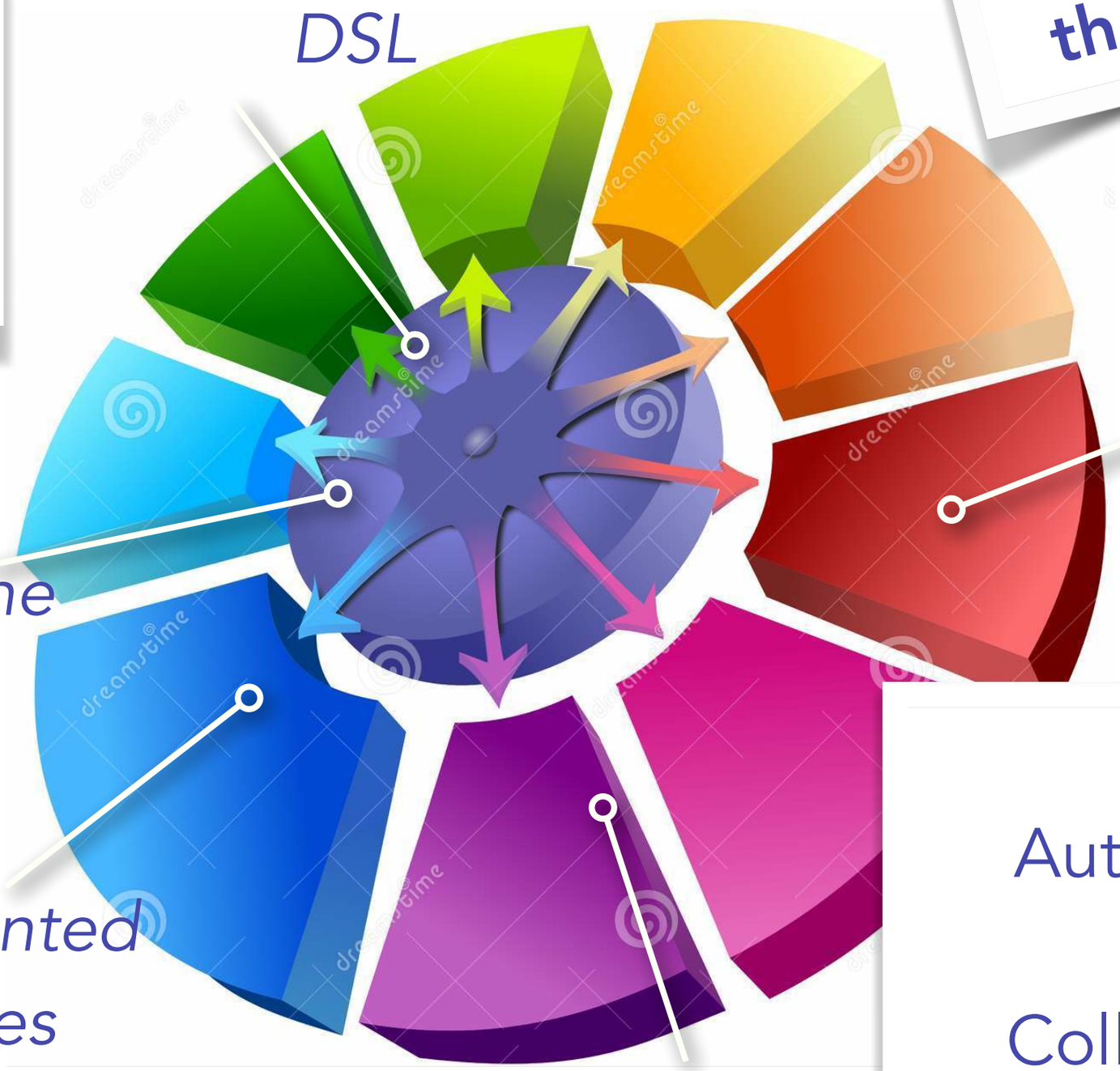
I
Adaptive
in the Small

Programming the Move !

