Enablers to Support Verticals

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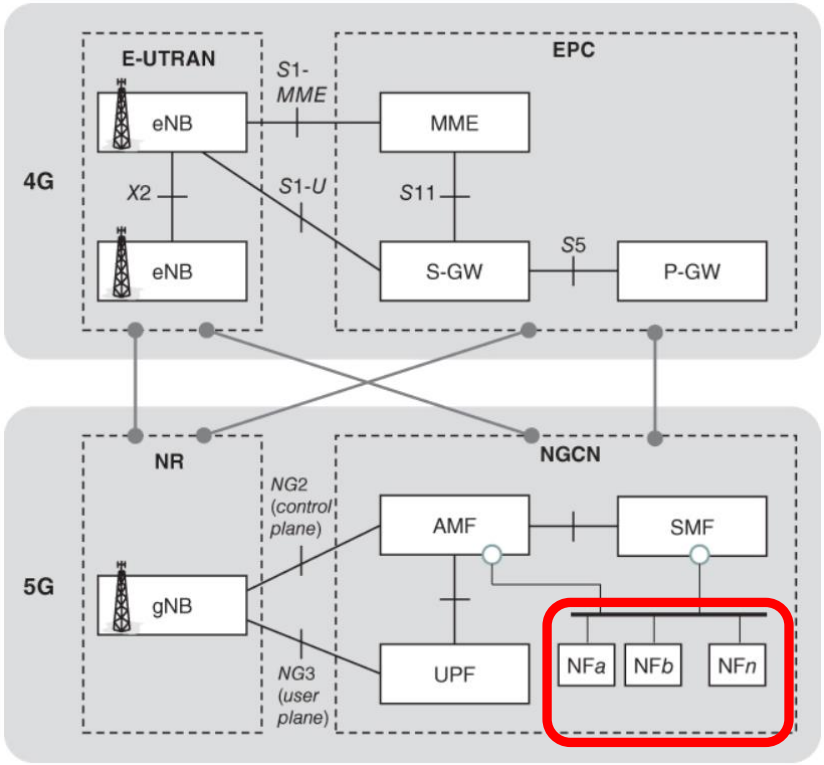
Multiaccess Edge Computing

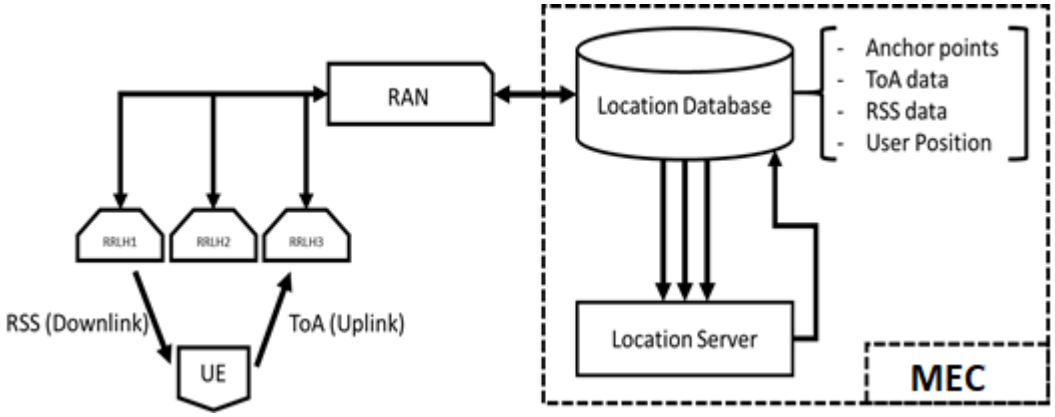
- 5G system provides possibility to virtualize the network functions (NF) on MEC



