5G-IANA: 5G Intelligent Automotive Network Applications

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Scope

Provide an open and enhanced experimentation platform that will provide access to 5G network resources, on top of which third party experimenters (i.e., SMEs) in the Automotive-related 5G-PPP vertical will develop, deploy and test their services.

- **Different virtualization technologies** integrating **different MANO frameworks** for enabling the deployment of the end-to-end network services across different domains (vehicles, road infrastructure, MEC nodes and cloud resources).
- A new **Automotive VNFs Repository** that will form a repository for SMEs to use and develop new applications.
- A **distributed AI/ML (DML) framework**, that will provide functionalities for simplified management and orchestration of collections of AI/ML service components.
- Demonstration of **7 Automotive-related use cases in 2 5G SA testbeds**.
- **Multi-stakeholder cost-benefit analysis** to identify and validate market conditions for innovative, yet sustainable business models supporting a long-term roadmap towards the pan-European deployment of 5G as key advanced Automotive services enabler.

Objectives & Methodology

Specific Objectives

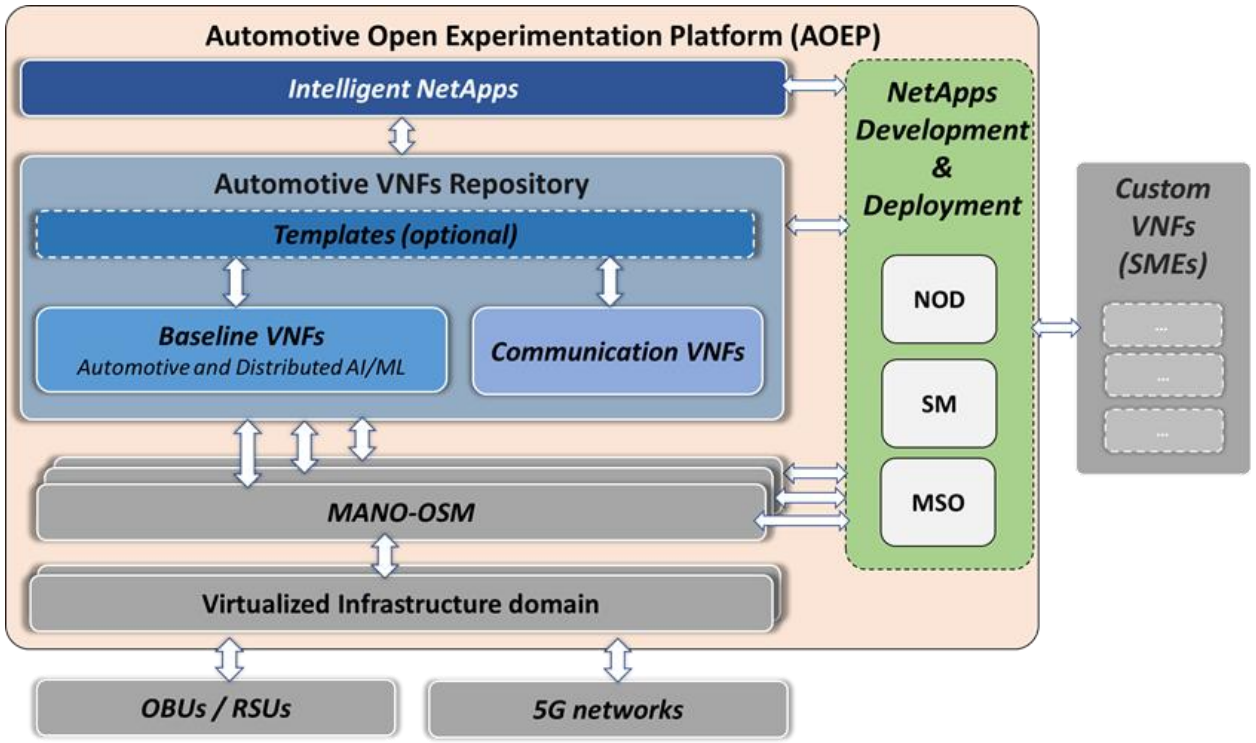
- Specify and provide an **Automotive Open Experimental Platform (AOEP).**
- Specify and implement a **repository environment for NetApps and VNFs** to ease the design and chaining of new Automotive-related services – to be **integrated with 5G-PPP open repositories.**
- **Ensure co-existence with DSRC and LTE/5G and enhance network platform performances** for the Automotive vertical.
- **Provide accurate localization and low latency mission-critical applications.**
- Define, implement and trial **Connected and Automated Driving relevant Use Cases** to validate and assess the AOEP suitability and functional improvements.
- **Improve service creation time (5G-PPP KPI).**
- Create **new business opportunities and boost market for start-ups and SMEs** with Automotive NetApps.
- **Increase road safety and reduce automobile carbon footprint** by leveraging Connected and Automated Mobility using enhanced network performances.
- Ensure **cross-domain and cross-platform interoperability** and boost standardisation committees on NFV and Network orchestration.