Context-aware DSL

Distributed Decision

Adaptive Virtual Machine

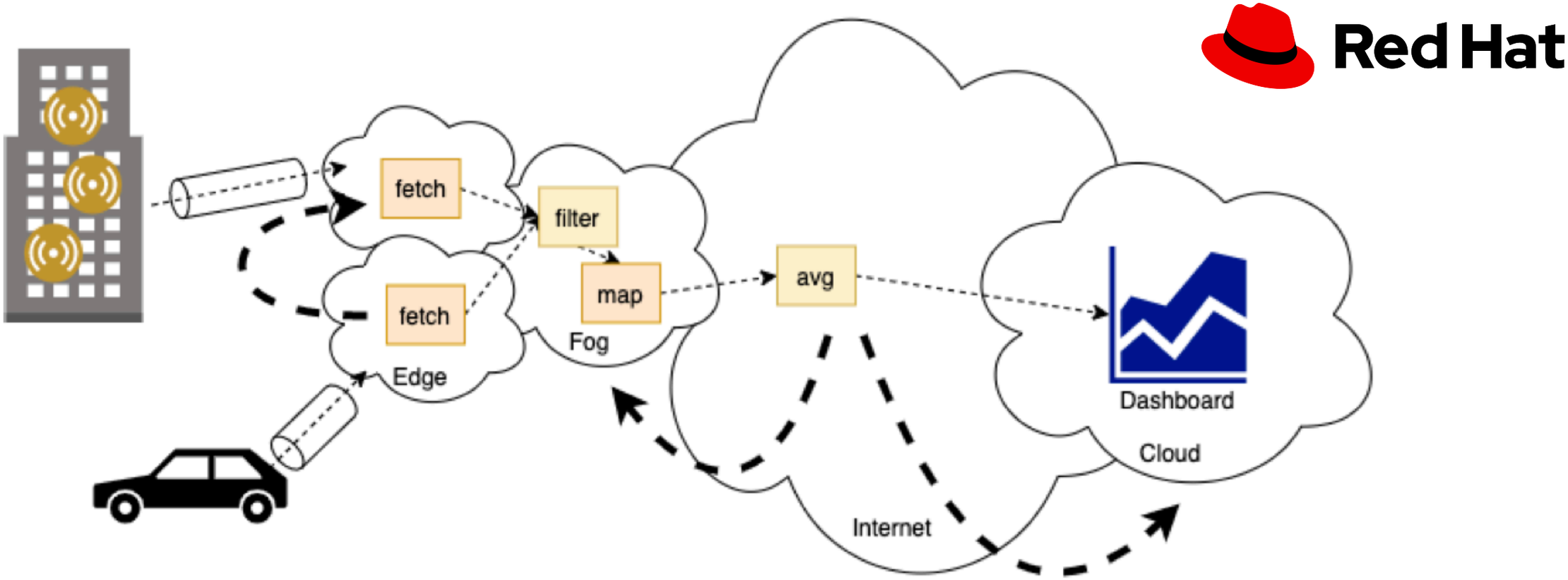


Long-life Software-Oriented Architectures

Bio-inspired Algorithms

II
Autonomous
and
Collaborative
in the Large

Automatic Service Deployment



Moving with your services and …
what if you switch from a Kubernetes infrastructure to a Mesos one?

Automatic Service Deployment

- Proposal: a DSL to manage and automatise your deployment
- Service generation according to the targeted infrastructure
- Synchronization avoiding SPOF

Abstraction	Description
@Service	Services are defined like function annotated. Dyninka generates a service with the same capabilities than the function. The annotation @Service is used to identify functions from which we generate services.
@Placed(val location: String)	User-defined local variable. The annotation *@Placed(val location:String)* is used to place variables. This technique is used for introducing local memory to normally stateless functions and services.
Abstracted synchronization	Generated services provides asynchronous constructs (Promise, Future) to perform dead-lock free communication.
Client side type safety	*T :->Future<T>* Type safety performed on client side is respected when converting functions into asynchronous services.

Automatic Service Deployment

Kotlin (prog lang)
Gradle (deps)
ANTLR (parsing)

```
@Placed("get") val vertx: Vertx = Vertx.vertx()

@Placed("movingAvg") var counter: Int = 0

@Placed("movingAvg") var movingAvr: Float = 0F

@Service fun get(): Future<JsonObject>
{
  return WebClient.create(vertx)
    .get("sensor","/").expect(SC_OK)
    .send().map {
      it.bodyAsJsonObject()
    }
}
```

