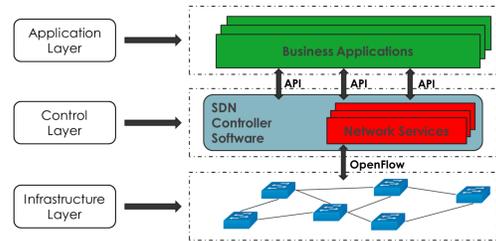


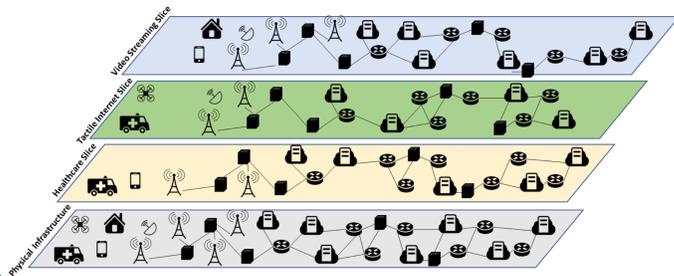
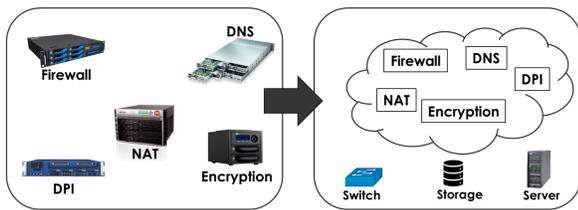
RESEARCH TOPIC

The research activity was mainly focused on 5G networks. It will represent an architectural revolution as compared to previous technologies, thanks to the increasingly use of cloud-based networking paradigms like **Software Defined Network (SDN)** and **Network Function Virtualization (NFV)**.



SDN allows to decouple the control plane from the data plane, using a protocol that modifies forwarding tables in network switches, shifting network intelligence to a centralized SDN Controller.

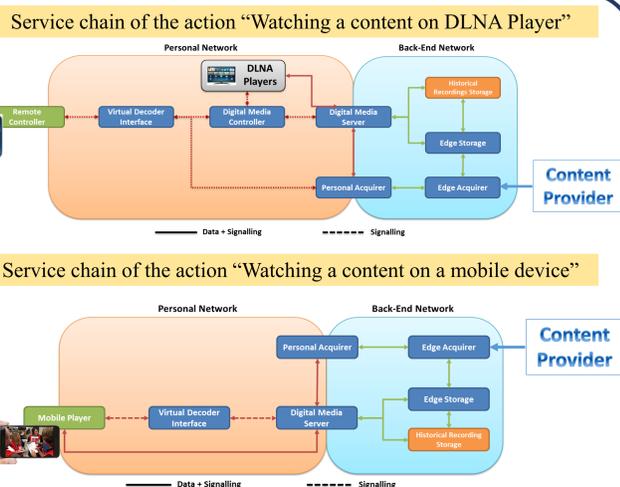
NFV technology is used to transform network functions to software applications, so Telco Operators can migrate functions based on particular optimization policies or launch more network functions without the problem of having to install new hardware.



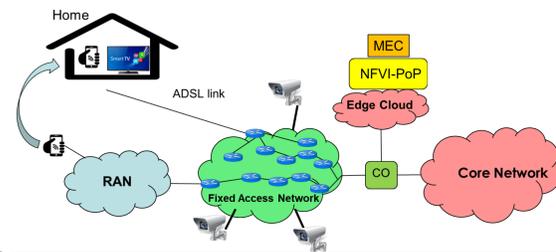
A key feature of 5G is **network slicing** that consists in the creation of a dedicated virtual network architecture with the aim of providing specific functionalities for certain services sharing the same resources of the real available physical network.

INPUT project

INPUT was an H2020 EU project. It developed Open Volcano, a **Multi-Access Edge Computing (MEC)** platform based on SDN and NFV, to provide users with a personal network service. A use case of the INPUT project was the **virtual Set-Top Box (vSTB)**, a virtualization of a smart device (SD) running on the edge of the network, which is able to follow the user when he is in mobility.



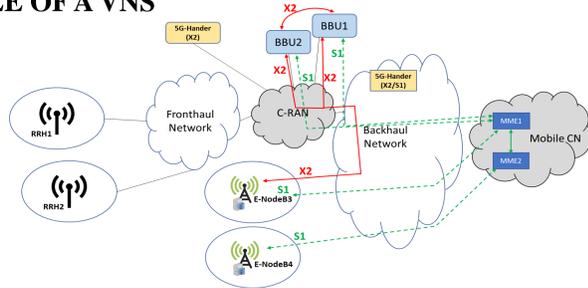
DiMoViS project



DiMoViS is an experiment activity on the **TRIANGLE Project**. It reproduces a small Proof of Concept (PoC) of a bigger capillary video surveillance platform over a 5G network infrastructure with a huge number of IP cameras.

