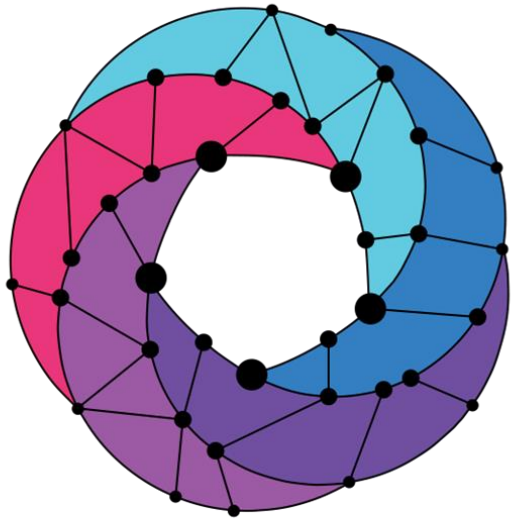

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Integration of 5G Experimentation Infrastructures into a Multi-Site NFV Ecosystem using OSM

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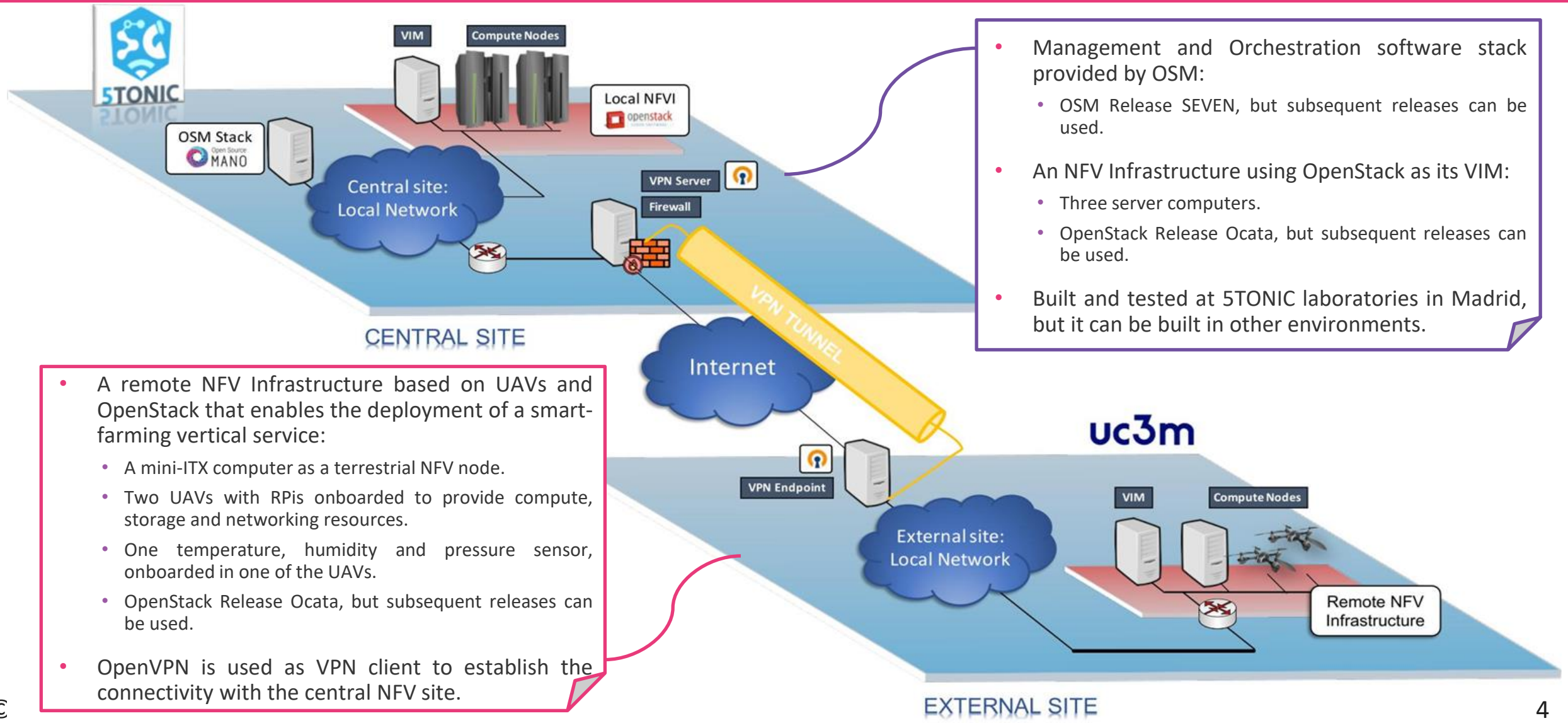
Key Takeaways

