is the network a software like any other ?

orange™

« Raison d'être »

Invent with you a story of the future for Orange

Missions

- **Light the future** : identify risks and ruptures, explore and build opportunities, influence ecosystems
- **build strategic assets** : knowledge, skills, intellectual property, standards & open source , partnerships.
- **Feed our innovation** chain aiming to differentiate our infrastructure, products and services, customer relationships and / or business models.

« Because tomorrow's world will emerge from increasingly intelligent interaction between the physical and digital worlds, we strongly believe that research must be integrative. »

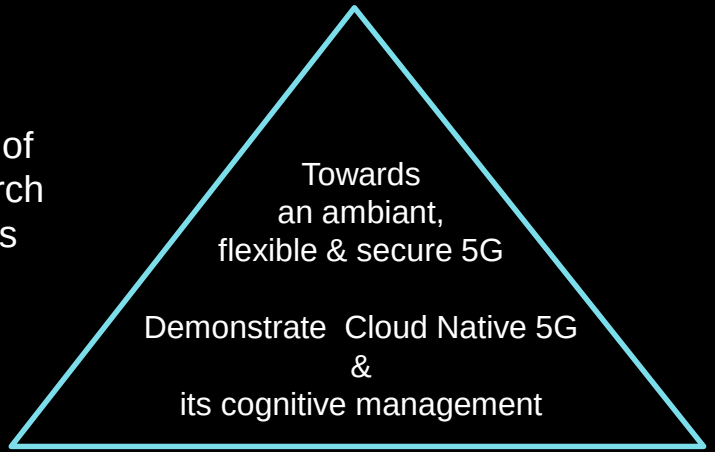
« … a research in mode DevOps »

Plug'in
Ambiant Connectivity

Thing'in
Web of Objects

Home'in
Sensible Home

Ambition of the research platforms



Build the Cornerstone of the Web of Objects: Indexing and Search Engine for Object Discovery, Exploitation and Enrichment of Object Relationships

Design the intelligent and sensitive home that protects our private lives and allows openness to the other: an experimental house, an open and interoperable environment, a common architecture

Major advances expected

- 5G for Verticals
- Automating network management with AI.
- Built with partners

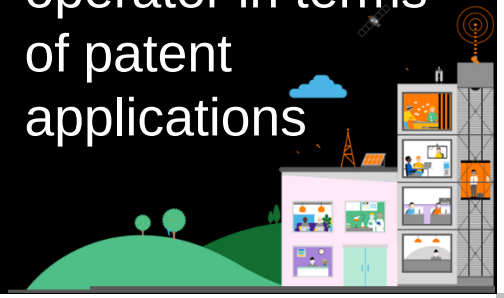
- Alignment and Enrichment of Ontologies for Scale Upgrading Scalability to one billion objects

- Management of contents and services of the sensitive house
- Better relevance of interactions through the detection of the user's personality

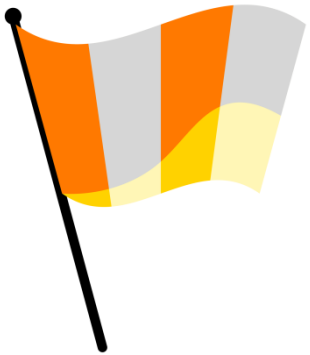
Our research in numbers

No. 1

European operator in terms of patent applications



200 patents filed in 2017



600 researchers

140 PhDs / post-doctorates

100 partnerships (labs, collaborative projects, tech research labs, etc.)

All-IP + Virtualization + Cloud + API + 5G

= **agile networks**

5G a network which adapts in real time to process and business model thanks to softwarisation, cloud, prediction and automation

All-knowing

Deployable on the fly

Always optimal

orange™

Key industry trends

Microservices

An approach to develop a single application as a suite of **small services**, each running in its **own process** and communicating with **lightweight mechanisms**

✓ Innovate more rapidly and be more agile

Containers

A technology to give each application running on a server its own, **isolated environment** to run.
It holds the components necessary to run the desired software.

✓ Speed up the testing process and build large, scalable cloud applications

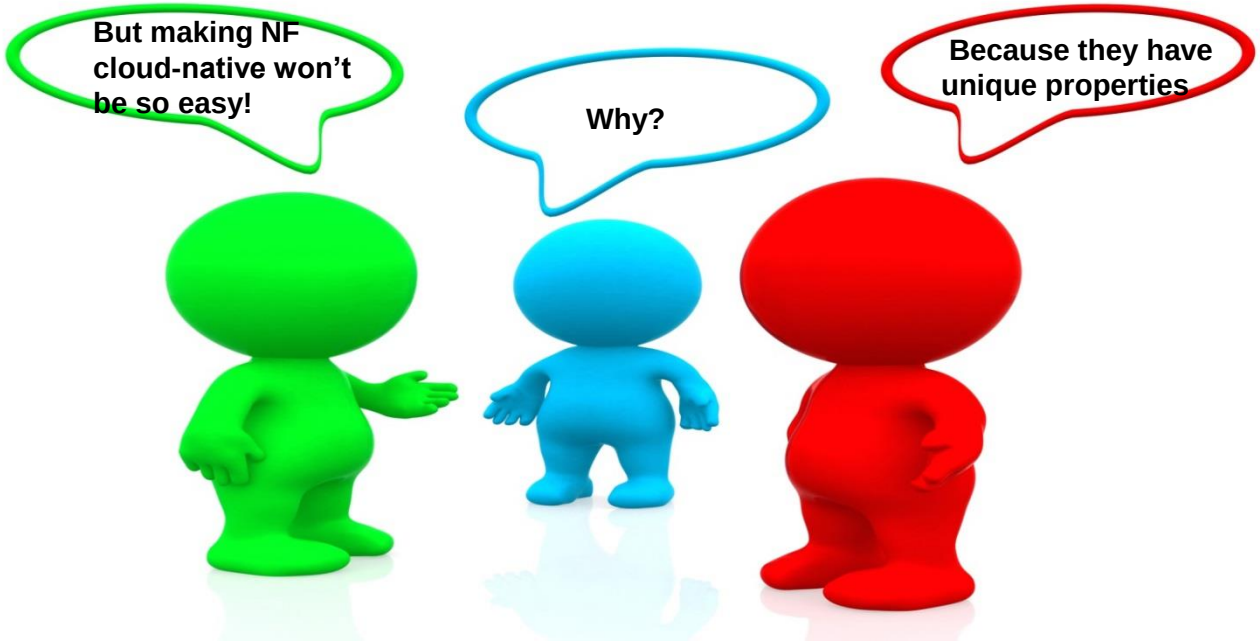
Automation

"Infrastructure as code" approach to enable the entire infrastructure deployment to be expressed and controlled through software

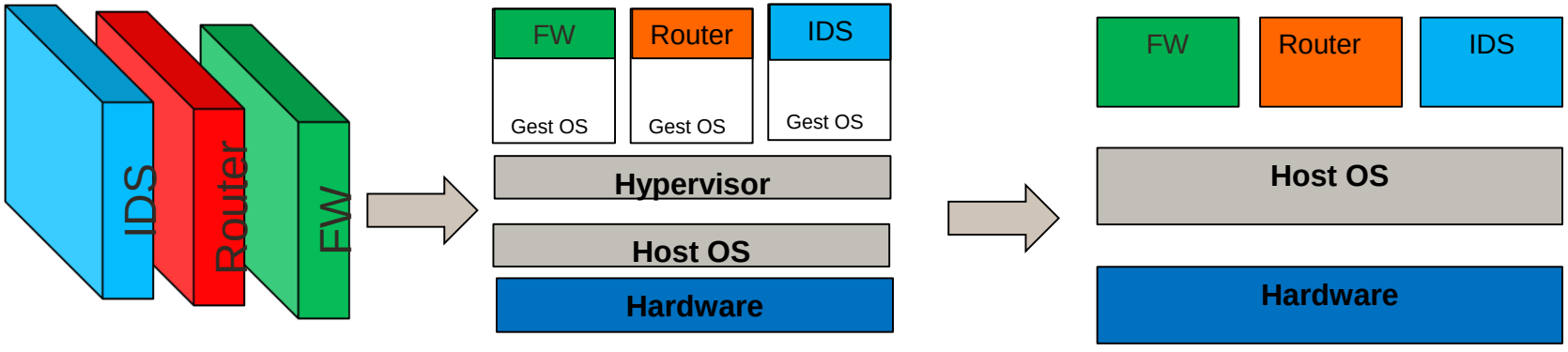
✓ Reduce complexity and offer a more responsive IT environment;

Operator ambitions

- Need to increase network flexibility while reducing CAPEX and OPEX
- All these approaches are eminently suitable to be used in NFV environments
- NFV should be equally agile and automated



How to make network functions cloud-native



Traditional physical NF

Virtualized NF 1.0

Cloud-native NF 2.0

Containters

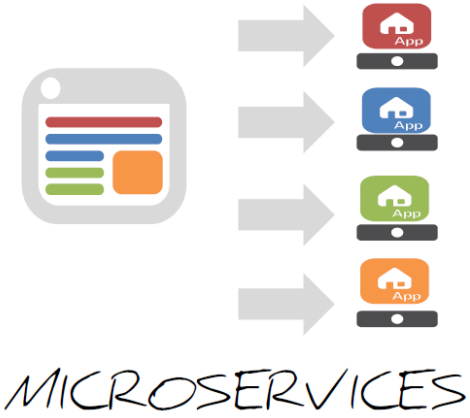
14.5 x greater density	**94%** faster to launch
57% lower I/O latency	**~0%** CPU overhead