[...]

```
@Service fun Future<JsonObject>.movingAvg(): Future<JsonObject>
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  this.onSuccess {
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    val result = JsonObject().put("Average", movingAvr)
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fun main()
{
  get().filter().map().movingAvg()
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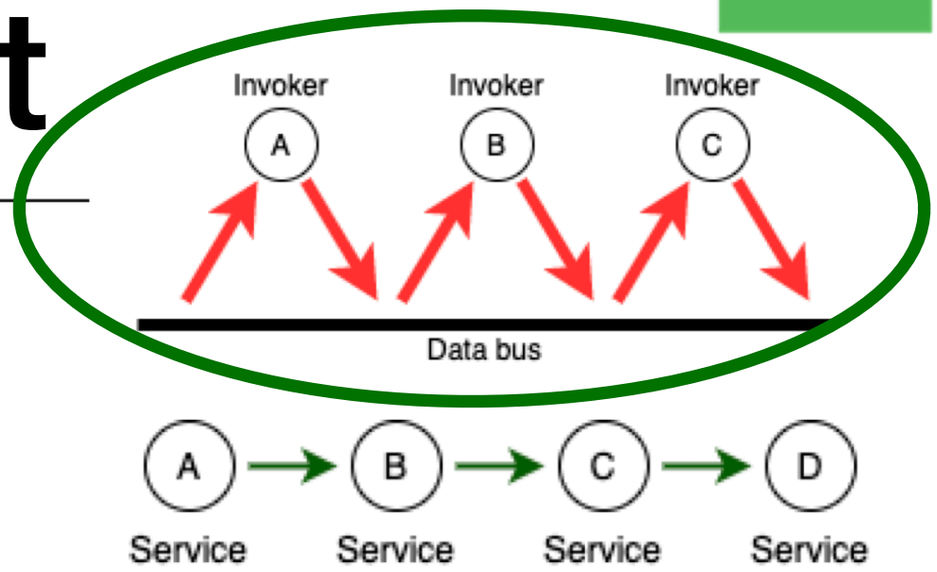