5G-HANDER: AN EXAMPLE OF A VNS

5G-Handover Detector (5G-Hander) is a virtual network service constituted by a chain of two virtual network functions: a handover sniffer and a broker. It is aimed at capturing autonomously information relating to the handover events in the RAN where it is running



BLOCKCHAIN AND 5G

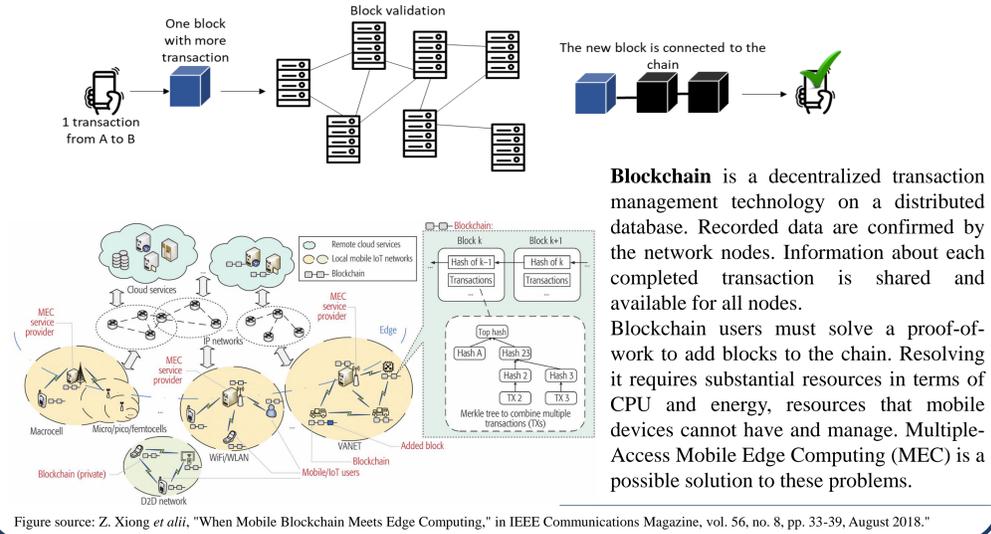
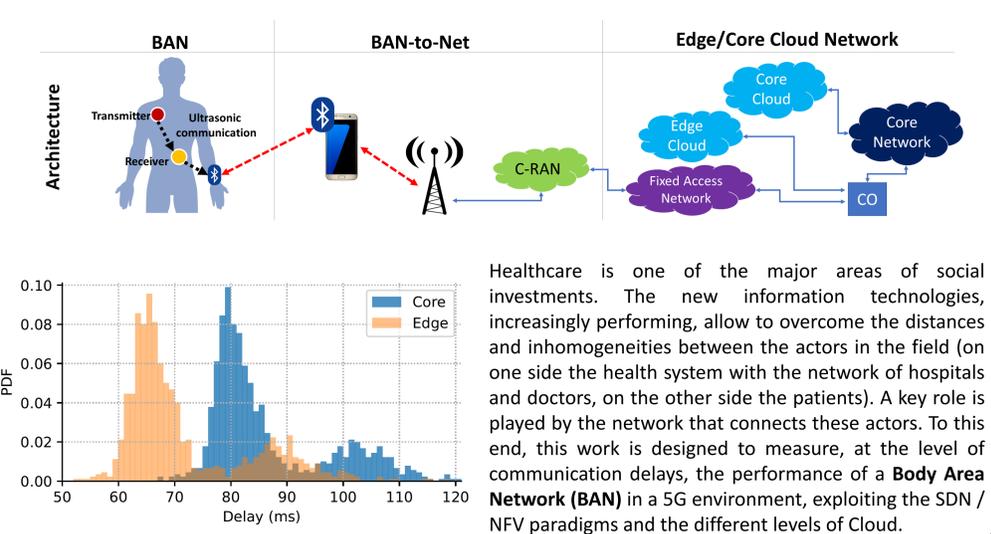


Figure source: Z. Xiong et alii, "When Mobile Blockchain Meets Edge Computing," in IEEE Communications Magazine, vol. 56, no. 8, pp. 33-39, August 2018.