Containers are part of a “terrific” transformation of the IT landscape: from Cloud Ready to Cloud Native Applications

Agile development
DevOps
CI/CD

Containers
Orchestration

Cloud Native Applications



Micro services

New Ways to Deploy and Manage Applications at Scale

CNA to fully exploit the benefits of the cloud computing model

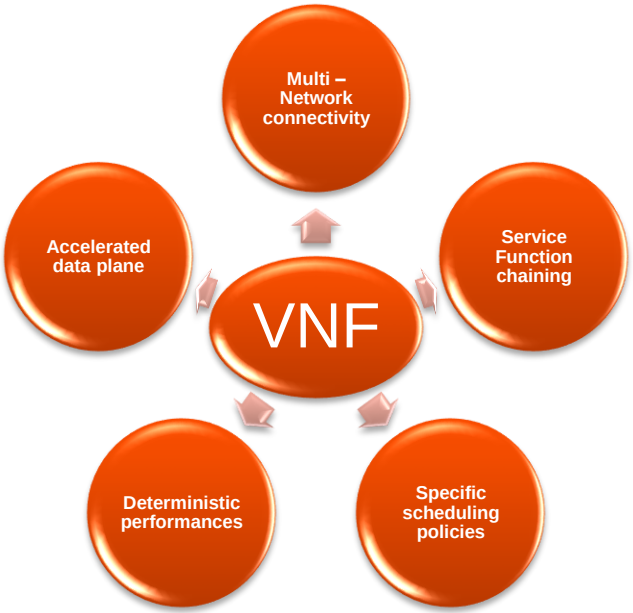
Telco-Grade features and orchestration challenges

- **Multi-network conncectivity:** telco workloads may require sophisticated network models to support multi-homing with various QoS
- **Service function chaining**: telco applications must be configured together as a service through which traffic needs to be correctly steered

- **Specific scheduling policies:** new placement constraints need to be supported ➔ Network-related, inter-component affinity/anti-affinity, energy, etc.

- **Deterministic performances:** some telco workloads are performances sensitive and hence need predictable access to CPU and memory

- **Accelerated data plane:** some telco workloads require native network performances to achieve very low latency and jitter



From Legacy network functions to VNFaaS

Functional decomposition approach

mmm…okay…! But,
Specifications are not that detailed to allow such an approach
and are we moving towards decomposed architectures for 5G?

2. Separation of state

- Separate the service logic and data/state to build **stateless services**

3. Functional independence

- Define the new service processes
- Ensure functional independency **loosely coupled**

Design of new VNFaaS
Cloud-native & aaS features

Structure	Cohesion	✓
	Reuse	✓
	Abstraction	✓
	Invariance	✓
	Statelessness	✓
	Mutualization	✓

Interactions	Loose coupling	✓
	Invocation	✓
	Composition	✓

Management	Description	✓
	Registration	✓
	Exposition	✓
	Auto-management	✓
	Ubiquity	✓

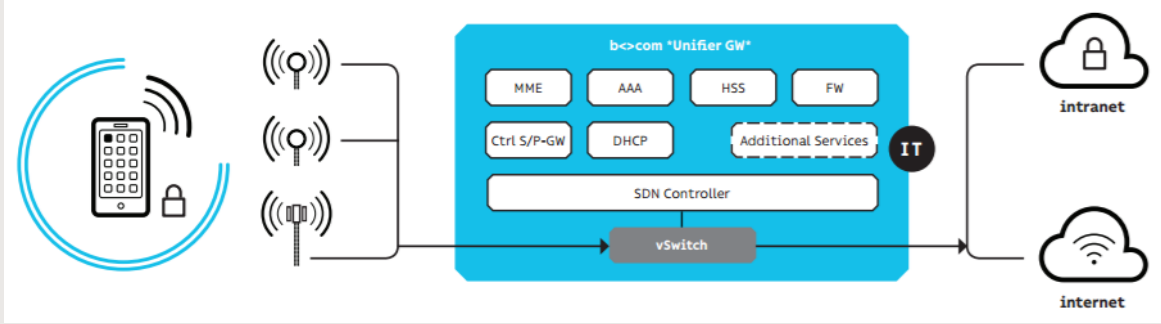
b<>com *Unifier Gateway*

Value proposition

pre-5G core network software solution that leverages on **SDN** and **NFV** technologies to offer a convergent and secured connectivity to private networks users

Keywords – 4G/5G, SDN, NFV, WLAN, LTE, OpenDaylight

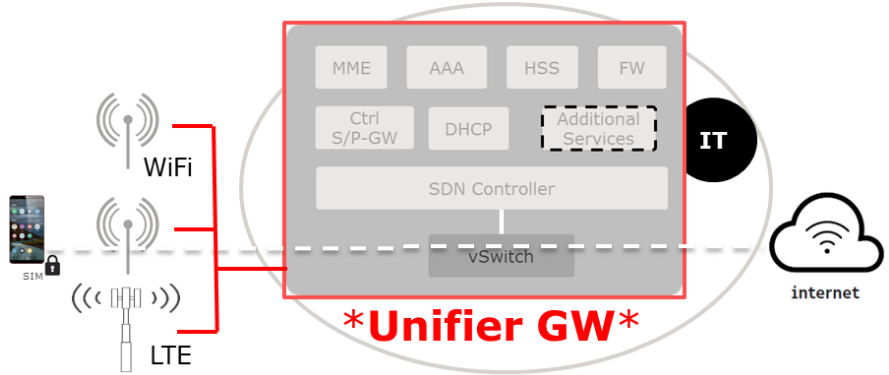
Overview



Features

> Full 3GPP Rel10 LTE EPC
> Distributed SDN Firewall
> EAP-AKA, EPS-AKA SIM based authentication mechanisms

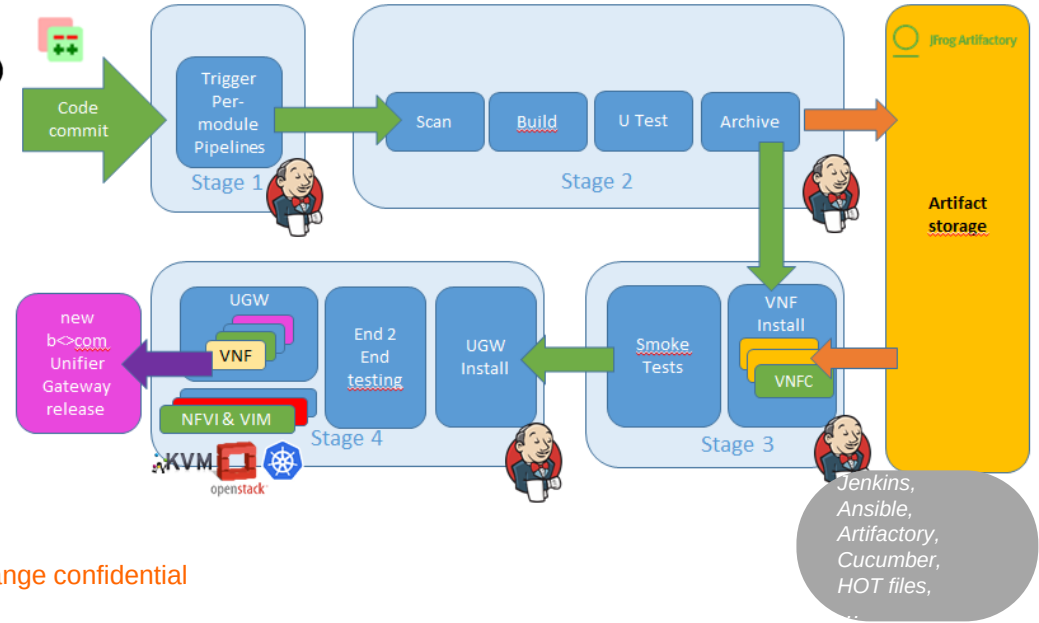
DevOps mode



b<>com ***Unifier GW*** Virtual Network Functions

Automated deployment

- Continuous Integration & Delivery chain (CI/CD)
- Relying on Ansible playbooks
- Target platforms: KVM, Openstack



Next step: a microservice based 5G mobile core

VNF skeleton with standard API (AMF, SPF, NRF)