Type of Vertical Supporting Services

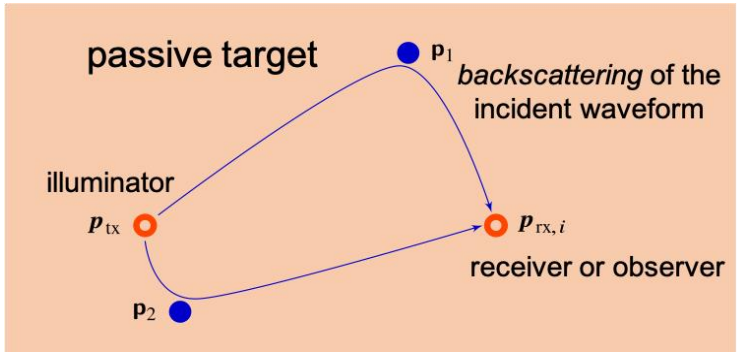
- Location Measuring Services
  - 5G Based
  - 5G Device Free Based
  - Non-5G Based
- Location Exploiting Services
  - Follow-Me
  - Location Based Data Access
- Network Resource Management Services
  - Multi Source Streaming
  - Load Balancing
- Network Security Services
- Network Slice Services
  - Network Slice Building
  - Network Service Building

Location Measuring Services:
5G based Indoor Location Service



- Location Server (LS) & Location Database (LD) are VNFs on MEC.
- Position of Remote Radio Light Heads registered as Anchor Points on LD
- VLC Received Signal Strength (RSS) measurements regularly sent from User Equipment (UE) to LD
- mmWave Time Difference of Arrival (TDoA) measurements regularly sent from RRLH to LD
- LS processes LD data into UE position using data fusion to an accuracy < 10cm
- UE position data available for applications to use

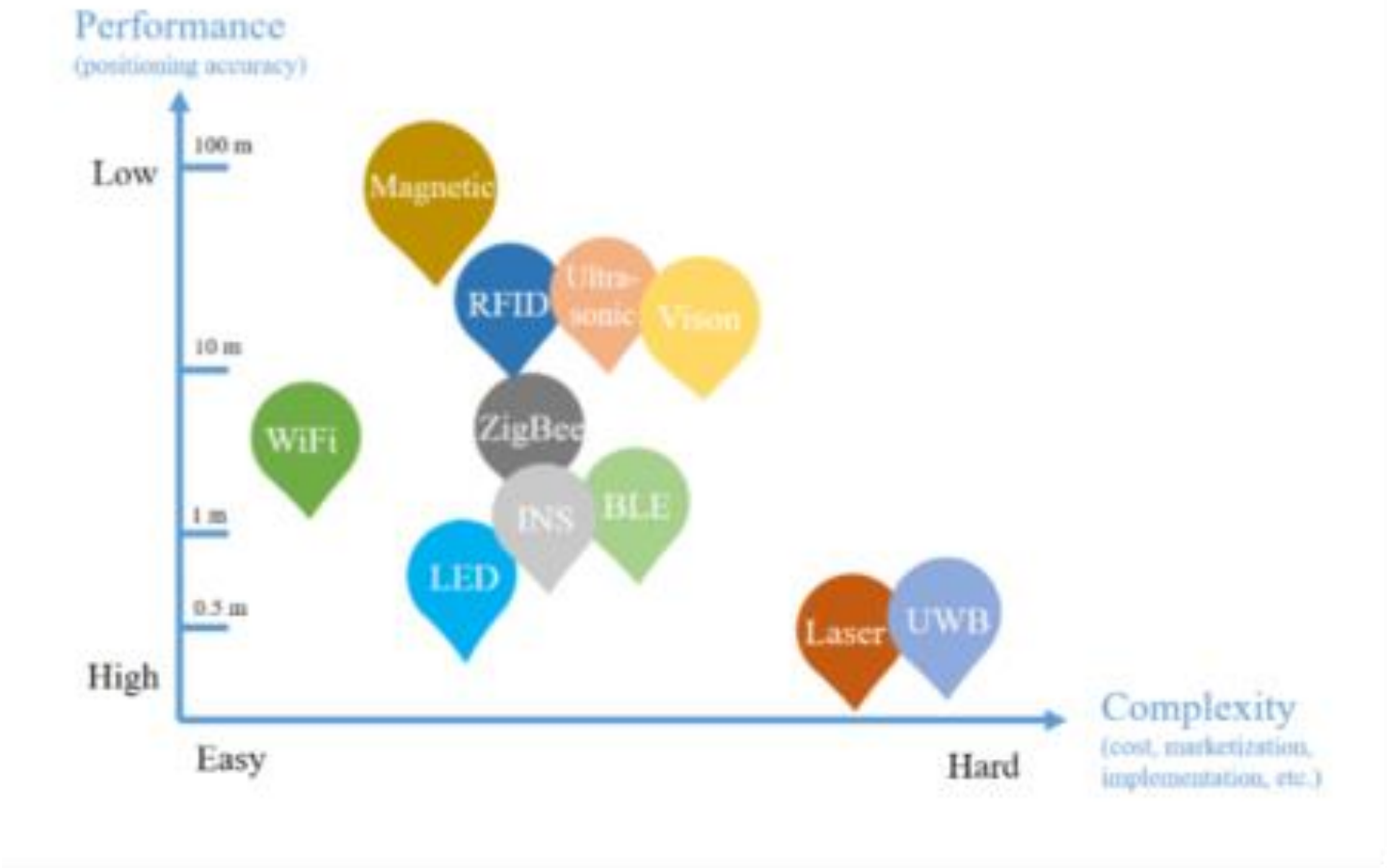
Location Measuring Services: 5G Device-free Localization



