Orchestration of 5GCity edge computing with OSM: pilot trials and lessons learnt

Shuaib Siddiqui (Dpty. Project Coordinator)
Fundación i2CAT

OSM 5G Day @Lucca Nov 2019
5GCity Project Vision

Design, develop, deploy and demonstrate, in operational conditions, a distributed cloud & radio platform for municipalities and infrastructure owners acting as 5G neutral hosts (BCN, Bristol & Lucca)

Objectives:

✔ Build & deploy a common, multi-tenant, open platform that extends the (centralized) cloud model to the extreme edge of the network
✔ Distributed, 3-tier architecture with network sharing, slicing & MEC capabilities.
✔ MEC node virtualization platform and guest optimizations
✔ Network virtualization @ edge
✔ Scalable edge management & orchestration and service programming models
✔ City-wide pilots’ deployment and validation & commercial outreach and standardization
Neutral host and slicing

5GCity - A Distributed Cloud & Radio Platform for 5G Neutral Hosts

© ETSI 2019 20/11/2019
5GCity architecture principles

• Split vertically across three layers

• **Service/Application Layer**
  • specific set of functions/tools of the proposed 5GCity architecture available for the operators of the infrastructure, their customers, subcontractors and any third party actor

• **Orchestration & Control layer**
  • entry point of network services (Dashboard), core orchestration components (5GCity orchestrator), as well as control between the central orchestration platform and the infrastructure (WAN managers, VIMs, and SDN controllers)

• **Infrastructure layer**
  • The actual radio and computing virtualization infrastructure spanning from far-edge to datacenter
5GCity architecture

Service Layer

- 5GCity SDK
- Public 5G Services and Application Catalogue

Orchestration & Control Layer

- Resource Placement
- Slice Manager
- SLA Manager
- NFV Orchestrator & MEC Cmpnts
- Infrastructure Abstraction
- WAN Resource Manager

5GCity Platform

- 5GCity Dashboard
- 5GCity Orchestrator
- OSS-BSS
- AAA
- Monitoring

Infrastructure Layer

- VIM - Core
- SDN Controller
- VIM - Edge
- VIM - Ext. Edge
- SDN Controller

Data Plane

- Core NFVI
- Edge NFVI
- Extended Edge NFVI
5GCity Platform high level architecture

- DASHBOARD
- SDK
- 5GCity Orchestrator
  - Resource Placement
  - SLA Manager
  - Slice Manager
  - Infrastructure Abstraction
  - WAN Resource Manager
  - NFVO
  - MEC Cmpts

© ETSI 2019  20/11/2019  5GCity - A Distributed Cloud & Radio Platform for 5G Neutral Hosts
Mapping into software modules

- **5GCity-Dashboard**
- **5GCity-SDK**
- **5GCity-AAA**
- **5GCity-monitoring**
- **5GCity-slice-manager**
- **5GCity-resource-placement**
- **5GCity-infrastructure-abstractiion**
- **5GCity-multi-tier-orchestration**
- **Fog05-MEAO**
- **Fog05-MECVP**

Using:
- ETSI OpenSourceMano (OSM) incl. 5GCity extensions
- ETSI OpenSourceMano (OSM) incl. 5GCity extensions
- ETSI OpenSourceMano (OSM) incl. 5GCity extensions
- ETSI OpenSourceMano (OSM) incl. 5GCity extensions
- ETSI OpenSourceMano (OSM) incl. 5GCity extensions

Implemented as proprietary code
MTO includes:

- an **Abstraction API**, which is used to trigger the required API invocation chains on the different orchestrators when a high-level action is performed

- a **layer of intelligence** (Forwarding and coordination logic), which implements new inter-orchestrator workflows based on the high-level inputs

- a series of **Southbound clients**, which are used in order to connect to NFV, MEC, and Cloud native orchestrators

High-level architecture of multi-tier orchestration solution

Other “goodies” of 5GCity slices

1) Automated **DHCP server** deployment for users connected to a 5GCity slice via Wi-Fi nodes. The configurations are *dynamically performed* by the 5GCity platform.