This Proof of Concept (PoC) demonstrates the feasibility of a protocol to integrate 5G experimentation and vertical infrastructures in a multi-site NFV ecosystem for the deployment of multi-site telecommunications and vertical services.

- OSM is intended to support the management and orchestration of network services on the NFV ecosystem. The VNFs composing those network services may be deployed at multiple geographically distributed sites.
- The PoC details the necessary steps to incorporate external sites into NFV ecosystems. This allows to flexibly increment the portfolio of compute, storage and networking resources, provided by external NFV sites, available in an experimentation ecosystem.
- An overlay network architecture based on VPN is used to allow (and manage) the data exchange between sites. This overlay is used for both MANO traffic, and data exchanged between VNFs in different sites.
- The validation of the effectiveness of the protocol to incorporate external NFV sites is performed through the deployment of a smart-farming vertical service, which involves an external site composed of multiple UAVs.
- The PoC is totally based on open-source technologies (i.e., OSM, OpenStack and OpenVPN).

PoC Platform



- Management and Orchestration software stack provided by OSM:
  - OSM Release SEVEN, but subsequent releases can be used.
- An NFV Infrastructure using OpenStack as its VIM:
  - Three server computers.
  - OpenStack Release Ocata, but subsequent releases can be used.
- Built and tested at 5TONIC laboratories in Madrid, but it can be built in other environments.

- A remote NFV Infrastructure based on UAVs and OpenStack that enables the deployment of a smart-farming vertical service:
  - A mini-ITX computer as a terrestrial NFV node.
  - Two UAVs with RPis onboarded to provide compute, storage and networking resources.
  - One temperature, humidity and pressure sensor, onboarded in one of the UAVs.
  - OpenStack Release Ocata, but subsequent releases can be used.
- OpenVPN is used as VPN client to establish the connectivity with the central NFV site.

