



5G-DIVE

EDGE INTELLIGENCE FOR VERTICAL
EXPERIMENTATION

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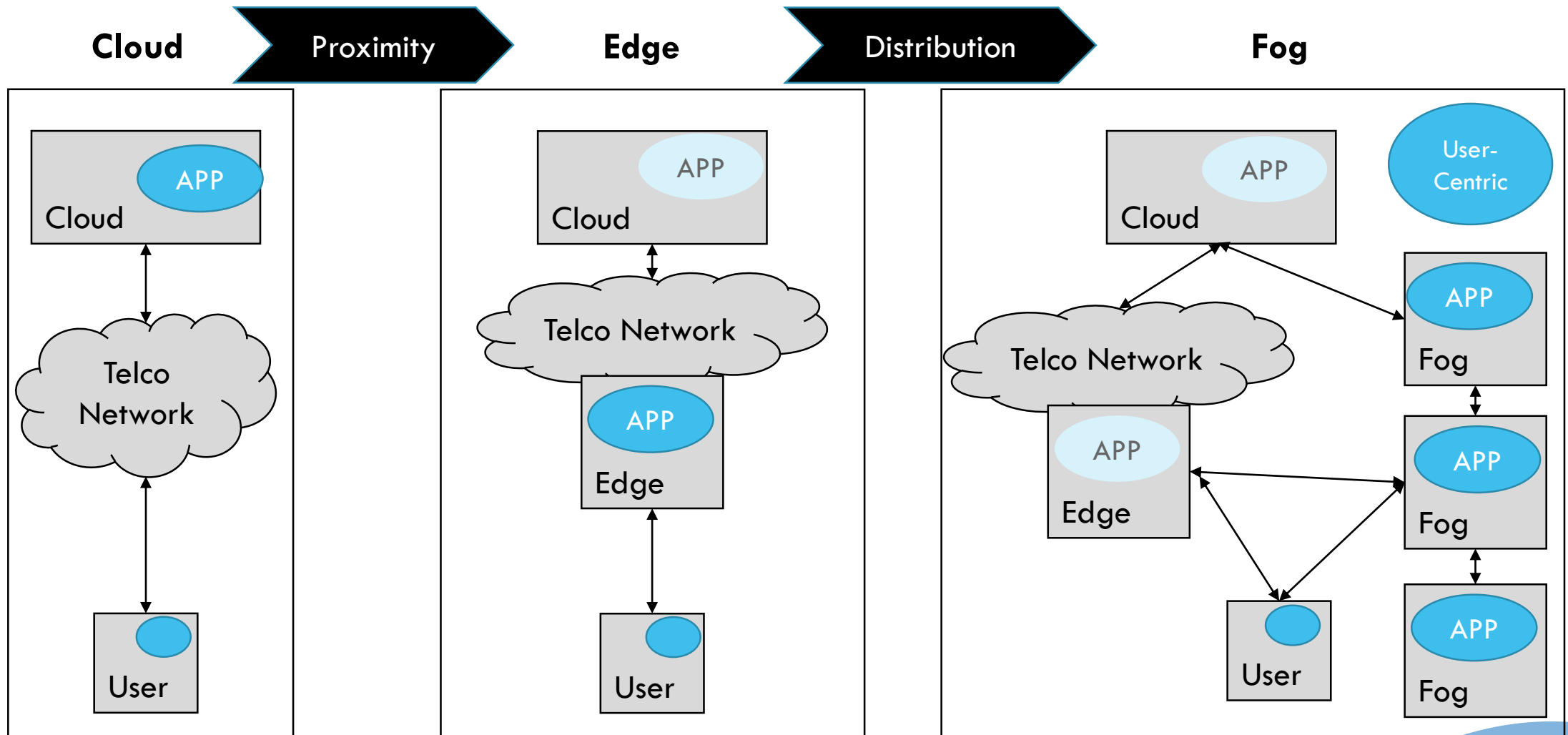
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Project Overview

5G-DIVE Project expects to have major impacts on:

1. Validating 5G technologies, focusing on 5G connectivity including 5G New Radio, Crosshaul transport and Core
2. Validating the virtualized edge and fog computing including control, management and orchestration of 5G resources
3. Designing and validating the 5G-DIVE solution in real-life testbeds demonstrating it (hardware, software and spectrum) in Europe and Taiwan
4. Deployment trials of the targeted vertical use cases