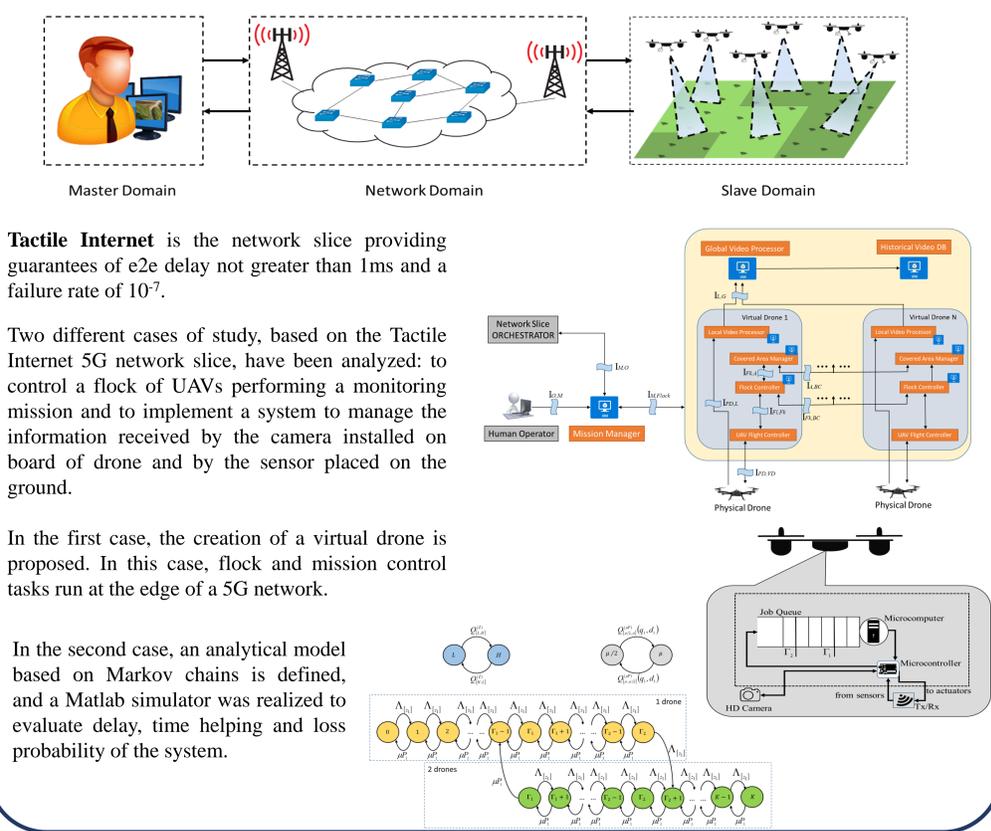
Blockchain is a decentralized transaction management technology on a distributed database. Recorded data are confirmed by the network nodes. Information about each completed transaction is shared and available for all nodes. Blockchain users must solve a proof-of-work to add blocks to the chain. Resolving it requires substantial resources in terms of CPU and energy, resources that mobile devices cannot have and manage. Multiple-Access Mobile Edge Computing (MEC) is a possible solution to these problems.

BODY AREA NETWORK (BAN): AN APPLICATION FOR SMART-HEALTH



Healthcare is one of the major areas of social investments. The new information technologies, increasingly performing, allow to overcome the distances and inhomogeneities between the actors in the field (on one side the health system with the network of hospitals and doctors, on the other side the patients). A key role is played by the network that connects these actors. To this end, this work is designed to measure, at the level of communication delays, the performance of a **Body Area Network (BAN)** in a 5G environment, exploiting the SDN / NFV paradigms and the different levels of Cloud.

UAV FOR TACTILE INTERNET AND SECURITY APPLICATIONS



Tactile Internet is the network slice providing guarantees of e2e delay not greater than 1ms and a failure rate of 10^{-7} .

Two different cases of study, based on the Tactile Internet 5G network slice, have been analyzed: to control a flock of UAVs performing a monitoring mission and to implement a system to manage the information received by the camera installed on board of drone and by the sensor placed on the ground.

In the first case, the creation of a virtual drone is proposed. In this case, flock and mission control tasks run at the edge of a 5G network.

In the second case, an analytical model based on Markov chains is defined, and a Matlab simulator was realized to evaluate delay, time helping and loss probability of the system.

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- C. Grasso and G. Schembra, "Design of a UAV-Based Videosurveillance System with Tactile Internet Constraints in a 5G Ecosystem," 2018 4th IEEE Conference on Network Softwareization and Workshops (NetSoft), Montreal, QC, Canada, 2018, pp. 449-455.
- F. D'Urso, C. Grasso, C. Santoro, F. F. Santoro and G. Schembra, "The Tactile Internet for the flight control of UAV flocks," 2018 4th IEEE Conference on Network Softwareization and Workshops (NetSoft), Montreal, QC, Canada, 2018, pp. 470-475.
- C. Grasso, R. Raftopoulos and G. Schembra, "The Triangle Platform for End-to-End Performance Analysis of a 5G Video Transmission Network Slice," 15th International Symposium on Wireless Communication Systems (ISWCS), Lisbon, Portugal, 2018.
- L. Galluccio, C. Grasso, S. Milardo, G. Schembra and E. Sciacca, "An Experimental Testbed for Managing BAN Services at the Network Edge," 14th International Conference on Network and Service Management (CNSM), Rome, Italy, 2018.
- C. Grasso and G. Schembra, "A fleet of UAVs to extend a 5G network slice for video monitoring with low-latency constraints", Submitted to MDPI Special Issue on Softwareization at the Network Edge for the Tactile Internet.