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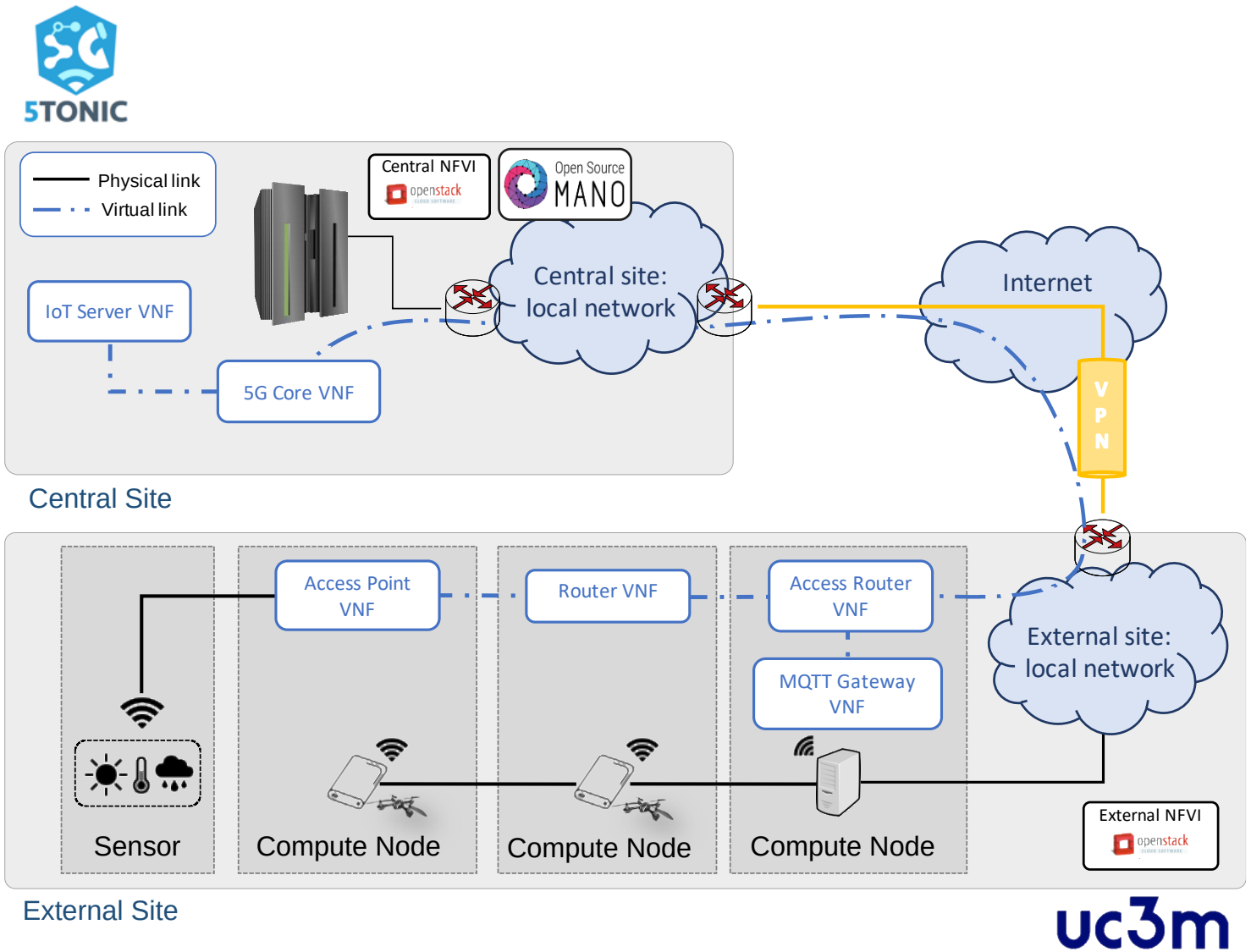
Smart Farming Network Service