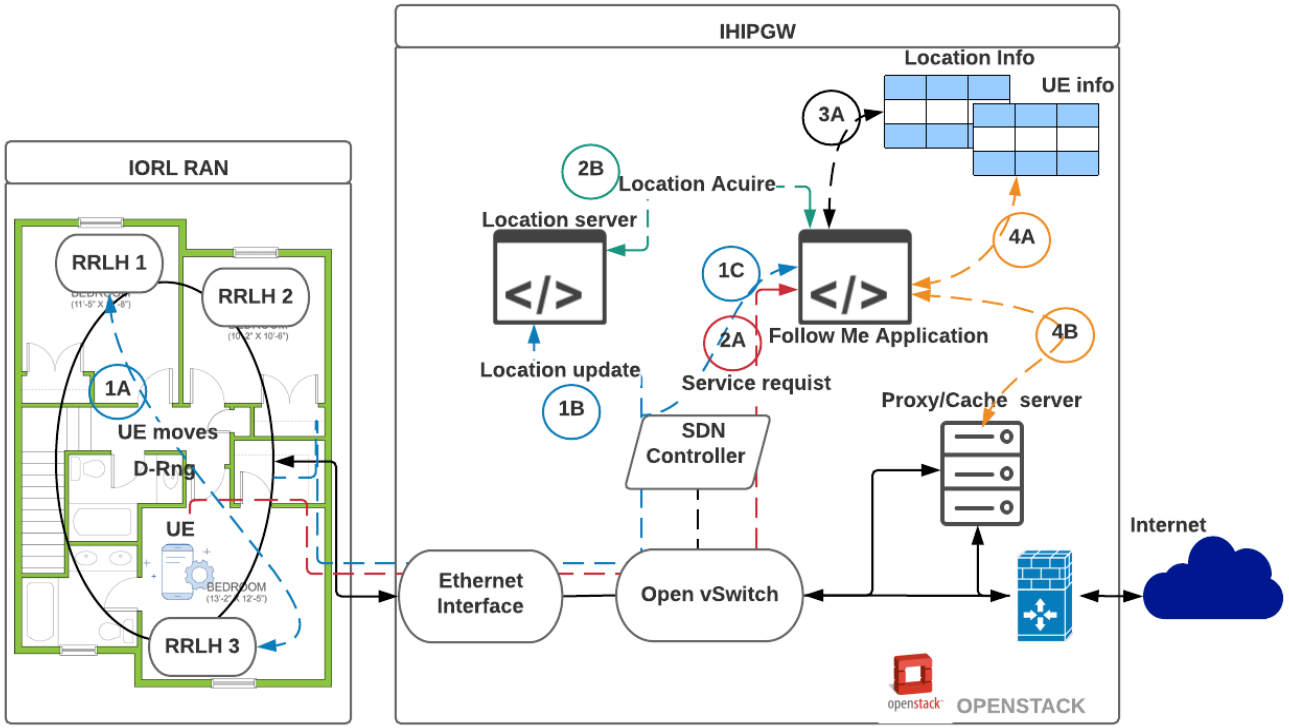
- Many scenarios where we need to detect, localize, or extract analytics related to people and things (targets) not equipped with communicating devices such as cars/bikes/pedestrians for road safety, anti-intruder systems, and people flow monitoring
- Device-free localization consists in processing such signals 'of-opportunity' after target backscattering at one or multiple nodes to extract information about presence, range, location that may serve as input for analytics extraction
  - Localization accuracy: 1m – 5m
  - Update Interval: 1s – 40s
  - Update rate: 2min
  - Service reliability: 90 - 99%
  - Service availability: 90-98%