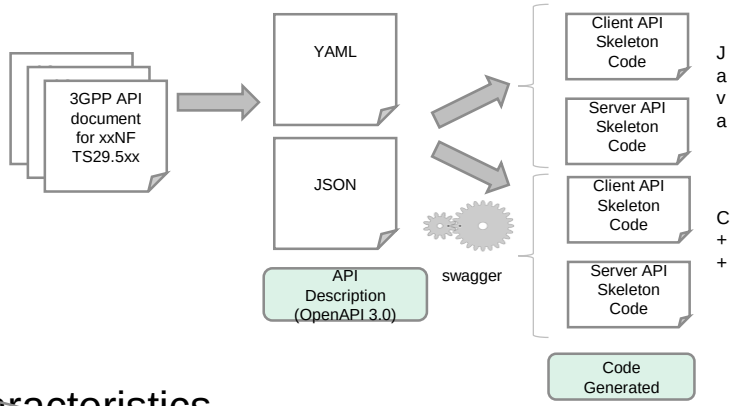
Bus implementation – HTTPv2

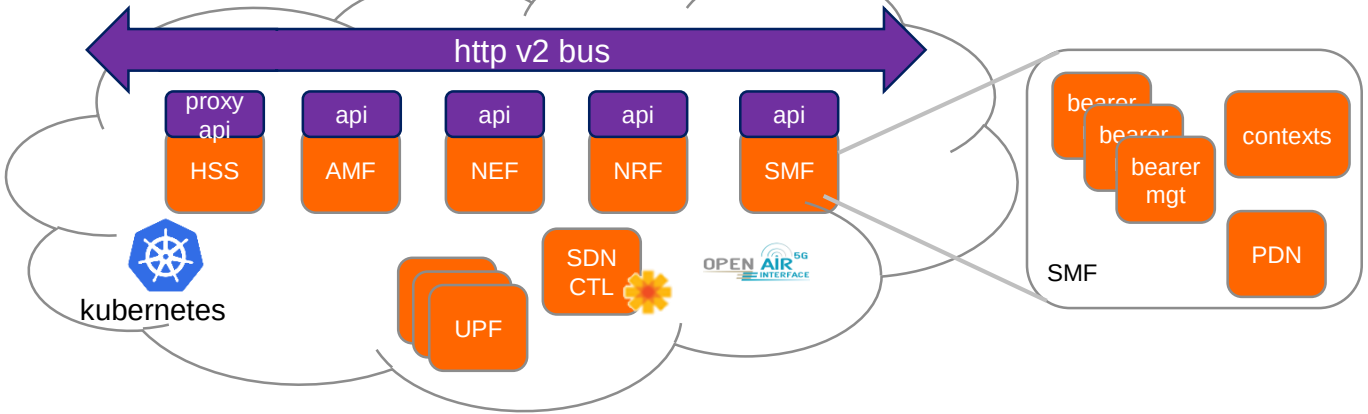
API Management and « processing optimisations »

Control and user plane separation

Efficient programmable user data plane

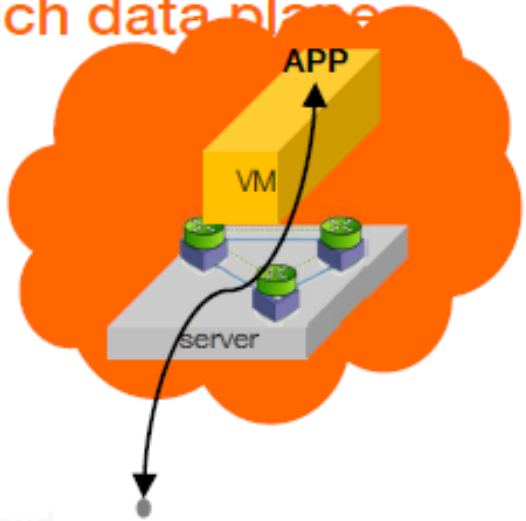
Microservices modularity and independent upgrade characteristics

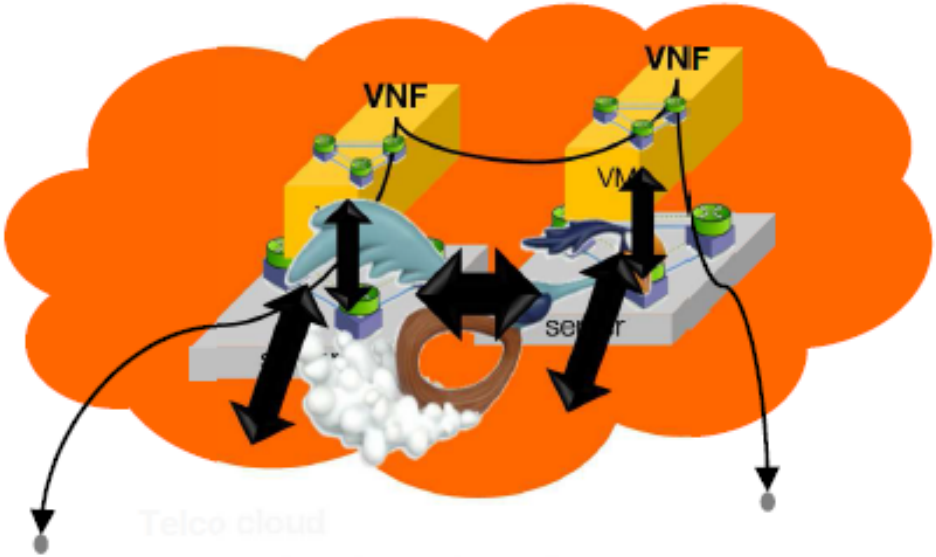




Telco Cloud

Telco cloud is different from classic IT cloud due to network traffic, raising specific issues for an optimal data plane, but which data plane





IT cloud

Request to a virtualized application located in the cloud

e.g.: request a database

Telco cloud

Run a network service using one or several virtual network functions located in the cloud

e.g.: internet access through DPI and firewall

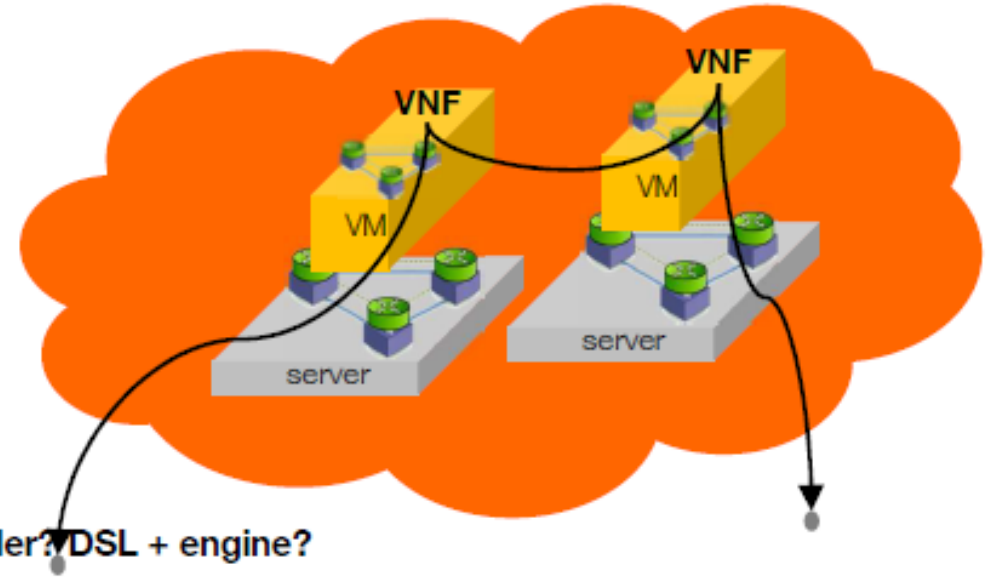
- Performant network access from outside to VNF and between VNF (infrastructure transport)
- Avoid stacking data plane layers through programmable offloading of VNF data plane to infrastructure

Telco cloud is different from classic IT cloud due to network traffic, raising specific issues for an optimal data plane, but which data plane

DPDK Click OVS

SR-IOV P4 VPP

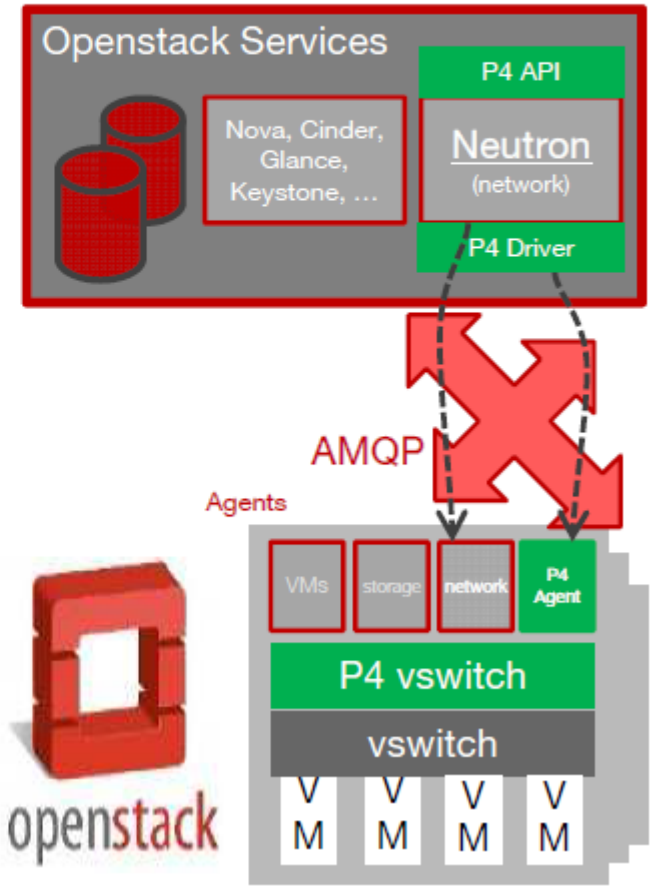
...