2) Automated **DNS server** deployment after a NSD is deployed in a 5GCity slice. Therefore, deployed **VNFs are reachable** inside the **network slice** using the “short-name” parameter of the VNFDs.

3) Automated **vEPC instance** deployment to provide **connectivity** between **user equipment** and **deployed VNFs** when LTE is part of the 5GCity slice.
5GCity: distributed, 3-tiers architecture

Which edge computing do 5GCity have?

- **MEC Node Virtualization Platform and Guest Optimizations**
  - Unikernels and containers for reduced boot times (i.e. in 10s-100s ms depending on CPU arch) and lightweight images (i.e., in the few MBs)
  - EdgeVIM and EdgeNFVI for attestation capabilities and isolation at the hardware level by leveraging VOSYSmonitor and ARM TrustZone

- **Innovative RAN virtualization**
  - Slicing of physical wireless interface (LTE and Wi-Fi) among a set of tenants

- **Scalable edge management & orchestration and SDK**
5GCity Edge in Barcelona (ES)
5GCity Edge in Bristol (UK)

5GCity - A Distributed Cloud & Radio Platform for 5G Neutral Hosts

© ETSI 2019 20/11/2019
5GCity Edge in Lucca (IT)
5GCity EdgeVIM and EdgeNFVI

**Motivation**

- Security Hardening of the 5GCity Virtualized Infrastructure
  - Authenticated devices, geo/asset tagging and secure storage
- Why does this matter in smart cities environments?
  - Distributed architecture
  - Privacy issues related to the sensitive data used (cameras, mobility services, health, etc.)

**Components**

- **EdgeVIM** - based on OpenStack with added attestation capabilities
- **EdgeNFVI** - isolation at the hardware level by leveraging VOSYSmonitor and ARM TrustZone
- **Security Services**: running inside a Trusted Execution Environment
EdgeVIM/NFVI performances

- ~+2% average overhead during VM creation with node attestation, ~+4% overhead if we add location awareness
- VM deletion process not affected

OpenStack (release Pike) controlling:
- One x86 controller node: Intel(R) Xeon(R) CPU E5-2623 v4 @ 2.60GHz, 32GB memory, Ubuntu 16.04.4 LTS, KVM-enabled 4.4.0-128 Linux kernel
- One ARM64 compute node: Xilinx Zynq UltraScale+ MPSoC ZCU102 with a quad-core ARM Cortex-A53, 4GB memory, Ubuntu 18.04.4 LTS, KVM-enabled 4.14.0 Linux kernel
5GCity RAN Virtualization

**eNodeB SPLIT for Neutral Host**

- For lower latency and local traffic breakout conditions, virtual EPC and virtual vL3 function are co-located at edge

**Infrastructure abstraction**

- Support different RAN controllers by 5GCity platform and integration of the underlying RAN technologies
RAN Virtualization performances

- Differences in throughput can be explained by different distances (close/far) and the use of different chipsets in client cards (ath9k, ath10k).
A practical problem with edge on-street

RATIONALE

- 5GCity will be deployed in the 3 cities with different underlying infrastructures
  - BCN, BRS and LUCCA have different layouts
  - Some variations from pilot to pilot
    - E.g. access to cameras in Lucca
    - L2 capabilities in BCN and BRS
    - Optical transport in BRS,
    - ...

- No unified deployment model can be offered
  - In principle, infrastructures may belong to single or multiple administrative operators

- Inherent configuration of 5GCity 3-tiers architecture as multi-operator infrastructure
Live HD TV streaming from Torre Guinigi to Real Collegio, Lucca (IT) – 6-7 June 2019

European Digital Forum 2019

Speedtest on Torre Guinigi

6.1 Mbps continuous full HD H.264 streaming from backpack

Speedtest on street

Torre Guinigi Mobile backpack

500 m

200 m
Thank you!

www.5gcity.eu

@5GCity