

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

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Materials

Name	Company	Catalog Number	Comments
Bebop 2	Parrot		UAV used in the experiment to transport the RPis and thus, provide mobility to the compute units of external site.
BME280 Sensor	Bosch		Sensor capable of providing readings of the environmental conditions regarding temperature, barometric pressure, and humidity.
Commercial Intel Core Mini-ITX Computer	Logic Suppy		Computer server which hosts the OpenStack controller node (being executed as a VM) of the experiment's external site. In addition, another unit of this equipment (along with the RPis) conforms the computational resources of the NFV infrastructure included in that site.
Iptables	Netfilter - Open source tool		(Software) An open source command line utility for configuring Linux kernel firewall rule set. Source-code available online: https://www.netfilter.org/projects/iptables/
Lithium Battery Pack Expansion Board. Model KY68C-UK	Kuman		Battery-power supply HAT (Hardware Attached on Top) for the UAV computation units composing the NFV infrastructure of the external site.
MacBook Pro	Apple		Commodity laptop utilized during the experiment to obtain and gather the results as described in the manuscript.
Mainflux	Mainflux Labs - Open source platform		(Software) Open source Internet of Things (IoT) platform used in the experiment for implementing the

			virtual network function called as IoT Server VNF. In addition, this platform includes an open-source software based on Grafana which allows the visualization and formatting of the metric data. Source code available online: https://www.mainflux.com/
Open Source MANO (OSM) - Release FOUR	ETSI OSM - Open source community		(Software) Management and Orchestration (MANO) software stack of the NFV system configured in the experiment. Source-code available online: https://osm.etsi.org/docs/user-guide/
OpenStack - Release Ocata	OpenStack - Open source community		(Software) Open source software used for setting up both the NFV infrastructure of the central site and the NFV infrastructure of external site within the experiment. Source-code available online: https://docs.openstack.org/ocata/install-guide-ubuntu
OpenVPN - Version 2.3.10	OpenVPN - Open source community		Open source software implementing the VPN service presented in the experiment for the creation of the overlay network that will enable the operations of the NFV ecosystem (providing connectivity among all the sites comprising the ecosystem). Source-code available online: https://openvpn.net/
Openvpn-monitor	Python - Open source software		(Software) Open source program based on Python code that allows the visualization of the state of the VPN service, as well as the representation of the sites that are connected at every instant. For this purpose, the program check periodically the information provided by the VPN server implemented with OpenVPN. Source-code available online: https://github.com/furlongm/openvpn-monitor
Paho-mqtt 1.5.0	Python - Open source library		(Software) Open source library developed in Python code that enables the transmission of the data read by the sensor through the use of MQTT standard Source-code available online: https://pypi.org/project/paho-mqtt/
Ping	Debian - Open source tool		(Software) An open source test tool, which verifies the connectivity between two devices connected through a communications network. In addition, this tool allows to assess the network performance since it calculates the Round Trip Time (i.e., the time taken to send and received a data packet from the network). Source-code available online: https://packages.debian.org/es/sid/iputils-ping
Power Edge R430	Dell		High-profile computer server which provides the computational capacity within the central site presented in the experiment.
Power Edge R430	Dell		High-profile computer server in charge of hosting the virtual private network (VPN) service. Note that

			the computing requirements for provisioning this service are high due to the resource consumption of the encryption operations present in the service.
Power Edge R630	Dell		Equipment used for hosting the virtual machine (VM) on charge of executing the MANO stack. In addition, the OpenStack controller node of the central site is also executed as a VM in this device. Note that the use of this device is not strictly needed. The operations carried out by this device could be done by a lower performance equipment due to the non-high resource specifications of the before mentioned VMs.
Raspberry Pi. Model 3b	Raspberry Pi Foundation		Selected model of Single Board Computer (SBC) used for providing the computational capacity to the experiment's external site. In addition, this SBC model is used during the deployment of the included realistic service for interpreting and sending the data collected by a sensor.
RPi.bme280 0.2.3	Python - Open source library		(Software) Open source library developed in Python code that allows to interface the sensor Bosch BME280, and interpret the readings offered by that sensor. Source-code available online: https://pypi.org/project/RPi.bme280/