Proposed Solution – Main Items

Automotive Open Experimental Platform (AOEP)

- NetApp Orchestration and Development framework (NOD);
- Slice Manager (SM);
- Multi-domain Service Orchestrator (MSO);
- Virtualized infrastructure domains: **OBU, RSU, MEC nodes, Cloud resources;**
- 5G-IANA NetApps toolkit linked with a new **Automotive VNFs Repository;**
- **A Distributed AI/ML (DML) framework**, as part of the VNFs Repository.

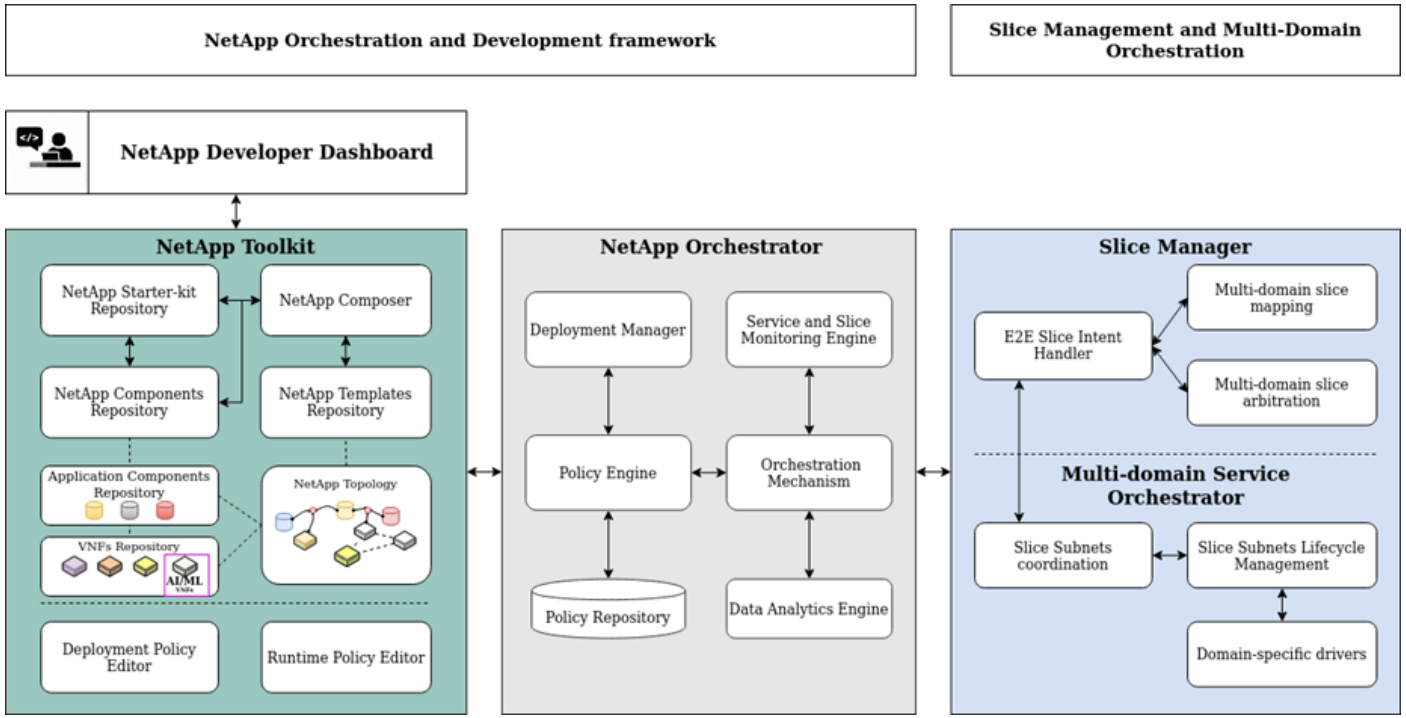
5G-IANA AOEP



5G-IANA NetApp Orchestration and Development framework (NOD), Slice Manager (SM) and Multi-domain Service Orchestrator (MSO)

5G-IANA NOD, SM and MSO