- Manage data plane or to speed up?
- Manage data plane: pure language ? Compiler? DSL + engine?
- Speed up: in-kernel / bypass? Data plane processing delegation?
- Possible combination? Pros/Cons ?
- ...

Project Programmable Data Plane for OpenStack using P4”

- P4 provides expressiveness, flexibility and dynamic programmability
- Find a way to bring P4 capabilities to OpenStack network infrastructure
- VNF offloading using P4 switches
  - addition and removal of packet processing modules in the P4 switch (infrastructure level)
  - integrating into Openstack Neutron the life-cycle management of P4 modules

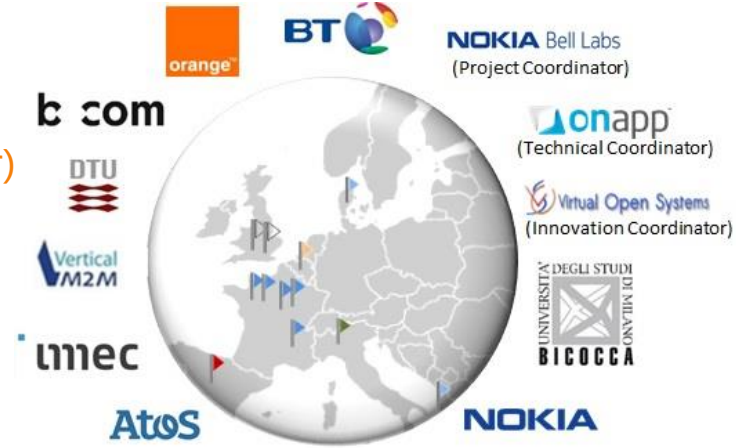


- **Work items:**
  - Analysis and implementation of solution to integrate P4-capable switches as Neutron backend
  - Specification and implementation of new networking APIs for Neutron to enable dynamic life-cycle management of P4 modules
  - Proof of Concept of VNF offloading using P4

Telco PaaS

NGPaaS project overview

- **5G PPP phase 2 IA project**
- **Aiming at building a next generation PaaS for 5G**
- **12 partners consortium:**
  - 6 Large companies: Nokia Bell-Labs France (coordinator) Nokia Israël, Orange, ATOS (SP), BT, ONAPP(UK, technical manager)
  - 2 start-ups: VOSYS (FR, innovation manager), VM2M (FR)
  - 4 research laboratories: BCOM, DTU (DK), IMEC (BE), UNIMIB (IT)
- **24-month project, start: June 2017, End : June 2019**



NGPaaS targeted properties

- **PaaS framework**
  - Modular components (re-use of Superfluidity component model)
  - Enable to build customized PaaS according to use cases by combination and extension of the framework components
- **Telco-grade**
- **IT/5G convergent**
- **Multi-sided**
  - Vendor PaaS + Operator PaaS + Vertical PaaS
- **Heterogenicity**
  - Address both VM, containers, Unikernel and any new techno to come
- **New OSS/BSS model**

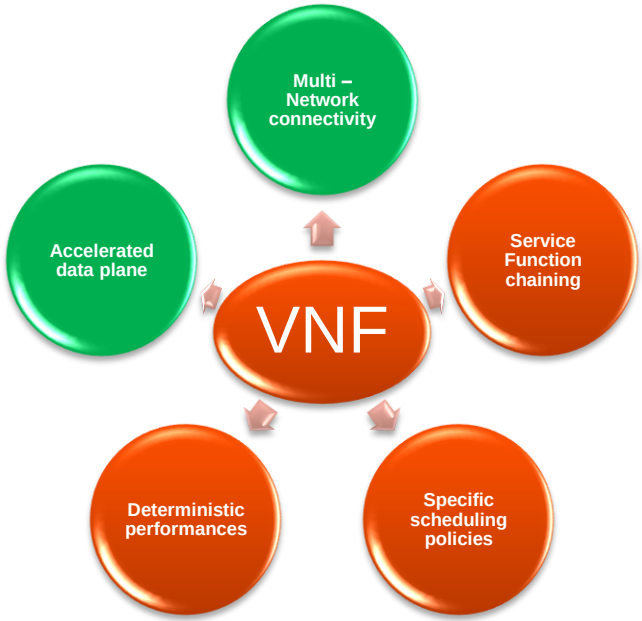
NGPaaS objective: a Telco-grade Kubernetes for an enhanced orchestration of cloud native VNFs

- **Scope**
  - Design, develop and deploy a Kubernetes based system for an automated management and orchestration of cloud-native container-based network functions

- **Objectives**
  - Customize Kubernetes to close the gap with regard to NFV requirements
  - A prototype of a telco grade Kubernetes with a first deployed use case

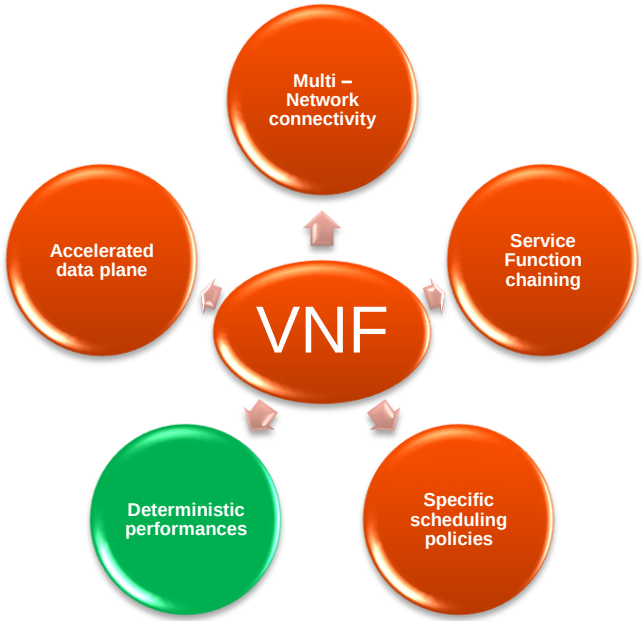
Kubertenes enhancements towards a telco-grade orchestration

#	VNF requirement	Enhancement	description
1	Multi-network support & data plane acceleration	Kubernetes with multi network support and dataplane acceleration	Kubernetes extensions to support multiple network interfaces per POD with DPDK and SR-IOV acceleration
2	Deterministic Performances	Kubernetes with EPA (Enhanced Platform Awareness) support	Kubernetes extensions to support customized CPU pinning policies and huge pages
3	Custom scheduler	Extended Kubernetes scheduling	Extension of Kubernetes scheduling to support new metrics (ex. Network)
4	SFC support	Kubernetes with service function chaining	Kubernetes extensions enabling service function chaining for NFV



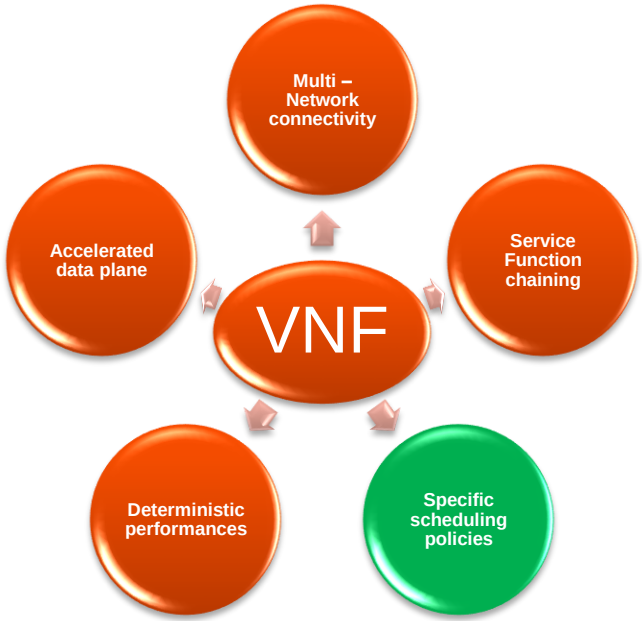
Kubertenes enhancements towards a telco-grade orchestration

#	VNF requirement	Enhancement	description
1	Multi-network support & data plane acceleration	Kubernetes with multi network support and dataplane acceleration	Kubernetes extensions to support multiple network interfaces per POD with DPDK and SR-IOV acceleration
2	Deterministic Performances	Kubernetes with EPA (Enhanced Platform Awareness) support	Kubernetes extensions to support customized CPU pinning policies and huge pages
3	Custom scheduler	Extended Kubernetes scheduling	Extension of Kubernetes scheduling to support new metrics (ex. Network)
4	SFC support	Kubernetes with service function chaining	Kubernetes extensions enabling service function chaining for NFV