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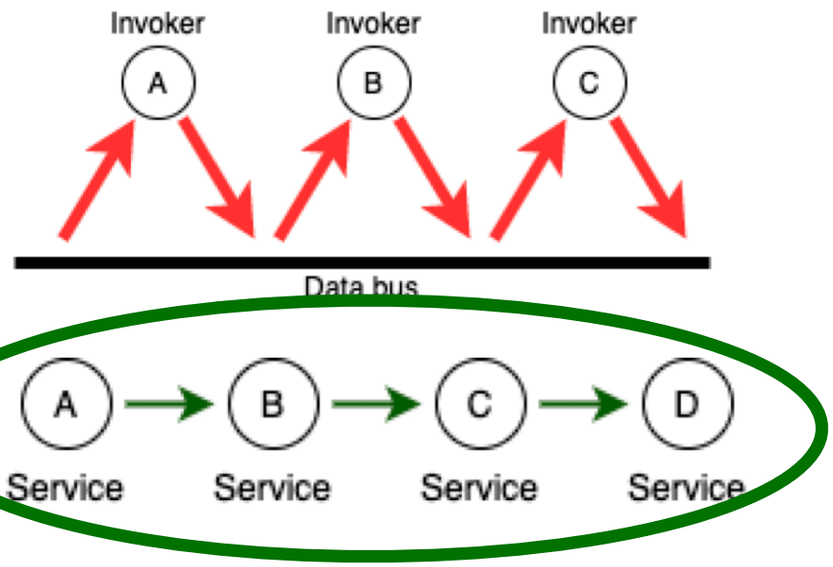


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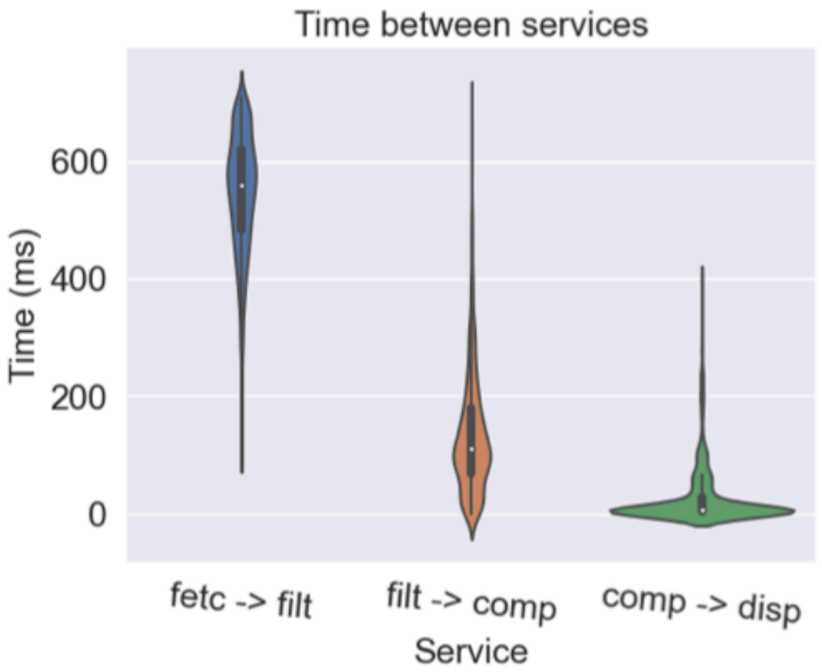
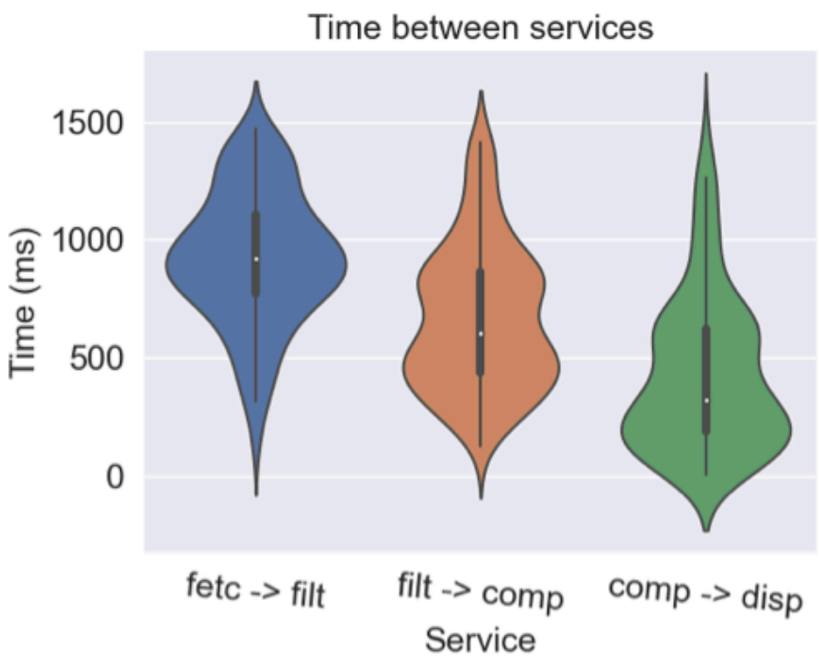


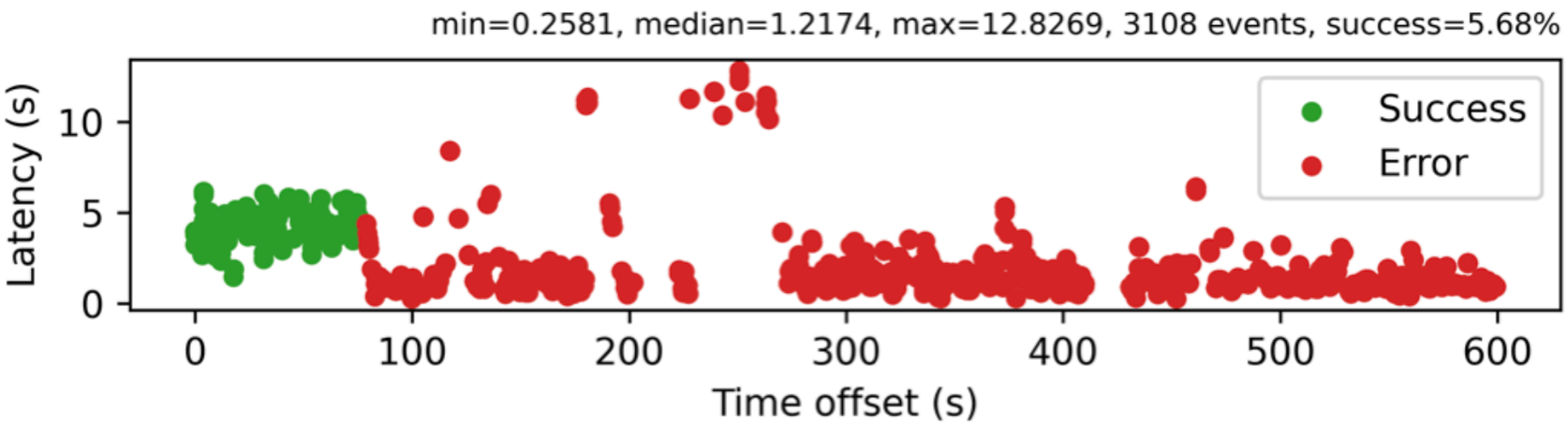
(a) Dyninka



(b) OpenFaaS

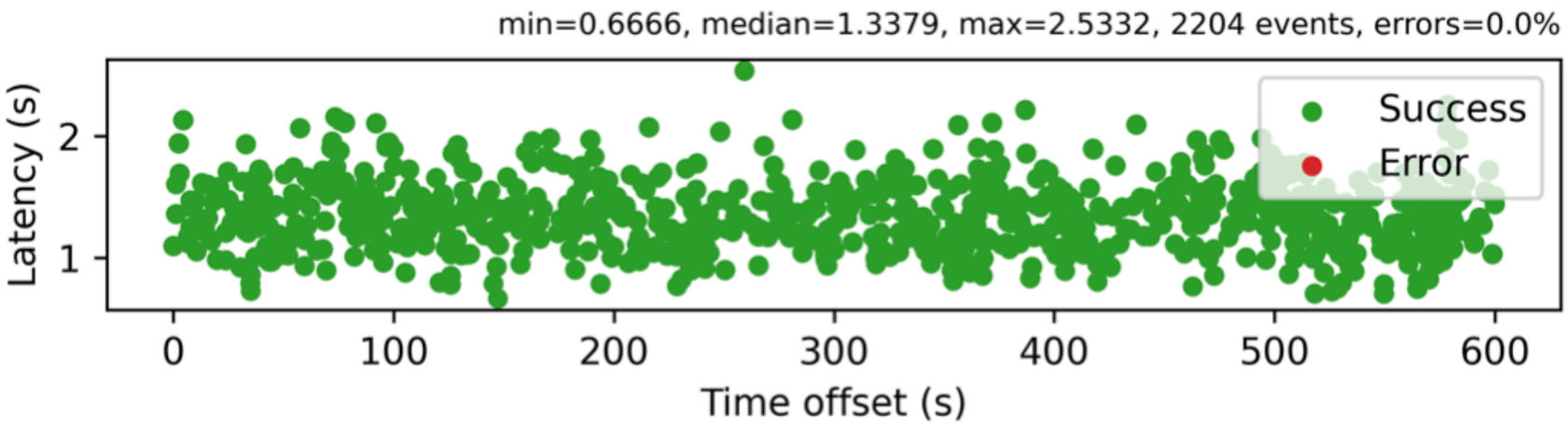
1 worker

Automatic Service Deployment