- **NOD** is in charge of handling the lifecycle management of the NetApp from the application point of view, processing a request from a Vertical/Service Provider (highest level of abstraction with respect to the underlying network).
- **SM** is in charge of defining and provisioning the end-to-end Network Slice (NS) across the underlying domain and technology-specific platforms (e.g., NFV Orchestrators, MEC platforms, serverless orchestrators, etc.).
- **MSO** role is the correlation and coordination of the different nested NS running an entire NetApp composing the end-to-end NS from an upper layer perspective (coordination and composition of NS, LCM, etc.).



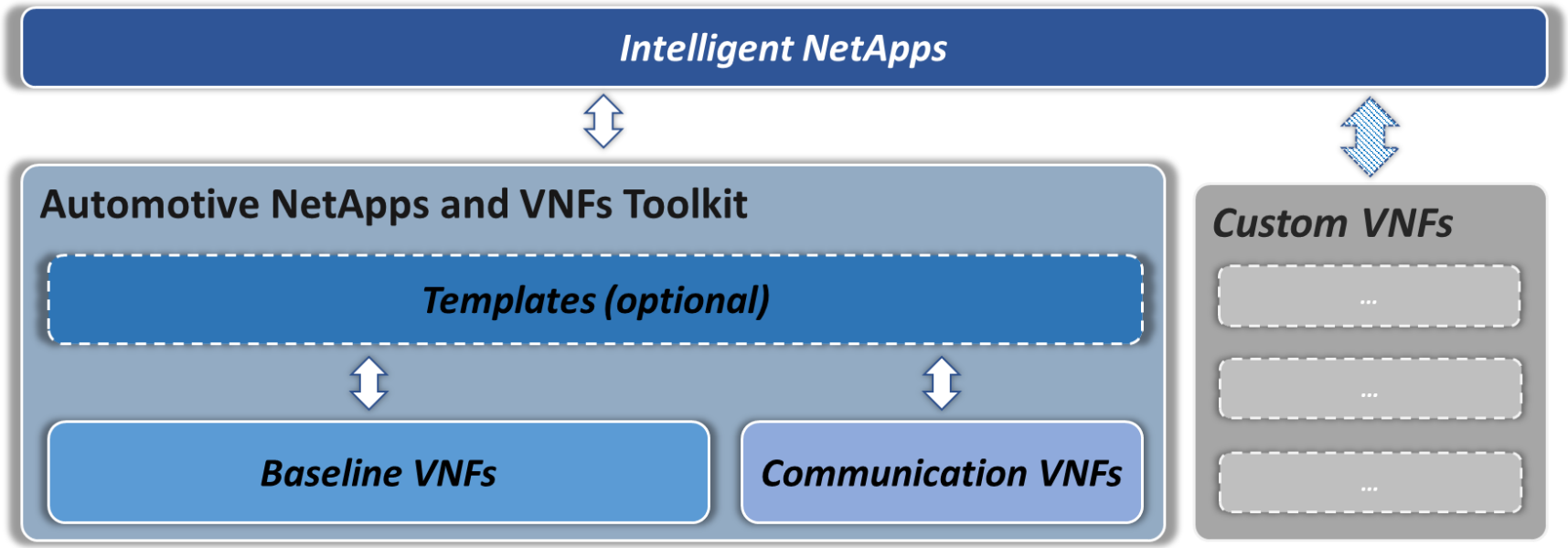
5G-IANA NetApps Toolkit and Automotive VNFs Repository