Introduction – The Cloud, Edge and Fog



Introduction – The Fog at the Extreme Edge

- Fog is **Logical** and refers to an overall **distributed** system
- Fog is composed of physically distributed **Fog nodes**
- A Fog node shall be “**connected**”
- Fog includes Edge and goes to the **Extreme Edge** closer to/including user terminals
 - Examples of Fog nodes at the extreme edge are UEs and CPEs: smartphones, vehicles, robots, drones, set-top-boxes, TV units, cameras, VR/AR units, access points, etc
- At the Extreme Edge, a fog node may be:
 - **Volatile** i.e. appear/disappear intermittently
 - **Mobile** i.e. on the move
 - **Constrained** i.e. limited capability (computing, storage, networking)
 - **Heterogeneous** i.e. different features and interfaces
 - Belong to **different owners** (not exclusively telco operators)

Key Potential Benefits

Lower latency, higher efficiency, pooling gains, lower cost, flexibility, scalability

- **Maximize the utilization** of all computing, networking and storage resources available locally in the RAN thanks to virtualization, abstraction and pooling
- **Promote cooperative** on-demand networking and computing
- **Lower deployment cost and time** thanks to the densification of constrained Fog devices and automated orchestration and control
- **Improve flexibility** in support of different topologies and **ease scalability** (up and down) through pluggable/detachable Fog nodes
- **Open the value chain** for more stakeholders including end users to participate in the solution as providers (towards incentives)
- **Relax dependencies** on sophisticated infrastructures (e.g. in out-of-coverage) leveraging local networks and resources

Artificial Intelligence / Machine Learning

- AI will bring smart automation and (almost) zero touch configurations into computer networks
 - Instead of programming step-by-step instructions, you express what you want to achieve!
- Analyse and mining a big amount of data in order to infer valuable and enhanced knowledge from it
 - Forecasting / prediction of events
 - Finding hidden patterns
 - Detect anomalies and security breaches
 - Detect and identify objects
- Learn behaviours by trial and error



Key Potential Benefits

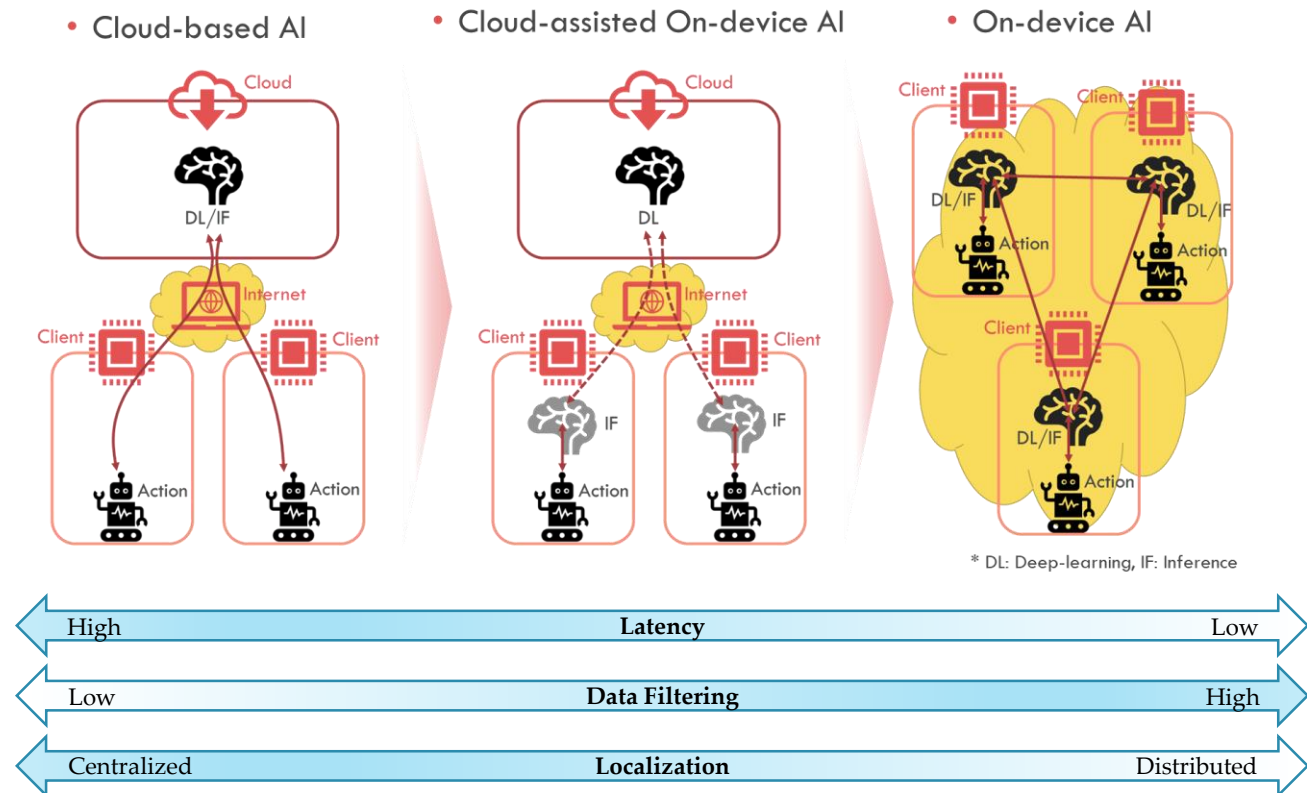
Smarter decisions, more automation, improved efficiency, dynamic adaptation, event prediction and forecasting