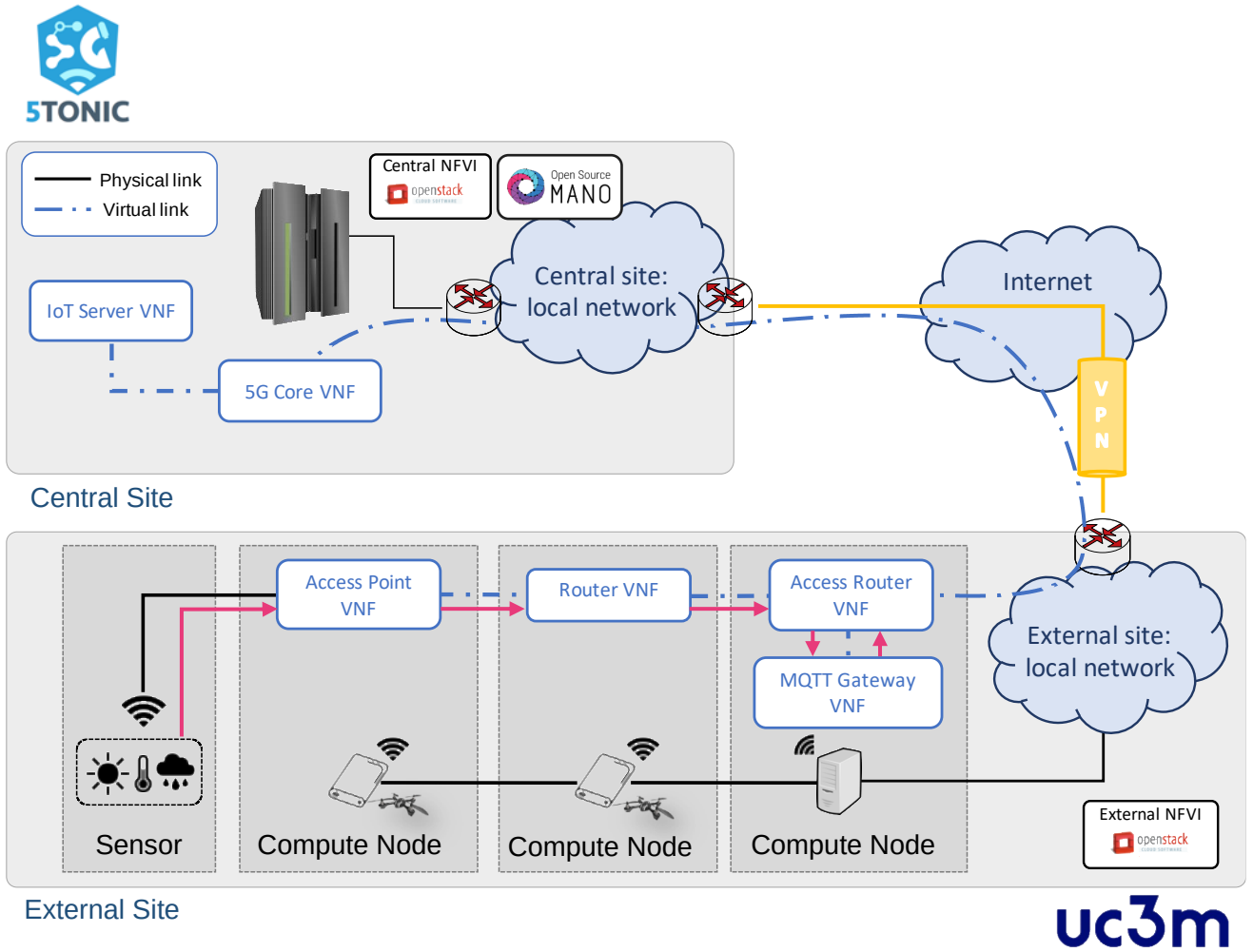
Network service to aid farming activities on a remote area by distributing temperature, humidity and pressure data into a database for monitoring.

All VNF images can be found in the public repository in UC3M [1].



