ONOFRE-3: On-Demand Provisioning of Network and Computing Resources from the Cloud to the Edge

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5G, and especially future networks (6G), introduce as defining features new massive latency-constrained service classes, cell-less architectures with multiaccess coordination and machine learning (ML)-based network intelligence, all of it supported by Multiaccess Edge Computing (MEC). Convergent networks work as their backhaul and meet their stringent requirements with Network Function Virtualization (NFV) techniques, MEC and Management and Orchestration (MANO), Software-Defined Networking (SDN), framing a solution able to manage and orchestrate the complete lifecycle of future services. Computation services can be instantiated in such virtualized infrastructures, enabling the possibility of offloading tasks from mobile nodes but requiring the design of frameworks to control and manage networks interconnecting cloud and MEC servers. The cell-less architecture is implemented by the coordinated use of multiple RAT with support from the MEC servers.

To realize this architecture, it is necessary to overcome the heterogeneity of the edge, fog, and cloud processing layers and proper management of dynamic quality of service (QoS) application requirements running on mobile nodes. To overcome this complexity, AI and Machine Learning techniques for contextual information prediction and network management is the trend. AI/ML can also support both offline planning methods and multiaccess coordination and control and be deployed at end devices. In this scenario, security is also mandatory from the start, with advanced cloud data privacy and security techniques, which must be smoothly managed and controlled across different cloud computing domains. Finally, practical evaluation of these mechanisms needs a realistic application scenario with clear requirements. Cooperative and Connected Autonomous Mobility (CCAM) and Cooperative Intelligent Transportation Systems (C-ITS) verticals provide such clearly defined and demanding QoS requirements and serve as reference area to analyse and develop concrete and meaningful benchmarks in a massive latency-bounded slice.

In this line, the ONOFRE-3 proposal, which is a national project awarded by the Spanish government in which UPCT participates as coordinator, studies and tests novel mechanisms at all the involved stages: offline network planning, online provisioning and management, multiple radio access and end devices. We propose to use intelligent orchestration of cloud, fog, and edge computing for CCAM and C-ITS, over a secured framework and supported by AI/ML techniques.

ONOFRE-3 bets on a platform to provide services in a cloud continuum environment as shown in Figure 1. In this architecture, the main parts of the system are identified, i.e., offline/online planning of resources on the basis of application needs; resource orchestration via NFV-supportive technologies; and monitoring of QoS for near and long-term allocation of resources. Note the cross-domain security perspective and the end-device to far-cloud continuum, linked with a double-purpose access network in the form of a simulation platform and a real 5G testbed, to be used for evaluation.

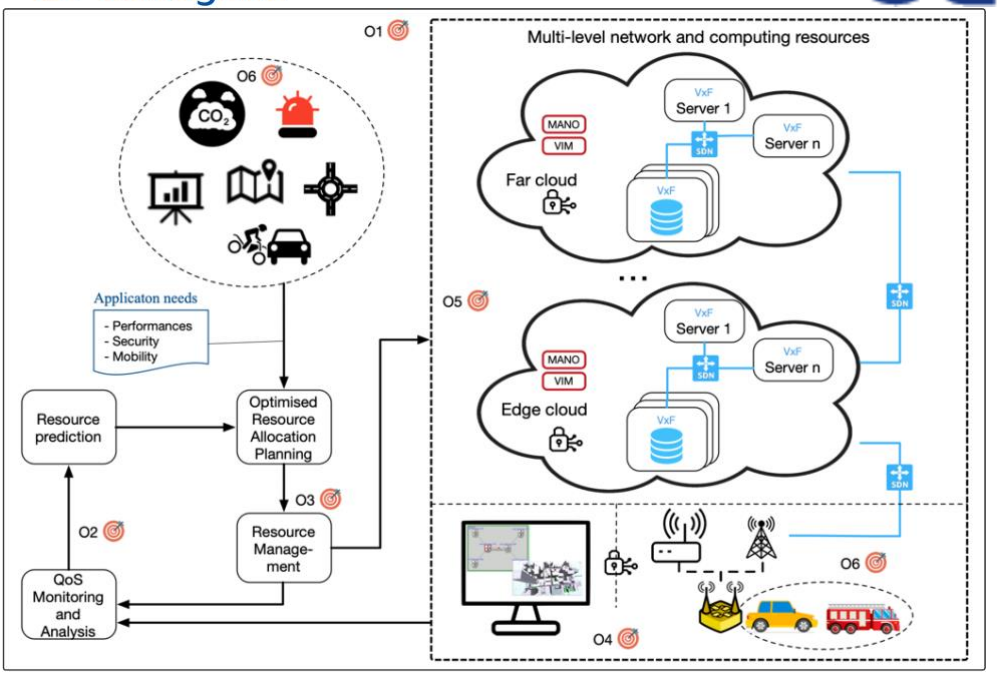

Figure 1 Overall architecture of ONOFRE-3

The UPCT work is focused on the optimization of the next generation multi-RAT operation for C-ITS, with the assistance of MEC; and the development of optimal planning algorithms coupled to the provisioning and orchestration techniques of the platform. In addition, a real on-board unit (OBU) prototype with multi-RAT capabilities adapted to urban mobility scenarios will be developed as the basis for experimental evaluation. The current Veneris simulator [1] is being extended with cooperative driving models and the planning tool Net2Plan [2] is being integrated in the SDN operational platform. AI/ML techniques are being applied to vehicle data generated from the simulator to predict C-ITS/CCAM context information.

References:

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