Location Measuring Services: Non 5G Localization

- Comparison of different indoor positioning technologies



Location Exploiting Services: Follow Me Service



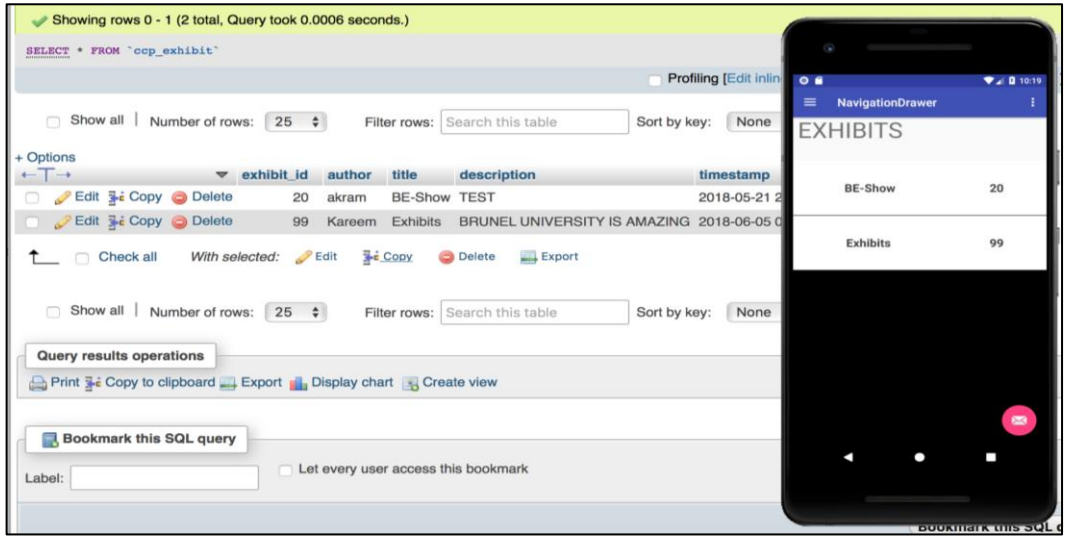
- Push media contents from MEC to the nearest TV device based on UE location
- Enables the SDN controller on MEC to update the Open Virtual Switch (OvS) forwarding tables with the correct TV destination.
- Follow Me Application on UE utilizes UE location information to ensure real time traffic switching instructions are sent via SDN controller.