- **Minimize the need for human intervention** and **maximize automation** by enabling entities can take decisions by themselves
- Make **smarter decisions** by leveraging a huge amount of information from different entities
- Enable **event prediction and forecasting**, a key aspect to trigger preventive measures that could avoid downtime of the network services
- **Improve the efficiency** of computer networks by making an optimal usage of available resources at each moment in time
- **Ease scalability** (up and down) through a **dynamic adaptation** of network services to face (unexpected) networking and computing demands
- **Lower operational cost and time** thanks to the automation of procedures

Project Vision

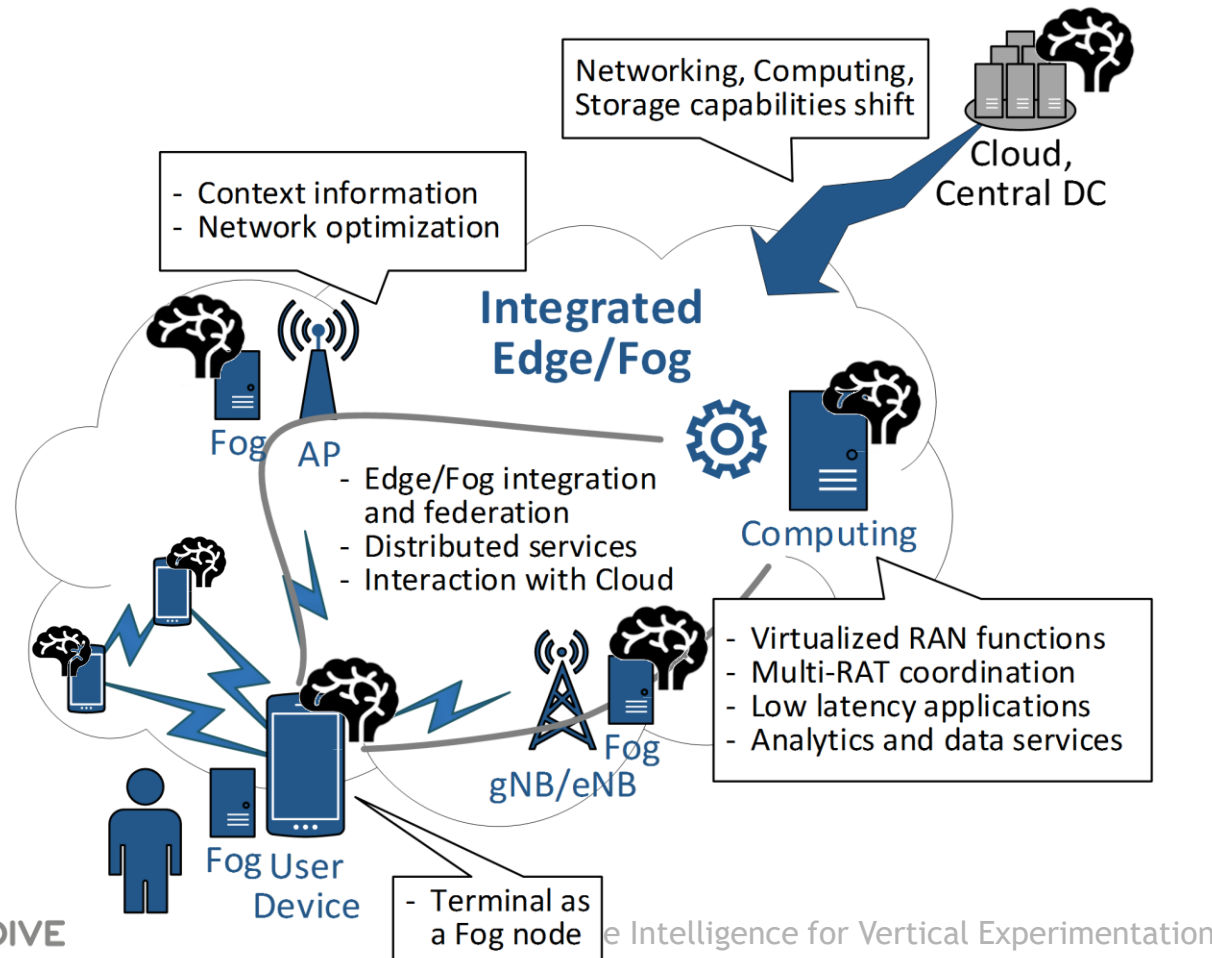
The computing fabric is no longer only centralized in the cloud but also pervasively distributed through the Edge and Fog, opening new possibilities to the integration of intelligence located closely to the user.