OpenFaas

10 workers



Dyninka

On-going projects

- Automatic service deployment in dynamic environments
- Service re-orchestration
- Service virtualization in automotive applications

Future works?

SPIE

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Edge AI: Data Flow Analysis in Edge Infrastructures

Chair INSA Lyon - SPIE ICS

Frédéric Le Mouël (INSA Lyon)

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AI & Data Flow

AI & Data Flow

- Sensing as a Network Service
- Network-traffic patterns in CDN
- Dynamic, Adaptive, Mobile, Multi-Tenant Slicing for E2E QoS

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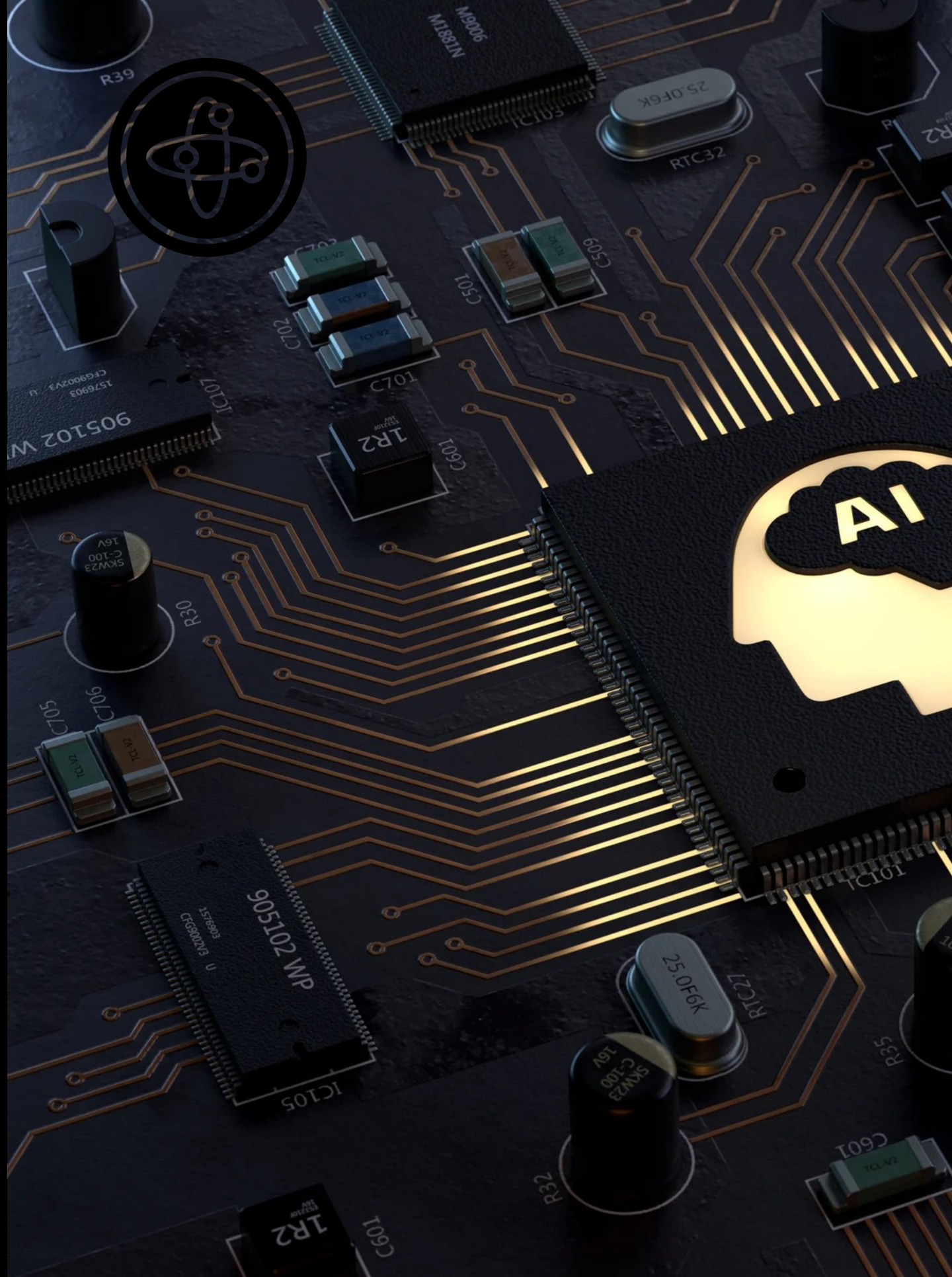
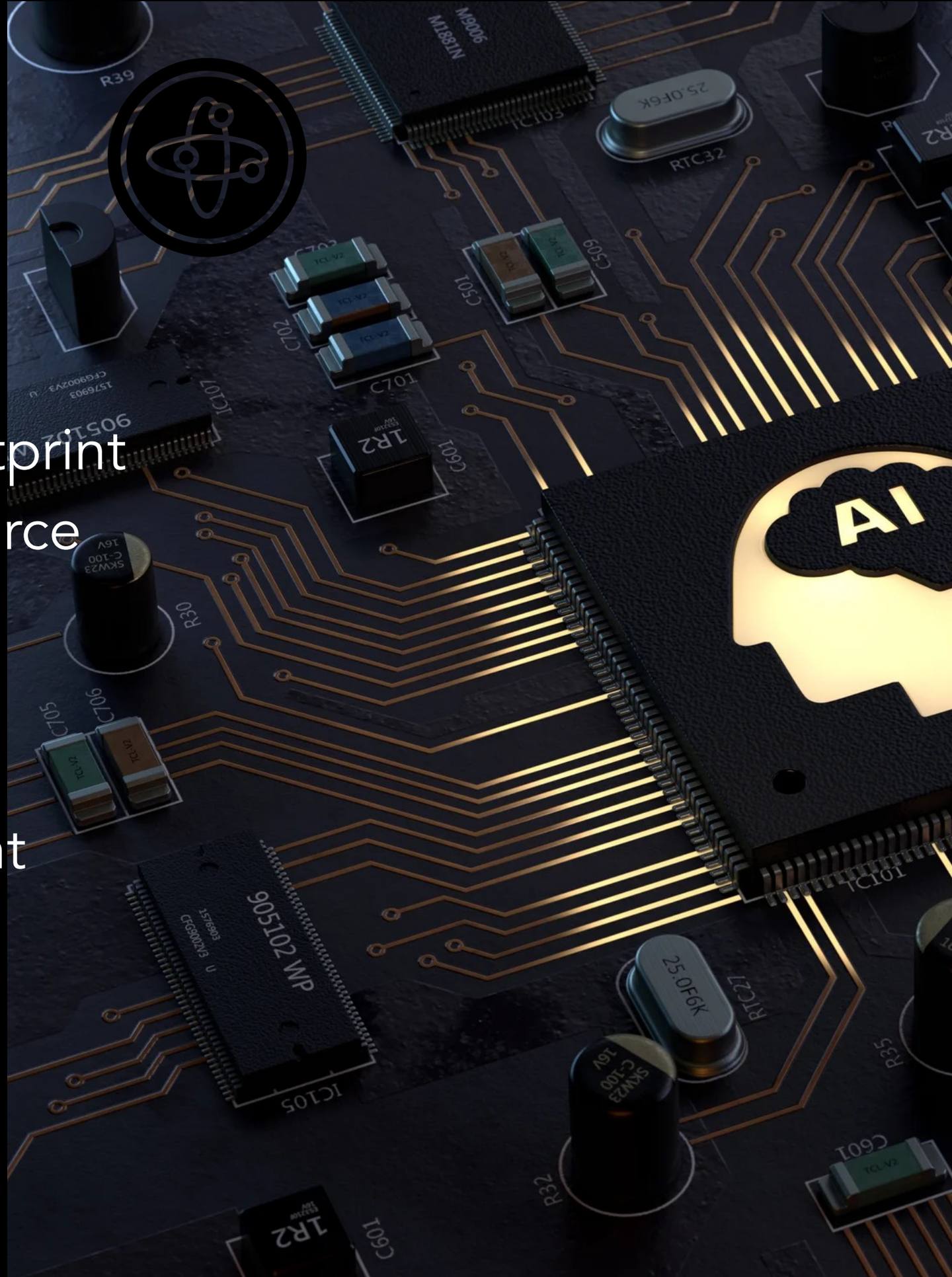
Embedded AI



Embedded AI

- Low carbon & energy-footprint AI - Learning under Resource Constraints