Location Exploiting Services: Location Based Data Access

- Museum, supermarket and train station use case scenarios, require a database that holds museum exhibits, food products and maintenance infrastructure media associated with location information, respectively.
- These use cases offer managers with services like adding, editing and deleting museum exhibits, food products and maintenance infrastructure related media.
- Museum visitors, shoppers and maintenance engineers have an application that allows them to know where is the exact location of the exhibits, food products and maintenance infrastructure

Android App to view Location based data

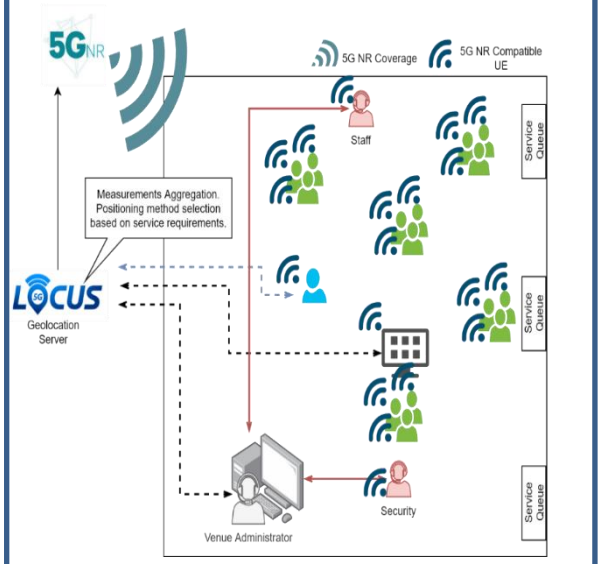
Curator's Apps to load Location based data



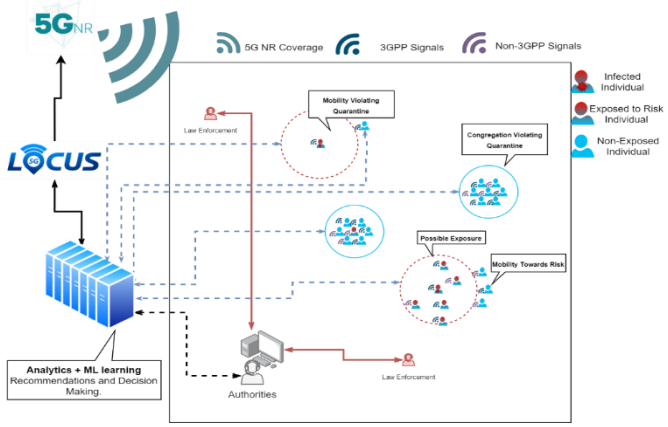
Location Exploiting Services:

Other Location Based Services

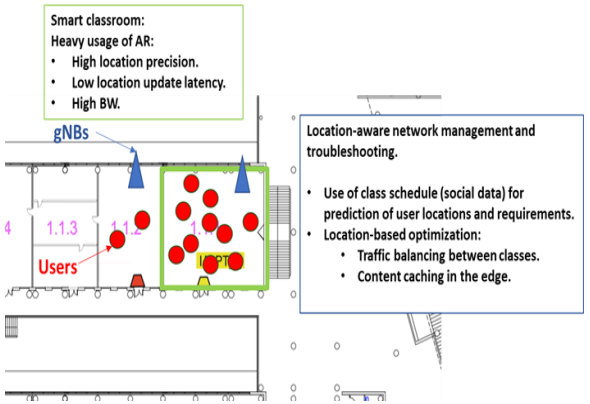
Positioning and Flow Monitoring in Large Venues and Dense Urban Environments



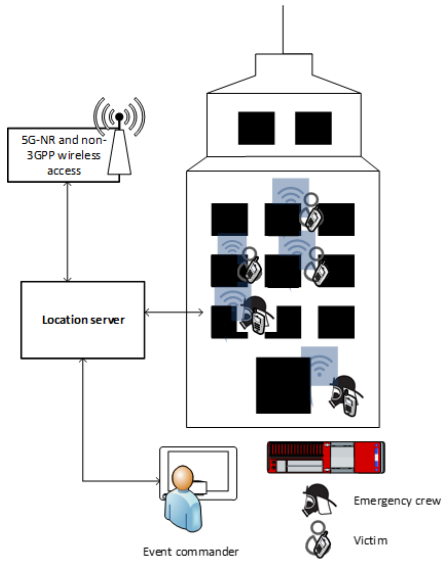
Positioning and Flow Monitoring for Controlling COVID-19