- There is a diverse set of terminal types which all have computing capabilities ready to be harvesting
- Edge and Fog are complementary, and jointly together will define the computing substrate of next generation radio access networks
- Distributing AI towards edge and fog devices will allow more tuned automation and dynamic adaptation



Project Mission

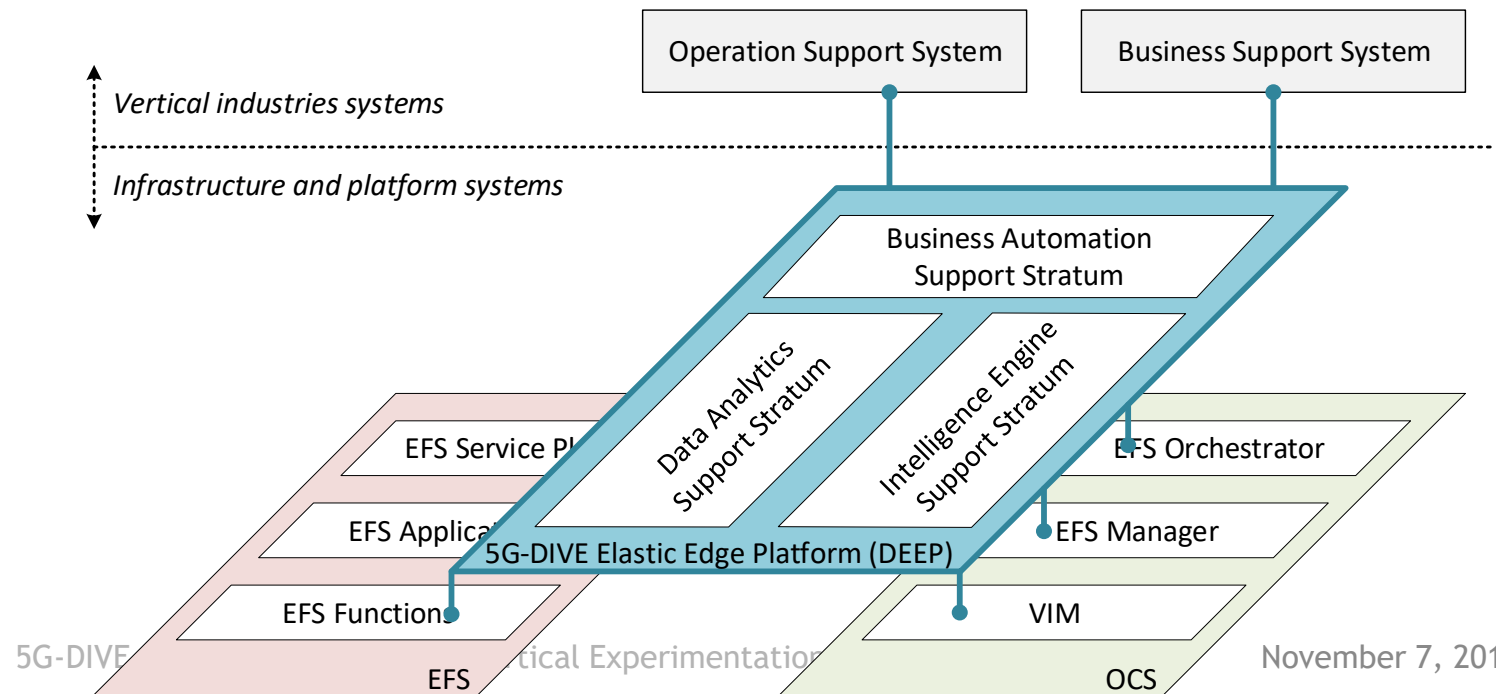
Targets end-to-end 5G trials aimed at proving the technical merits and business value proposition of 5G technologies