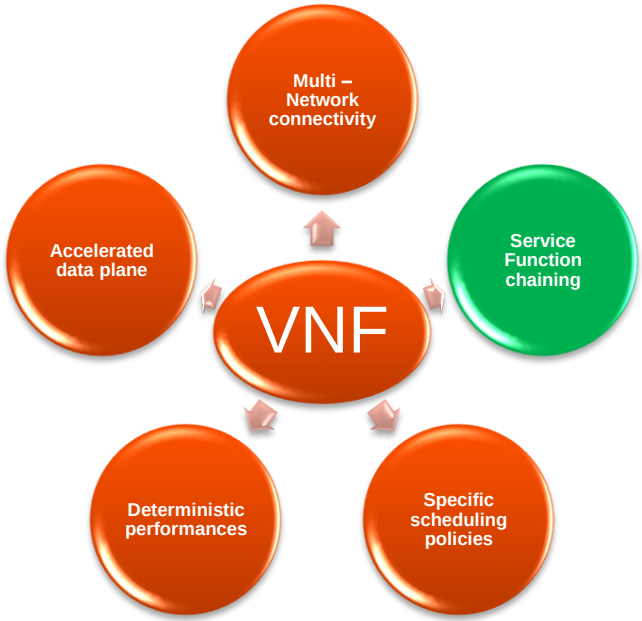
Kubertenes enhancements towards a telco-grade orchestration

#	VNF requirement	Enhancement	description
1	Multi-network support & data plane acceleration	Kubernetes with multi network support and dataplane acceleration	Kubernetes extensions to support multiple network interfaces per POD with DPDK and SR-IOV acceleration
2	Deterministic Performances	Kubernetes with EPA (Enhanced Platform Awareness) support	Kubernetes extensions to support customized CPU pinning policies and huge pages
3	Custom scheduler	Extended Kubernetes scheduling	Extension of Kubernetes scheduling to support new metrics (e.g. Network)
4	SFC support	Kubernetes with service function chaining	Kubernetes extensions enabling service function chaining for NFV

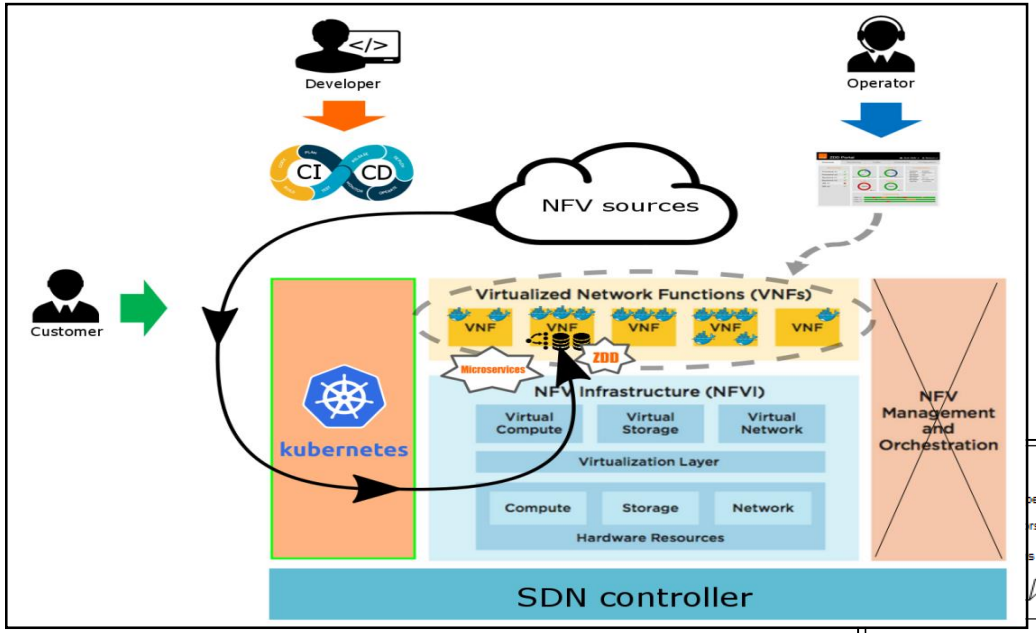


Kubertenes enhancements towards a telco-grade orchestration

#	VNF requirement	Enhancement	description
1	Multi-network support & data plane acceleration	Kubernetes with multi network support and dataplane acceleration	Kubernetes extensions to support multiple network interfaces per POD with DPDK and SR-IOV acceleration
2	Deterministic Performances	Kubernetes with EPA (Enhanced Platform Awareness) support	Kubernetes extensions to support customized CPU pinning policies and huge pages
3	Custom scheduler	Extended Kubernetes scheduling	Extension of Kubernetes scheduling to support new metrics (ex. Network)
4	SFC support	Kubernetes with service function chaining	Kubernetes extensions enabling service function chaining for NFV



ZDD for Ultra Agile 5G



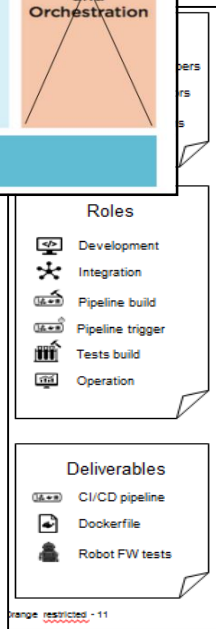
“Release Management”

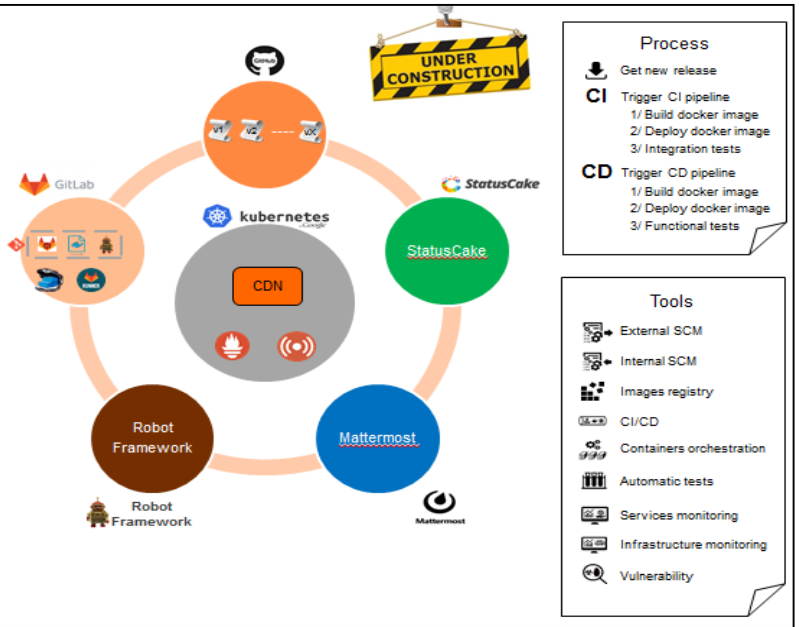
ambitions

1 Deploy VNF without interruption of service (ZDD) using Kubernetes

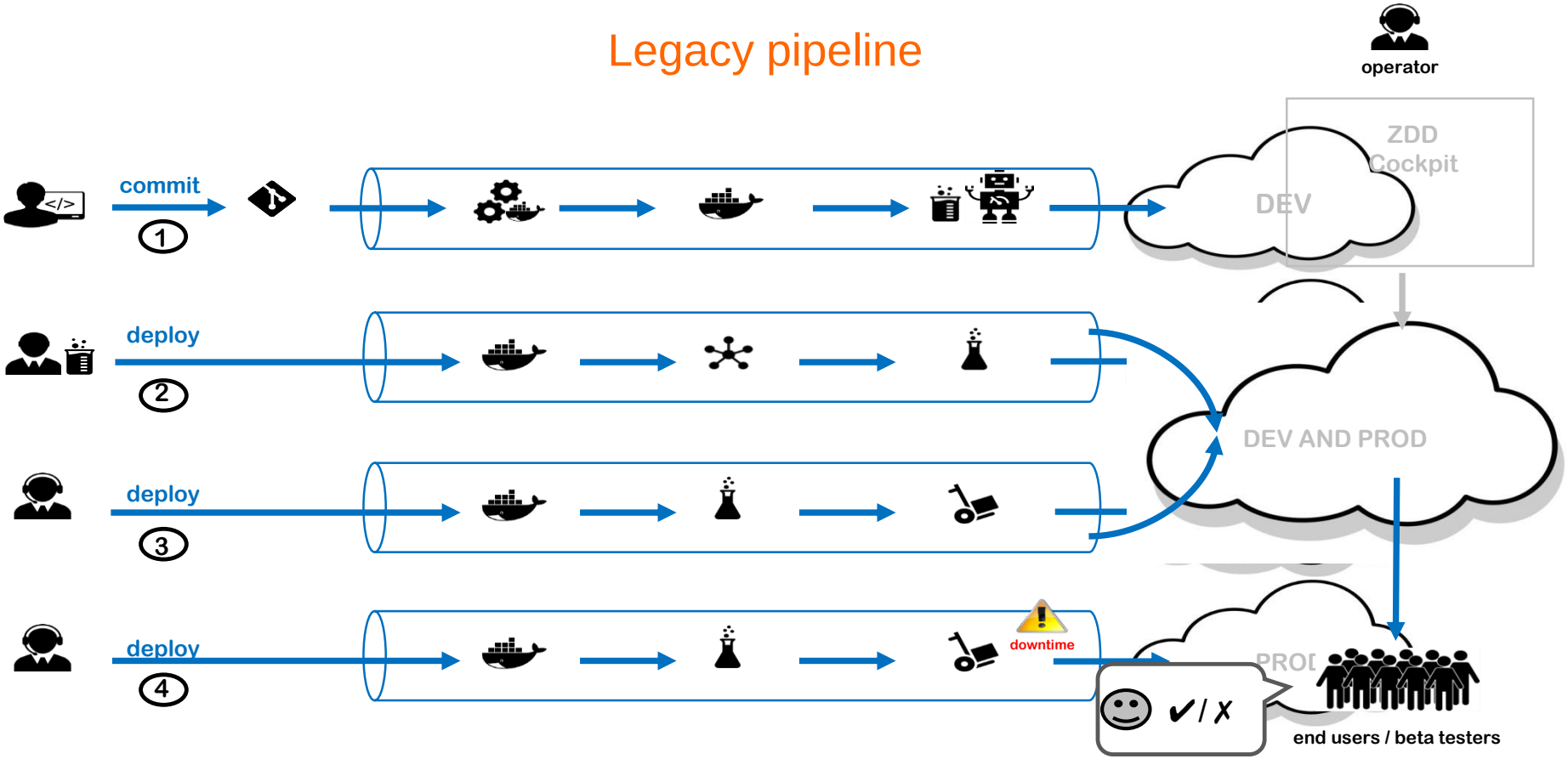
2 Define Process & Tools Cartography

)