- Decision-Making under Uncertainty
- Intermittent Reinforcement Learning



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Geo-distributed AI

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- Service Handover in Edge/Fog Computing Infrastructures for ML applications
- Low-Energy Federated Learning
- Fault-tolerant CNN & Generative Adversarial Learning

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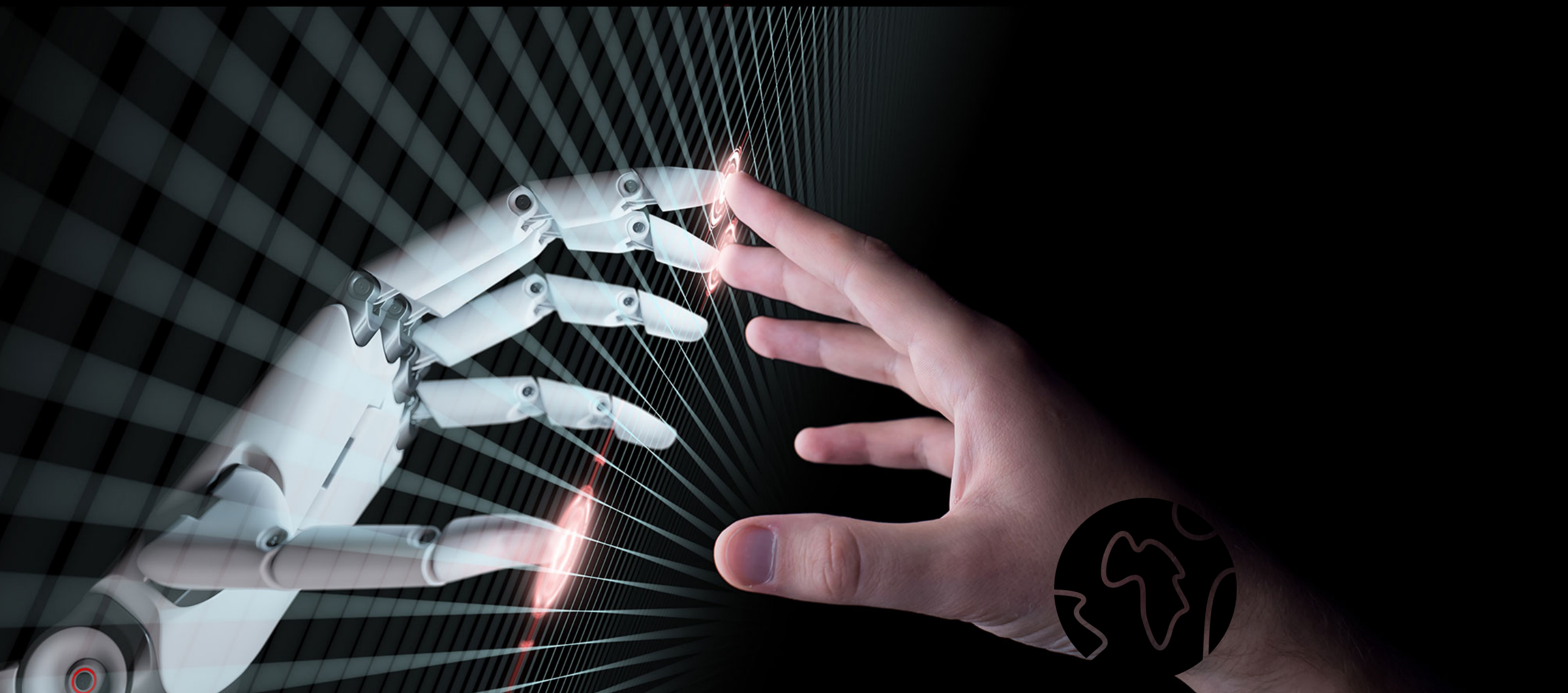