5G-IANA Toolkit and Repository

Provide functionalities for easing the design and chaining of new Automotive services:

- **Novel data-model** for offering to Verticals a simplified high-level representation of the different service components, in order to **hide the network complexity** from the point of view of the service deployment and inter/intra-domain components connectivity.
- **Interoperability with existing VNF repositories** (aggregation and integration point to offer a heterogeneous set of already existing virtualized management, communication and optimization functions for the Automotive industry and correlated business areas).
- Development of **6 Automotive-related Communication VNFs.**
- Development of **31 Automotive-related Baseline VNFs.**
- Development of **7 Intelligent NetApps** and demonstration through selected 5G-IANA Use Cases.
- All developed VNFs will be made available individually,, but also grouped into NetApp templates and "**starter-kits**" to facilitate 5G-PPP Verticals, and in particular SMEs, in the development and integration of newly developed NetApps.

Automotive VNFs Repository



Communication VNFs

- C-ITS messages short-distance communication (OBU,RSU)
- C-ITS messages long-distance communication (OBU,RSU,MEC)
- Long-distance data communication (OBU, RSU, MEC, DC)
- Autonomous driving module interface (OBU)
- Sensors' data interface (OBU, RSU, MEC, DC)
- In-vehicle end-user communication interface (OBU)

Baseline VNFs (1/2)

- ETSI Decentralized Environmental Notification Service (OBU,RSU, MEC)
- ETSI Cooperative Awareness Basic Service (OBU, RSU, MEC)
- ETSI Collective Perception Service (OBU, RSU, MEC)
- ETSI Manoeuvre Coordination Service (OBU, RSU)
- ETSI Traffic Light Manoeuvre Service (RSU, MEC)
- ETSI Road and Lane Topology Service (RSU, MEC)
- ETSI Infrastructure to Vehicle Information Service (RSU, MEC)
- Position and Time Service (OBU, RSU, MEC)
- Enhanced Local Dynamic Map Service (OBU, RSU, MEC)
- Events Relevance Service (OBU)
- Log Reporting Service (OBU, DC)
- Actuators Interface (OBU, DC)
- Video Decoding (OBU)
- Video Encoding (OBU)
- Object Detection with Deep Learning (MEC)