Legacy pipeline



Impacts :

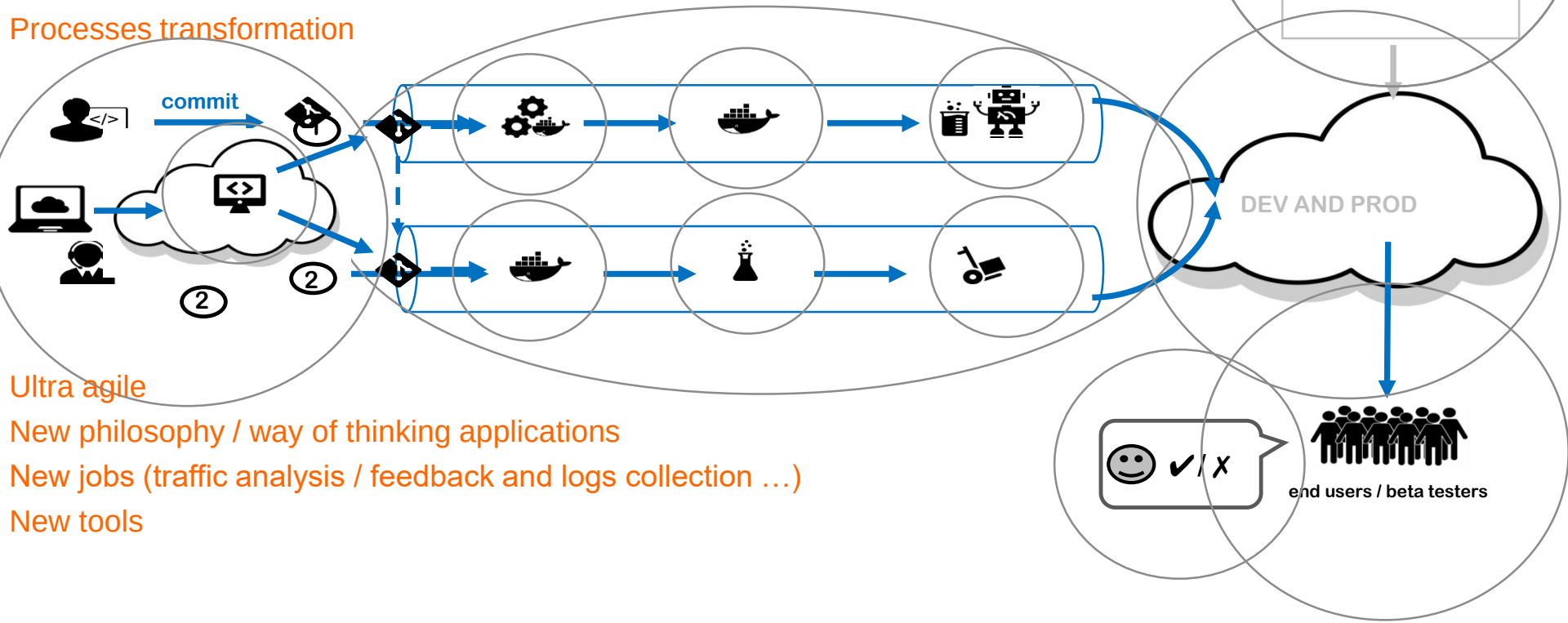
ZDD pipeline

Increase user experience

Infrastructure related cost reduction

High Time To Market reduction

Processes transformation



Ultra agile

New philosophy / way of thinking applications

New jobs (traffic analysis / feedback and logs collection …)

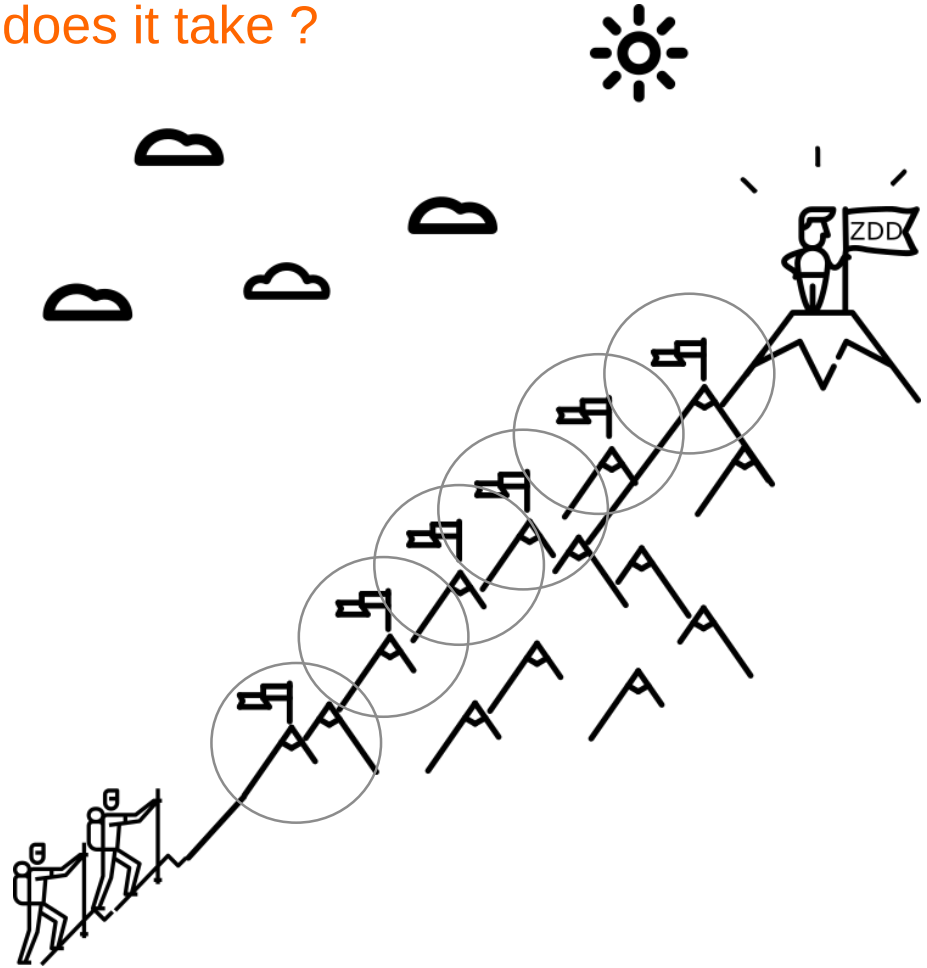
New tools

How much does it take ?

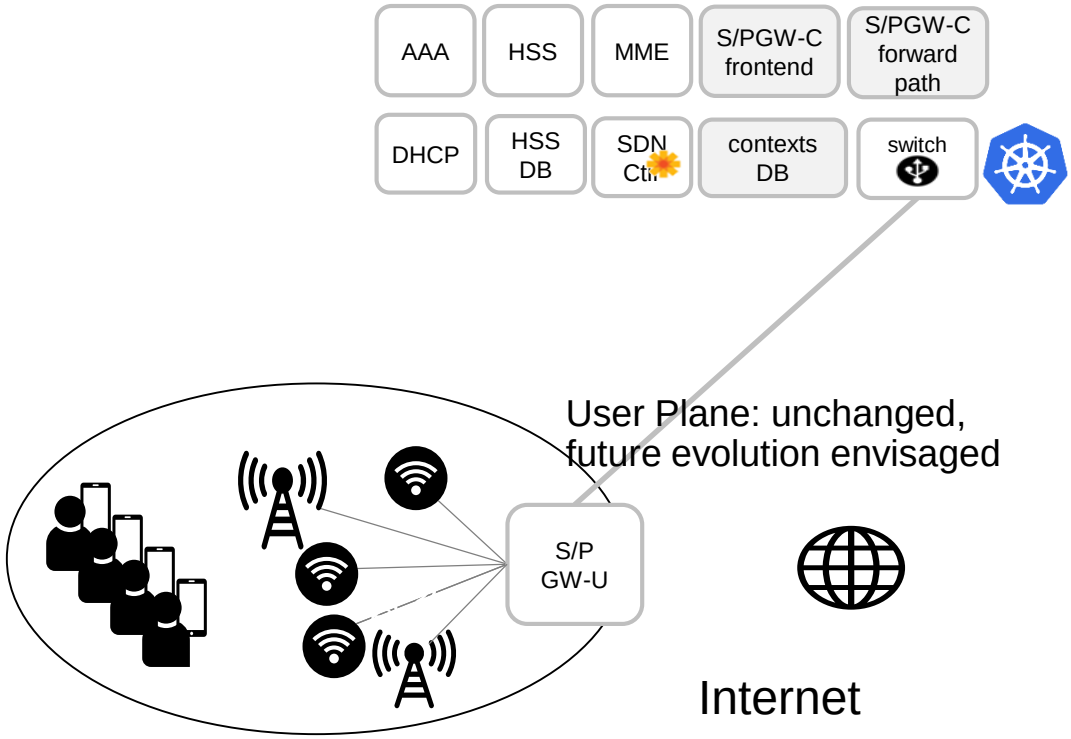
Enablers to reach ZDD :