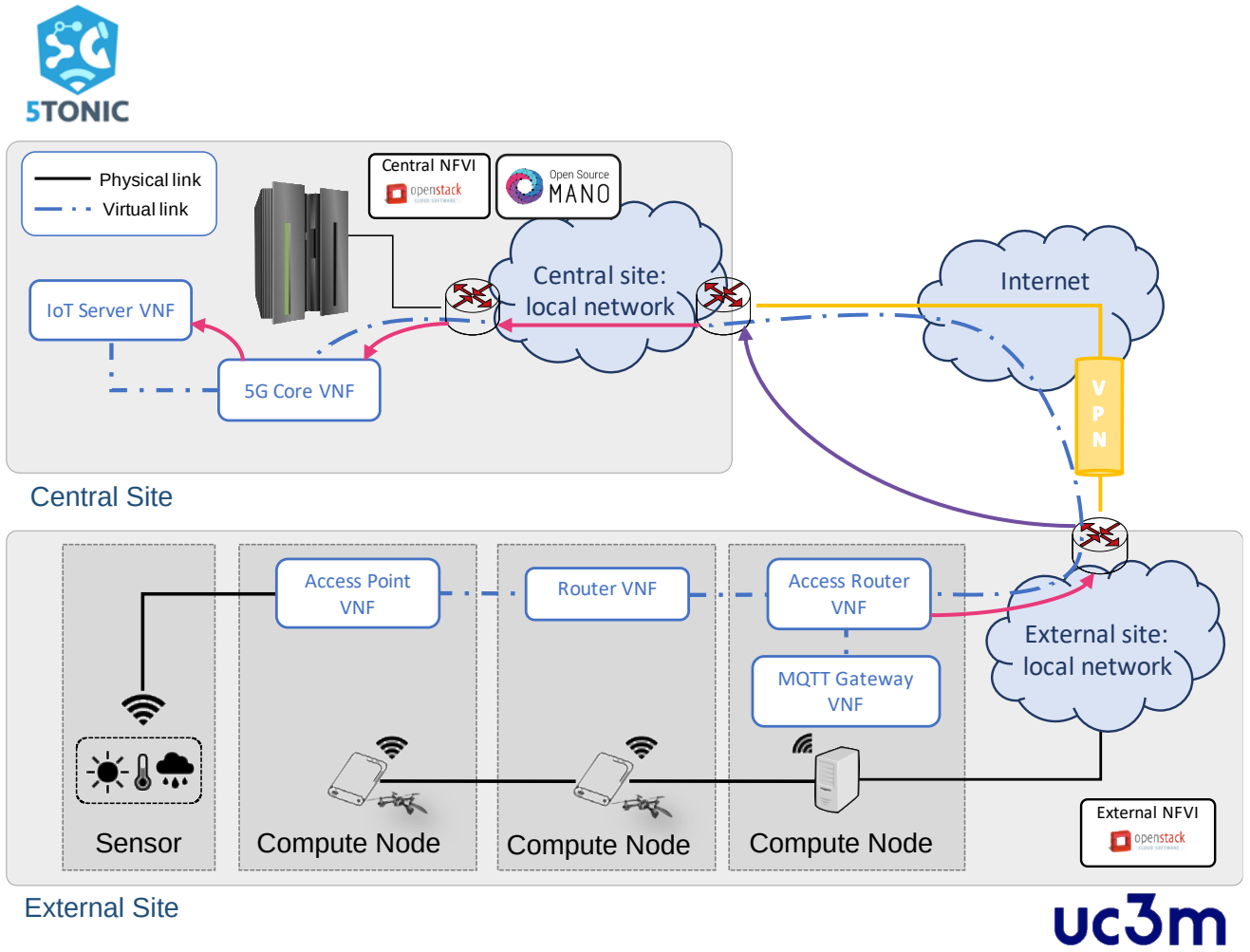
Smart Farming Network Service Elements

- **Sensor:** Single Board Computer (SBC) with a meteorological sensor attached. This SBC has also transceiver capacity to send sensor readings towards the Access Point VNF.
- **Access Point VNF**: provides a Wi-Fi access point to the sensor.
- **Router VNF**: supports the routing functionalities to enable the transmission of information generated from the sensor to the MQTT Gateway VNF.
- **MQTT Gateway VNF**: processes the data sent from the sensor through the MQTT Protocol [2], and later disseminates the data towards an IoT server VNF.



Smart Farming Network Service Elements

- **Access Router VNF**: implements the user-plane protocol stack defined by 3GPP for non-3GPP accesses [3-4]. It supports network routing functionalities between the external NFV site and the central site through a VPN service.
- **5G Core VNF**: implements the user-plane control stack defined by the 3GPP. It supports the network routing functionalities within the central site.
- **IoT Server VNF**: based on Mainflux, it stores the sensed data received from the remote site.