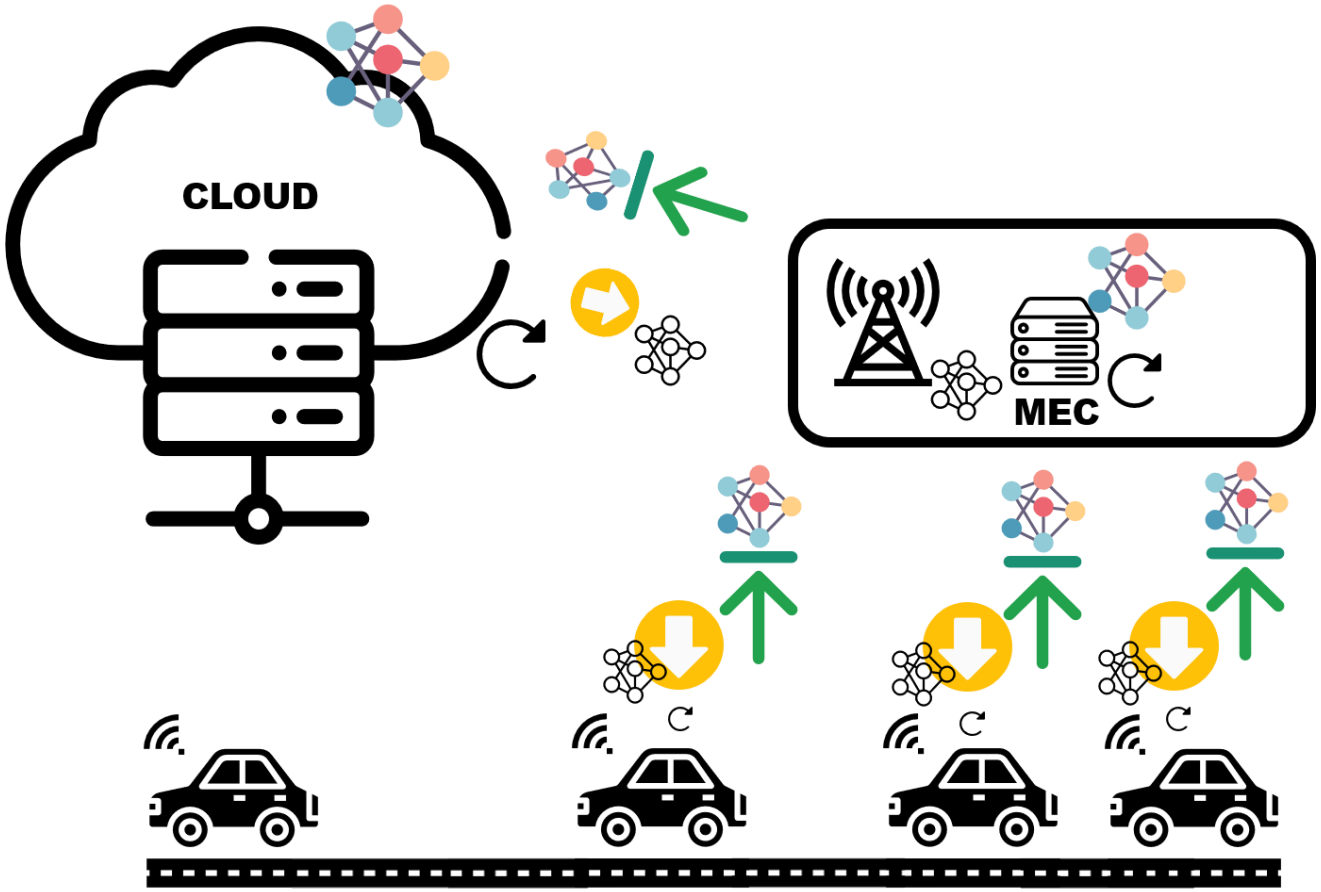
Baseline VNFs (2/2)

- Vehicle Condition Warnings Service (MEC)
- Remote Driving Central Control (MEC)
- Virtualized Cache – vCache (OBU, MEC)
- UHD Origin Streaming Server (DC)
- Load Balancer (MEC)
- vDNS (MEC, DC)
- Elasticsearch (incl. Kibana and Logtash) (MEC, DC)
- Telegraf (DC)
- 360º video slicer (MEC)
- Network (NW) monitoring (OBU, RSU)
- QoS prediction (OBU, RSU)
- Simulator of ETSI Cooperative Awareness Basic Service (MEC)
- Distributed ML Orchestrator (DMLO) (MEC, DC)
- DML Parameter Server (PS) (RSU, MEC)
- DML Aggregation Node (AggN) (RSU, MEC)
- ML node -Training Agent (MLN) (OBU, RSU, MEC,)

5G-IANA distributed AI/ML (DML) framework

5G-IANA DML framework

Provide functionalities for simplified management and orchestration of collections of AI/ML service components that support existing or newly chained services (ML topology selection and various performance and privacy configurations along the spectrums of ML model/parameter consistency and data distribution).