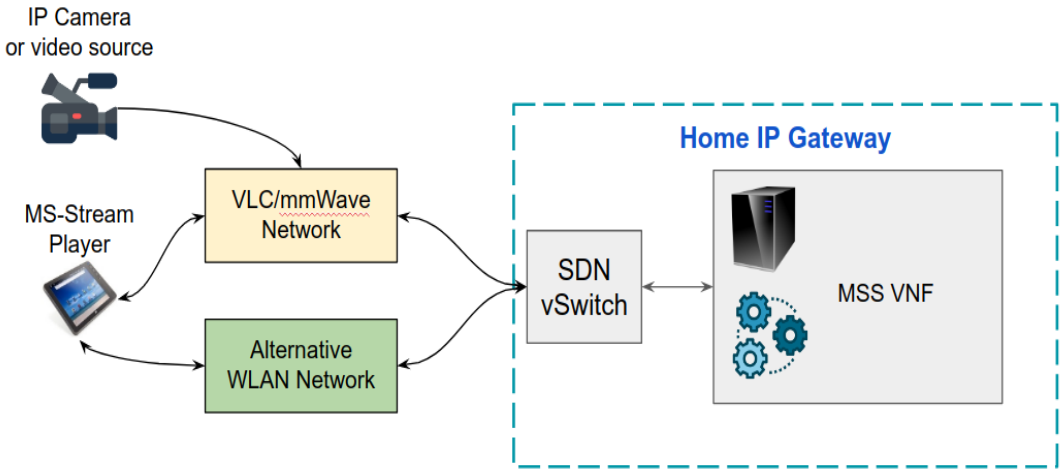
Localization and Network Management for Education



3D Indoor Localisation for Emergency Scenarios



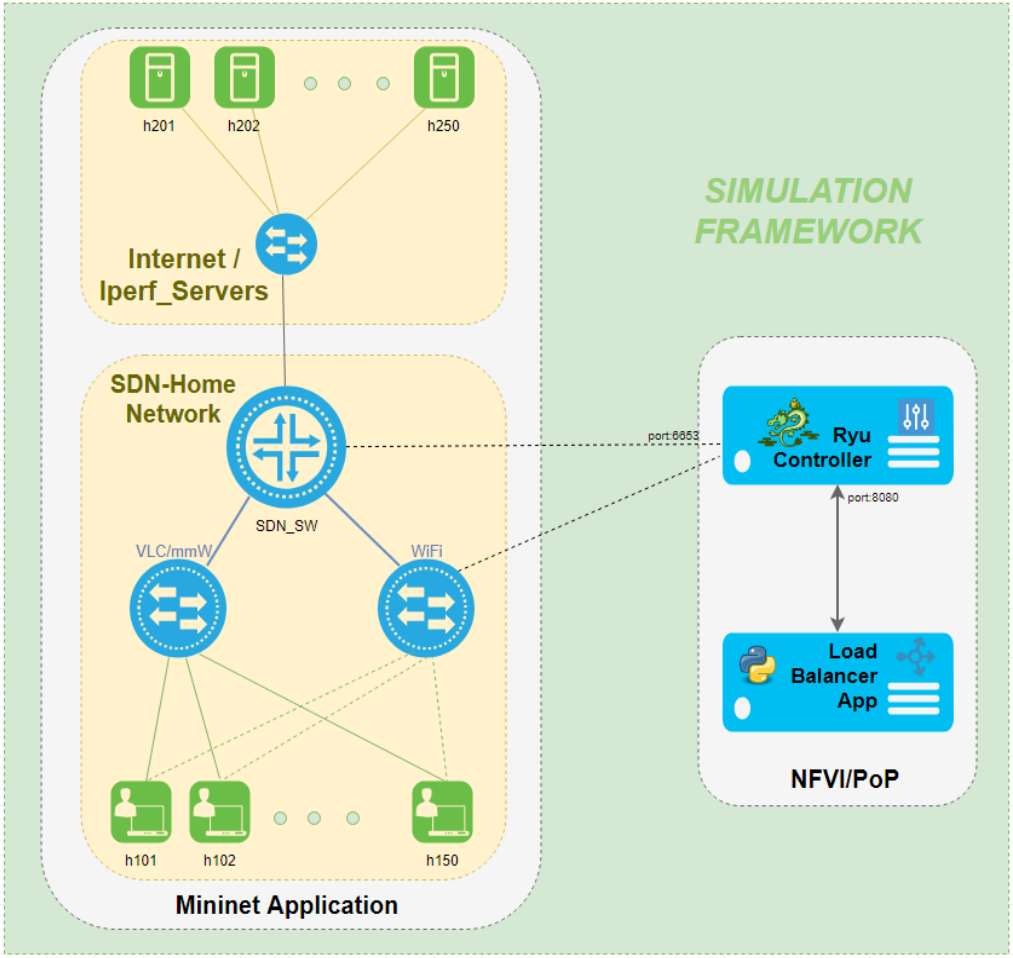
Network Resource Management: Multisource Streaming Service