Mission: Design, validate and verify an intelligent 5G solution that integrates 5G connectivity with edge and fog computing (and intelligence residing on this new distributed edge)

Solution Building Blocks

- (1) EFS: hosting all proposed virtualized functions, services, and applications
- (2) OCS: managing and controlling the EFS, and its interworking with other domains
- (3) DEEP: supporting vertical industries in day-by-day operations, management, and automation of businesses processes on-top of an edge and fog infrastructure.



DEEP – 5G-DIVE Elastic Edge Platform

- Leverage automation and intelligence capabilities by:
 - Provide support for a data analytics platform suitable for distributed and heterogeneous edge and fog environment
 - Provide support for an intelligence engine platform encompassing heterogeneous resources including terminal devices
 - Provide support to the vertical industries to achieve the automation of their business processes by allowing to plug their OSS/BSS systems in the platform.

Vertical Pilots – Industry 4.0

Digital Twin Apps

- Provides a virtual replica of a robot or of a part of a production line.
- The 5G network coverage will be deployed to enable real-time visibility and remote insights into robot status and performance without having to directly operate on the physical machine.
- Requires eMBB and URLLC for the on-time delivery of the information of the sensors to the virtual twin and for the interaction with the digital model.
- Facilitates assessing the concepts of remote control, monitoring for preventive maintenance, and safety.

Real Time Video Analysis for Zero Defect Manufacturing

- Explores the capabilities of Fog/MEC/Cloud multi-tier Edge to address this local processing and visualization of geometric features for manufactured parts.
- Deploys in the Fog devices (e.g., video cameras), algorithms able to detect characteristic patterns for defects in the production.
- Requires eMBB for the interaction with the platform for reinforced learning and URLLC for processing of results in the Fog devices.
- ZDM techniques may potentially reduce scrap by 100%, and predict form and/or welding errors.

Vertical Pilots – Autonomous Drone Scout

Drone Fleet Navigation

- Improves current Drone product portfolio, enabling a better piloting of the Drone swarm.
 - Providing intelligence in the Drones
- Requires **eMBB** and **URLLC** for the on-time delivery of the information of the sensors to the edge data centre for drone interaction.
- Enables new Drone-based services:
 - delivery, inspection and monitoring, scouting, Aerial Imaging, and precision agriculture on large scale.

Intelligent processing of images in the Drones

- Enables the deployment of intelligent functions in the Drones and its cooperation with the different tiers of the 5G-DIVE platform.
- Requires **eMBB** and **URLLC** for the on-time delivery of the information of the Drone.
- More automation in the scouting processes, creating a new value chain of services which can be used to provide more services to the customers.

Plans for international collaboration

- 5G-DIVE is a joint project between different partners from both EU and Taiwan
 - Design and implementation of the solution
 - Integration and deployment of trials in real-life testbeds in Europe and Taiwan
- Open to new collaboration opportunities with partners from other geographical regions
 - Enhancement of current trials and use cases with novel and/or alternative software
 - Integration and validation of different vertical industries
 - Exploitation of other testbeds to validate the trials

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