5G-IANA Use Cases

Intelligent NetApps and 5G-IANA Use Cases

- Hazard Notification
- Vehicle Movement
- Smart Traffic planning
- Infotainment

5G-IANA Use Case

- Remote Driving
- Manoeuvre Coordination for Autonomous Driving
- Virtual Bus Tour
- Content Delivery for Vehicular Networks
- Parking Circulation & High Risk Driving Hotspot Detection
- Network Status Monitoring
- Situational Awareness in Cross-Border Road Tunnel Accidents

Use Case 1: REMOTE DRIVING (UC1-RMD)

- **NetApp category:** Vehicle Movement
- **Description:** A vehicle that is controlled remotely via a 5G network.
- **Partners involved:** 5COMM, NOKIA, FSCOM
- **Communication modes:** V2N **|Network slice types:** URLLC**|MEC use:** YES
- **TRL: Current:** 4 **Target:** 6
- **KPIs:**
  - **Service Creation time**: Current value: 30 minutes Target Value: < 5 minutes;
  - **Latency**: 20 ms;
  - **User experience data rate**: 35 Mbps everywhere (UL/DL);
  - **E2E reliability:** 99,999%.
- **Impact:** Provide greater comfort to people when performing certain types of activities that do not require human presence, such as taking the car from one place to another, picking up another person or delivering objects, transport material to sites in dangerous areas, transport dangerous substances, transport goods to places that are far away.

Use Case 2: MANOEUVRES COORDINATION FOR AUTONOMOUS DRIVING (UC2-MCAD)

- **NetApp category:** Vehicle Movement
- **Description:** Maneuver coordination service that aims to identify conforming trajectories between autonomous vehicles.
- **Partners involved:** BYL, LINKS, NOKIA, 5COMM
- **Communication modes:** V2V, V2I **|Network slice types:** URLLC**|MEC use:** YES
- **TRL: Current:** 2 **Target:** 6
- **KPIs:**
  - **Service Creation time**: < 5 minutes;
  - **Latency**: < 20 ms;
  - **User experience data rate**: 35 Mbps everywhere (UL/DL);
  - **E2E reliability:** 99,999%.
- **Impact:** Co-existence of autonomous vehicles that can potentially have different procedures for the definition of trajectories. Being able to have autonomous vehicles that agree on the trajectories and consequently on the maneuvers to perform can increase the safety of autonomous driving.

Use Case 6: NETWORK STATUS MONITORING (UC6-NSTAT)

- **NetApp category:** Infotainment, Smart Traffic Planning.
- **Description:** Provide an overview of the status of network components or virtual network functions using ML techniques and draws conclusions and predictions with respect to the performance of the monitored components.
- **Partners involved:** UULM, NOKIA, FSCOM, ICCS
- **Communic. modes:** V2N, V2I **|Network slice types:** URLLC & eMBB **|MEC use:** YES
- **TRL: Current:** 2 **Target:** 5
- **KPIs:**
  - **Service Creation time**: < 5 minutes;
  - **Latency**: <20 ms; **Latency prediction error** < 10%;
  - **User experience data rate**: 20 Mbps everywhere (UL/DL);
  - **E2E reliability:** 99,999%, 10^{-4} packet error rate.
- **Impact:** Demonstrate the potentials of Distributed ML schemes in 5G-PPP verticals, where the network is volatile and privacy concerns is of outmost importance. Distributed and predictive Network Monitoring to support 5G based applications and make efficient use of their data and resources.

Expected Impact

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- Provide functionalities for easing the design and chaining of new Automotive-related services.
- Exploration of novel business models with new market actor landscapes.
- Increase the uptake of 5G services along Automotive-related services and thus increase the overall uptake of 5G.
- Low carbon and more energy efficient transport towards the use of automated driving and connectivity.
- Improvement of traffic flows, congestion and emissions through the use of real-life validation of a 5G infrastructure architecture enabling also DML techniques.

Thank you!

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