- MSS uses multiple network paths to increase both reliability and QoE of the streaming sessions.
- Client retrieves video packets in high quality through a VLC/mmWave network and simultaneously in low quality through a WLAN to provide reliability in case of data path interruption
- Sub-streams are merged at UE to reconstruct and display the original requested content quality.
- In the event of sub-streams loss content playback continuity is not affected, only image quality.

Network Resource Management: Load Balancing Service (LBS)

- When the total traffic requested by all users is above threshold then the LBS allocates random users to the WiFi network and keep the rest users to the high-speed VLC/mmWave access.
- When the total traffic requested by all users is below threshold, then some users will be randomly allocated from the WiFi to the VLC/mmWave network.



Distributed Network Security Service

- Scanning: By counting the number of “pending” connections per client IP address we are be able to distinguish a scanning machine from a benign one and thus eliminate the attacker.
- Denial of Service: To mitigate DoS attacks, security VNF limits the number of IP addresses that can be leased from the DHCP server.
- Sniffing: To discover machines that are sniffing in the network we identify which ones have Network Interface Controllers set to the promiscuous mode. Inflicting artificial load on the investigated machine using the *macof* and *ping* tools and measuring its Round Trip Time with and without the load identifies sniffer.

Network Slice Services: Network Slice Building

- 5G Vertical Slicer allows vertical industries to define vertical services from a set of offered Vertical Service Blueprints (VSB), which, along with instantiation parameters, will result in Vertical Service Descriptors (VSD).
- The SLA requirements can be of different kinds presenting specific business and service requirements:
  - (i) end-to-end latency and bandwidth requirements, necessary for the service to function correctly,
  - (ii) number of supported users, coverage area, etc., related to the dimensioning of the service,
  - (iii) availability and reliability,
  - (iv) deployment time, energy efficiency, i.e., optimization targets for the deployment of the service.
- Service catalogue is offered to the verticals via a **vertical-facing API** that enables the verticals to define and order vertical services in an automated manner with an API is exposed on the North Bound Interface (NBI) of the service management platform.

Network Slice Services:

Network (Plug & Play) Service Building

- Plug & Play (P&P) control framework enables flexible and powerful control capabilities for verticals regarding their own services over the commissioned network slices.
- P&P network slice instance comprises a group of self-contained micro-services following a micro-service topology graph and each of the micro-services can be activated or updated on demand at runtime individually without disrupting the rest of the existing P&P instances.
- Thus the P&P framework is able to implement the customizable control logic in relation to the concerned network slice for the vertical in a P&P manner.

Thank you for your attention

For more information about 5G PPP activities please visit https://5g-ppp.eu

The white paper is available at https://5g-ppp.eu/white-papers/