Cheap Local-IaaS

Self-Managed Infrastructures

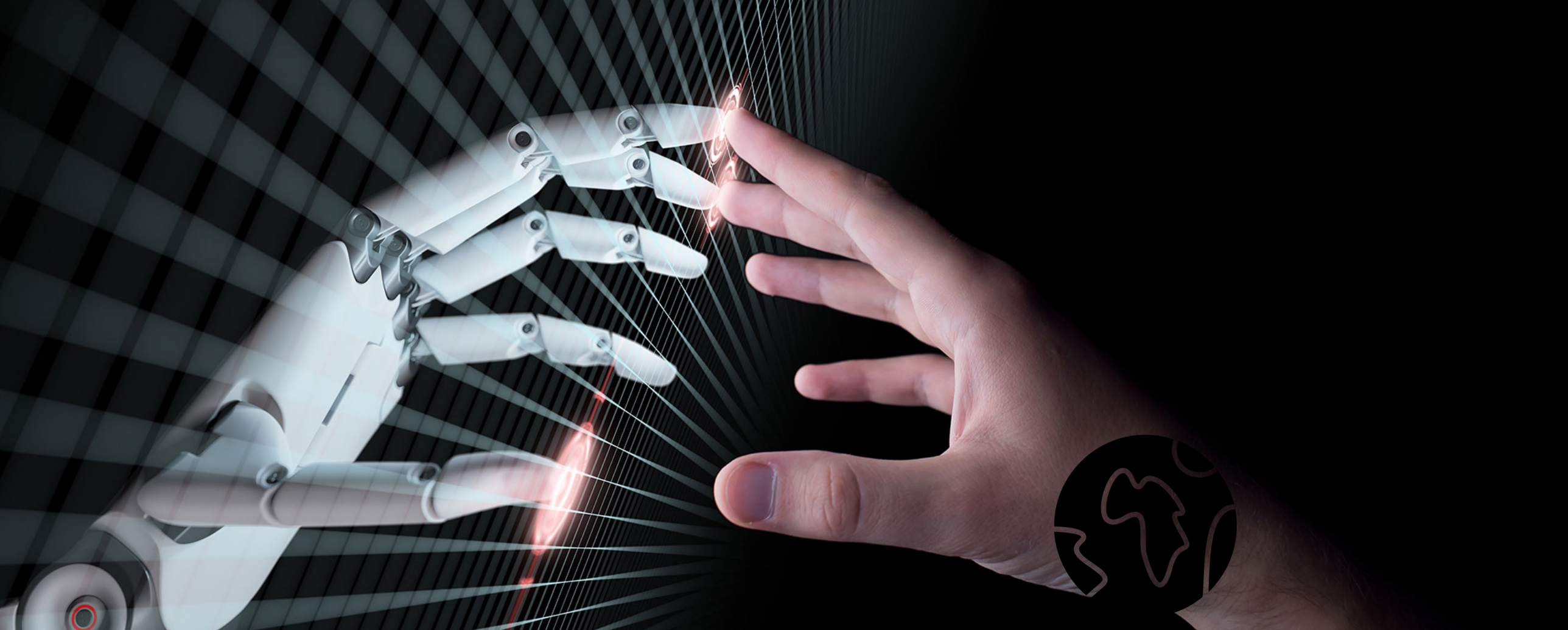
Remote Continuous Audits

Responsibility & Data Control



Responsibility & Data Control

- Trust & Privacy
- Sovereignty
- Embedded Ethics



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CITI Laboratory
http://www.citi-lab.fr

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@flemouel