- Docker containers
- Orchestration (**Rancher, Swarm, Kubernetes…) // PaaS**
- Chain automation (CI / CD)
- DevOps oriented
- Micro-services
- Stateless components

-> ZDD-native application



UGW release 3 : micro-services based



Control plane:

- a set of docker containers running in Kubernetes pods
- orchestrated as micro-services

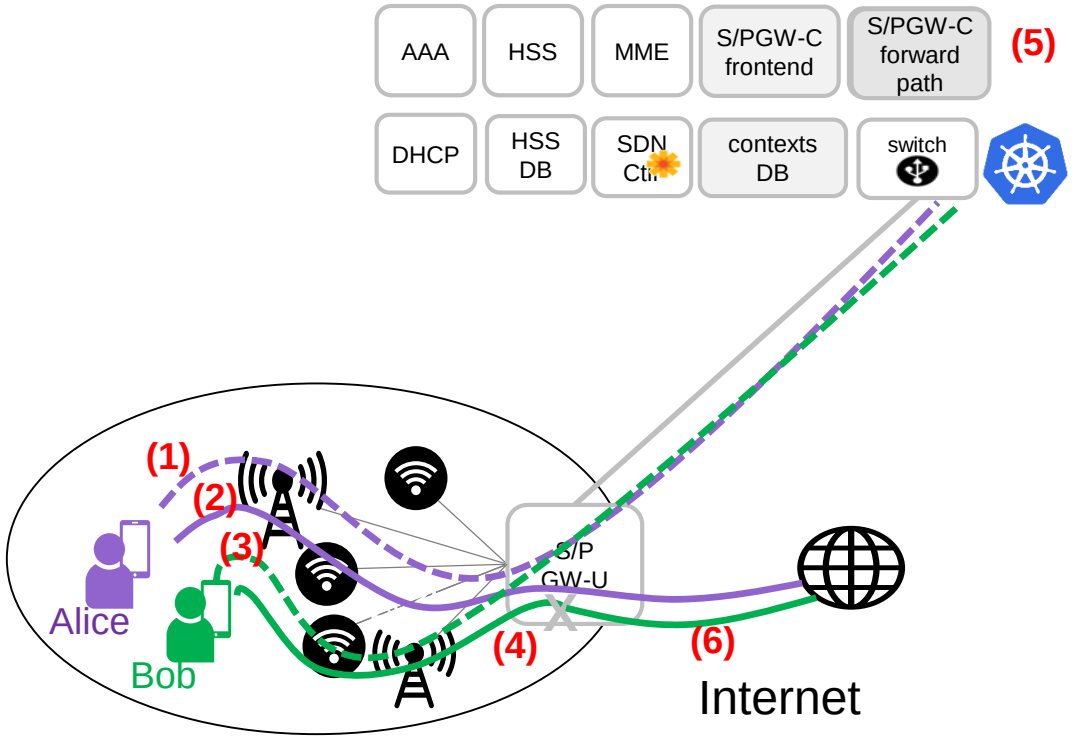
Initial focus on S/P-GW-C decomposition:

- stateless funtions: front-end, forward-path
- contexts DB

b com

orange™

ZDD - WEF



(1) Alice attach via Core control network (control plane signaling)

(2) Alice trafic routed toward Internet (user plane forwarding)

(3) Bob attach via Core control network

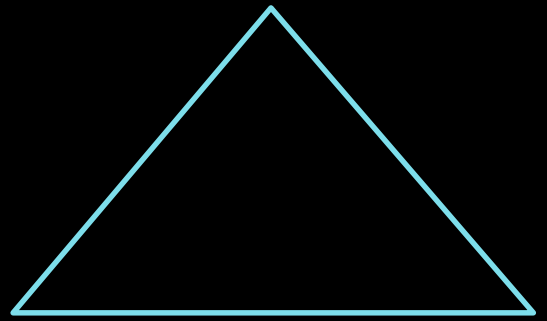
(4) S/PGW-C forward path function issue: forwarding path rules are wrong due to a bug in SPGW-C id management
Thus, Bob trafic cannot be routed
Alice traffic is not impacted

(5) S/PGW-C bug isolated and corrected
The new forward path pod is deployed to replace the previous version one's (ZDD)

(6) Bob user traffic is now routed thanks to the new rules updated by the S/PGW-C foward path pod