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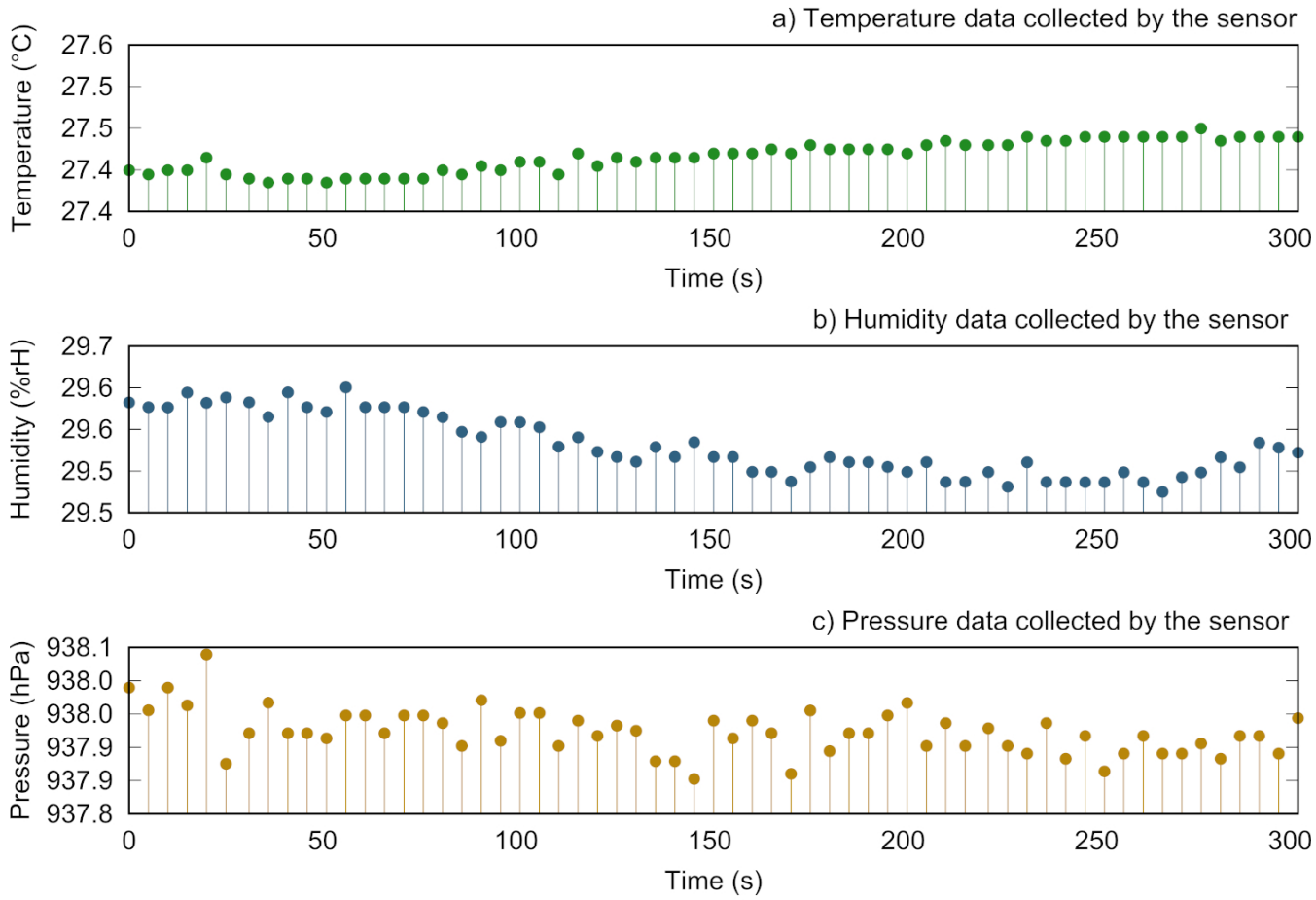
Sensor Data Representation

Data collected from a sensor deployed in a remote infrastructure.

These measurements were extracted from the IoT server VNF located in the central site at 5TONIC.



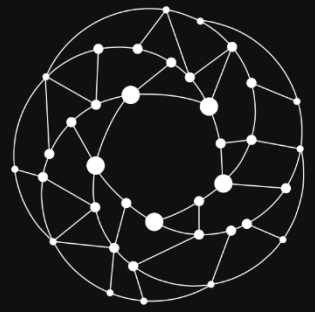
References

[1] *Public Experiment Repository*. Available from: http://vm-images.netcom.it.uc3m.es/JoVE_2020/ (2022).

[2] OASIS. ISO/IEC 20922:2016 Information technology – MQ Telemetry Transport (MQTT) v3.1.1. *International Organization for Standardisation*. (2016)

[3] 3GPP TS 23.501, "System Architecture for the 5G System; Stage 2, version 16.3.0," 3rd Generation Partnership Project, 3GPP, Technical Specification Group Services and System Aspects, 2019.

[4] 3GPP TS 23.502, "Procedures for the 5G System; Stage 2 version 16.2.0," 3rd Generation Partnership Project, 3GPP, Technical Specification Group Services and System Aspects, 2019.



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Scanning the following QR code will redirect you to our JOVE paper. This paper includes details to facilitate the reproducibility of the experiment, including a demo video:

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