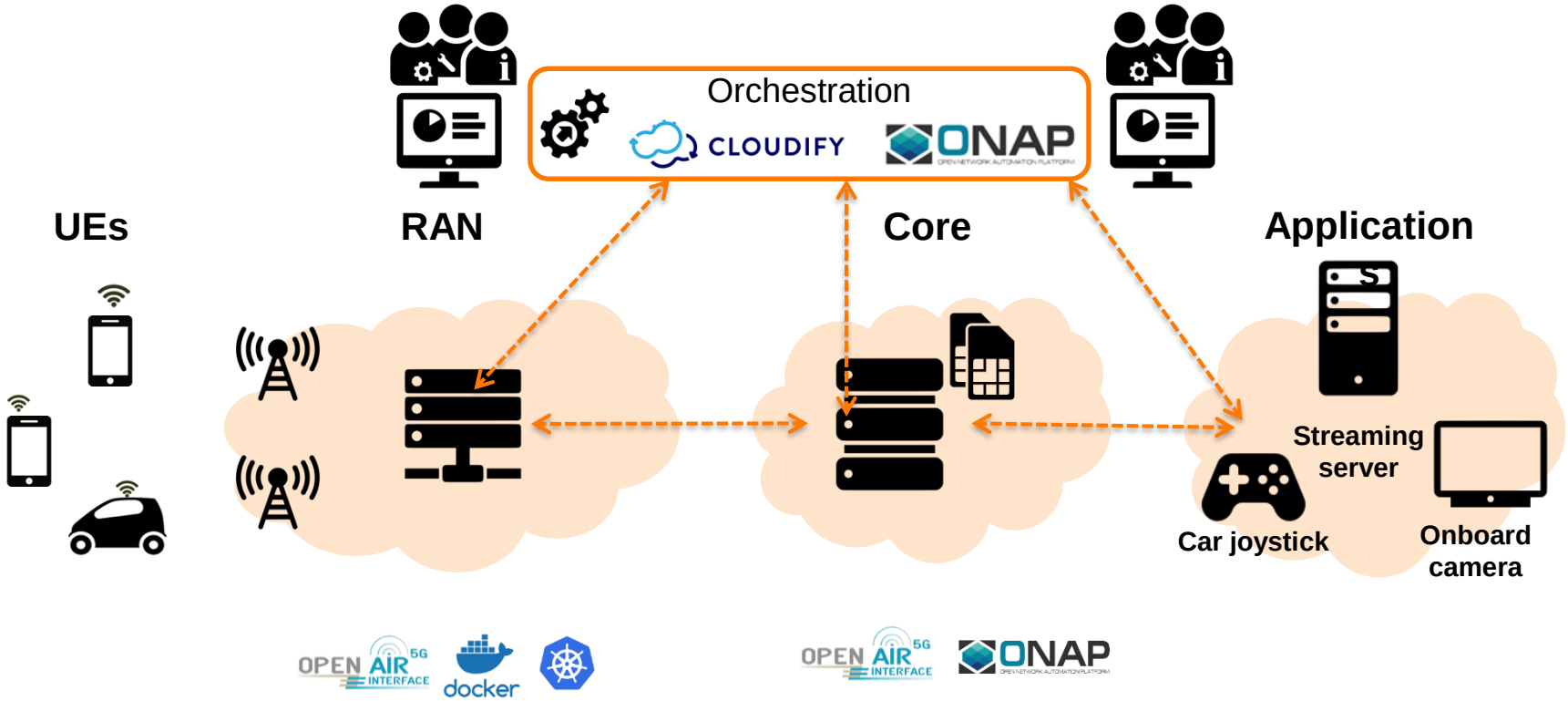
Plug'in

5G End-to-End Open-Source Network



5G End to End Open-Source Mobile Network

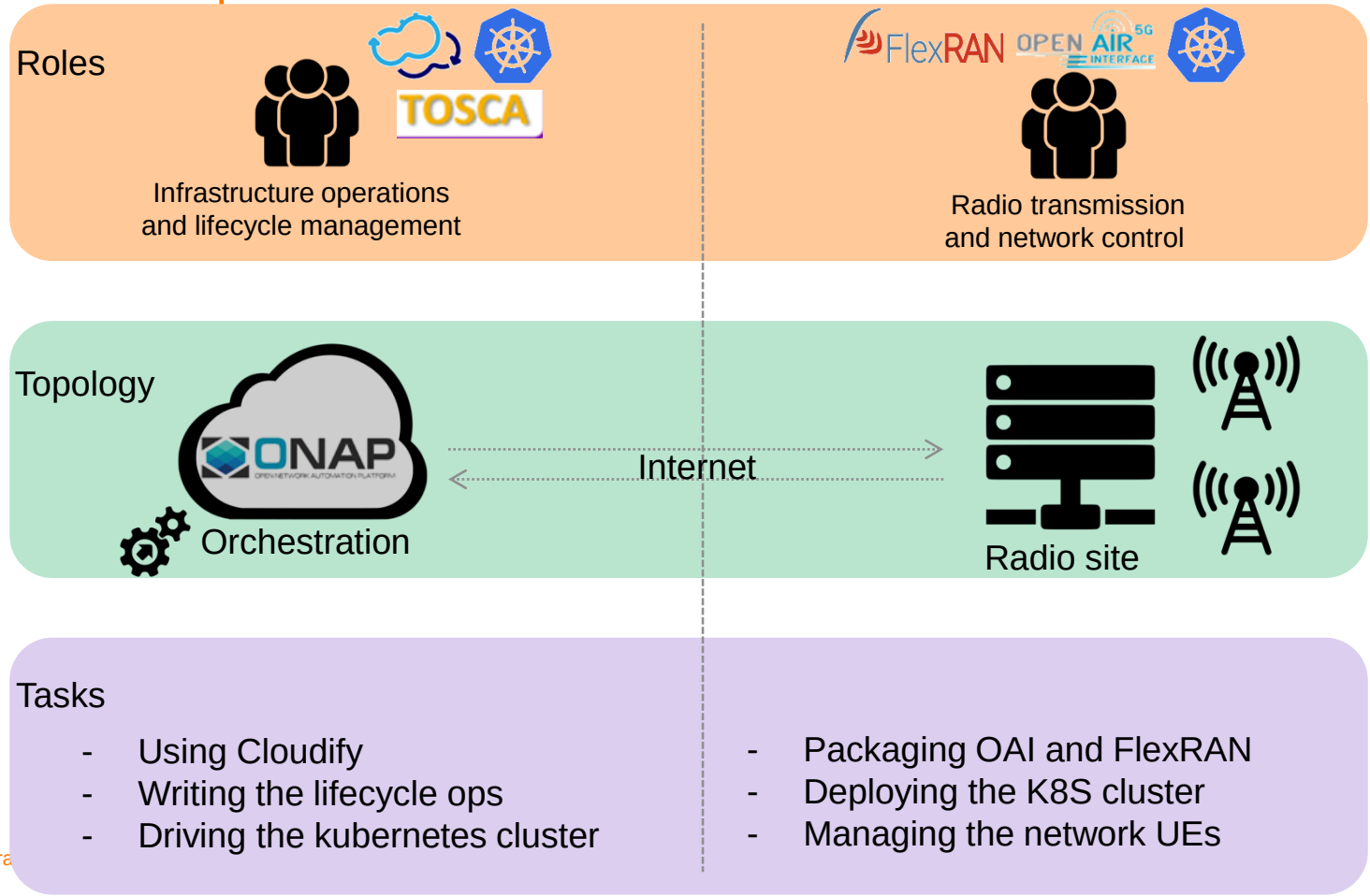
Plug'in



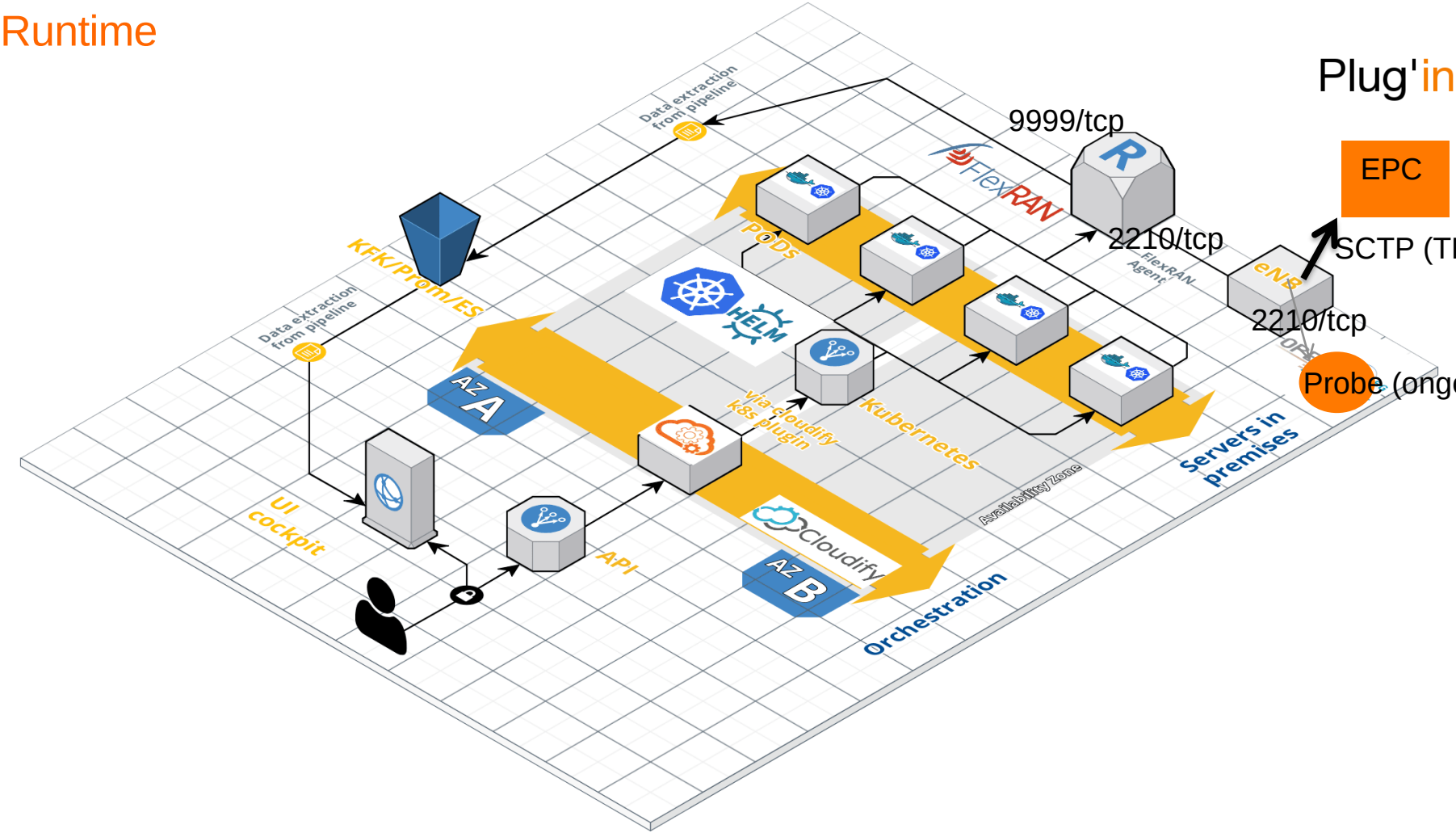
* UE: User Equipment – RAN: Radio Access Network

5G End to End Open-Source Mobile Network

Plug'in

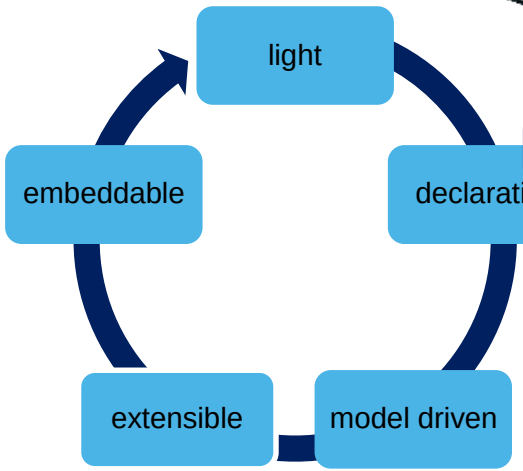


Runtime


Plug'in
EPC
SCTP (TBD)
9999/tcp
2210/tcp
2210/tcp
Probe (ongoing
FlexRAN
FlexRAN Agent
eNB
R
PODs
HELM
Kubernetes
via cloudify k8s plugin
Cloudify
Orchestration
AZ A
AZ B
Availability Zone
Servers in premises
KFK/Prom/ES
Data extraction from pipeline
Data extraction from pipeline
UI cockpit
API

Cloudify: Lightweight Orchestration

Plug'in



CLOUDIFY

OASIS TOSCA

Thank you