



# Welcome to the World of Standards



## **ETSI GANA in 5G Network Slicing PoC by ETSI INT AFI WG**

*5G Network Slices Creation, Autonomic & Cognitive Management & E2E  
Orchestration; with Closed-Loop (Autonomic) Service Assurance for the IoT  
(Smart Insurance) Use Case*

**Presenters:** *Tayeb Ben Meriem, PhD: Orange, AFI WG Chair; Ranganai Chaparadza, PhD: Altran Germany;*

# 5G PoC Consortium



- Orange
- Verizon
- NTT
- Telecom Italia
- Altran
- Asocs Networks
- Cellwize
- Huawei
- Incelligent
- QualyCloud
- IPv6 Forum
- Big Switch Networks



Accessible here: [https://intwiki.etsi.org/index.php?title=Accepted\\_PoC\\_proposals](https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals)



## AGENDA Outlook

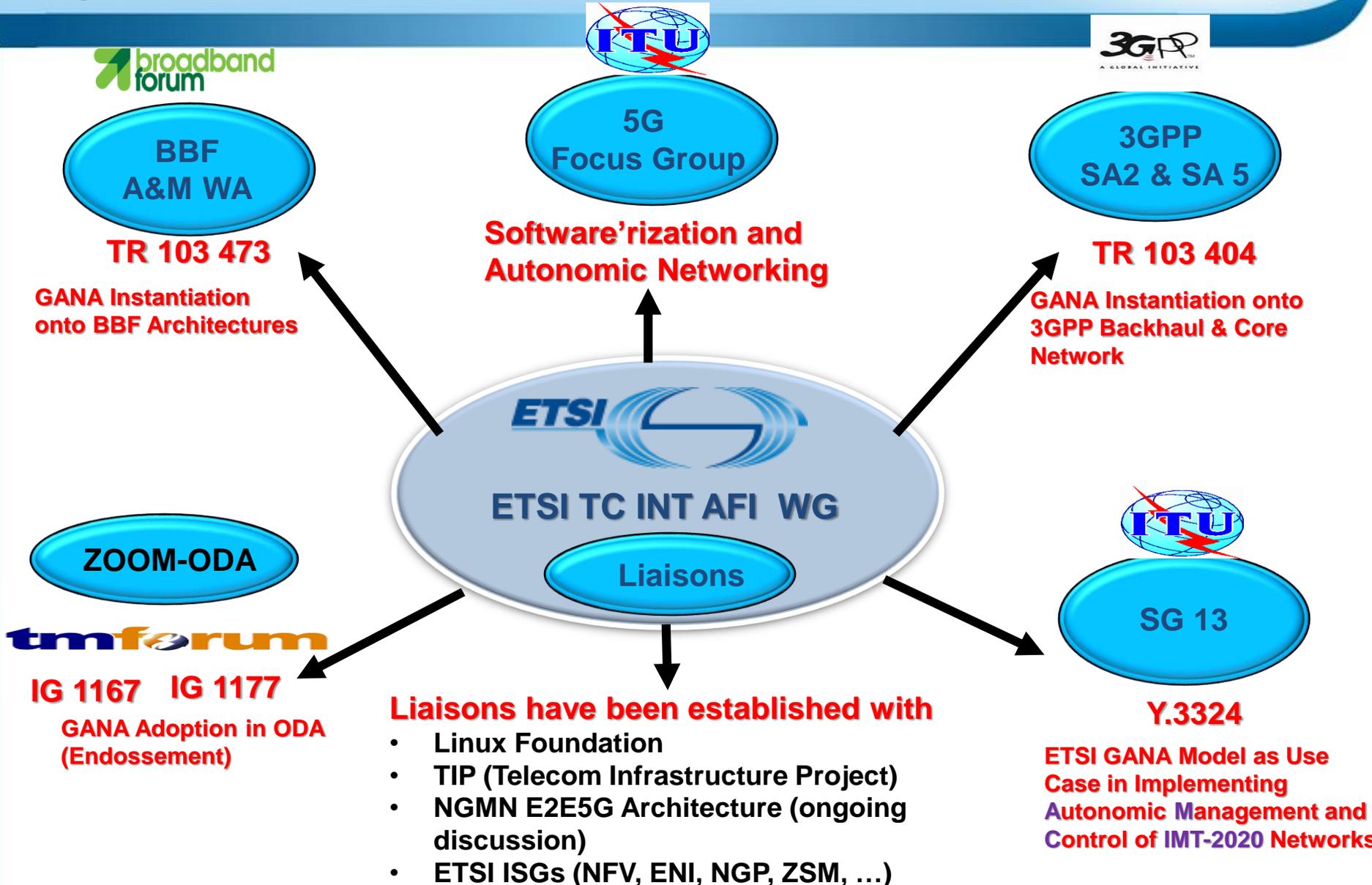
- **Overview of the 5G PoC; Business views of the overall 5G PoC**
- **Multi-Layer Autonomics and the Integration of the ETSI GANA Knowledge Plane (KP) with other systems required for AMC (Autonomic Management & Control) Paradigm**
- **Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service Assurance of 5G Slices across the various network segments/domains**
- **Demos Covered in the 5G PoC so far**
- **The White Papers and other material available for downloads**
- **How to Join the ETSI 5G PoC Program: 5G Network Operators; Network Infrastructure Suppliers; Monitoring Solutions Suppliers; Suppliers of AI Algorithms for GANA DEs as key stakeholders invited to showcase various aspects through Demos**





## Overview of the 5G PoC

# ETSI TC INT AFI WG: ETSI GANA Framework; Key Liaisons and Deliverables



**Liaisons have been established with**

- Linux Foundation
- TIP (Telecom Infrastructure Project)
- NGMN E2E5G Architecture (ongoing discussion)
- ETSI ISGs (NFV, ENI, NGP, ZSM, ...)

**ETSI GANA Model as Use Case in Implementing Autonomic Management and Control of IMT-2020 Networks**

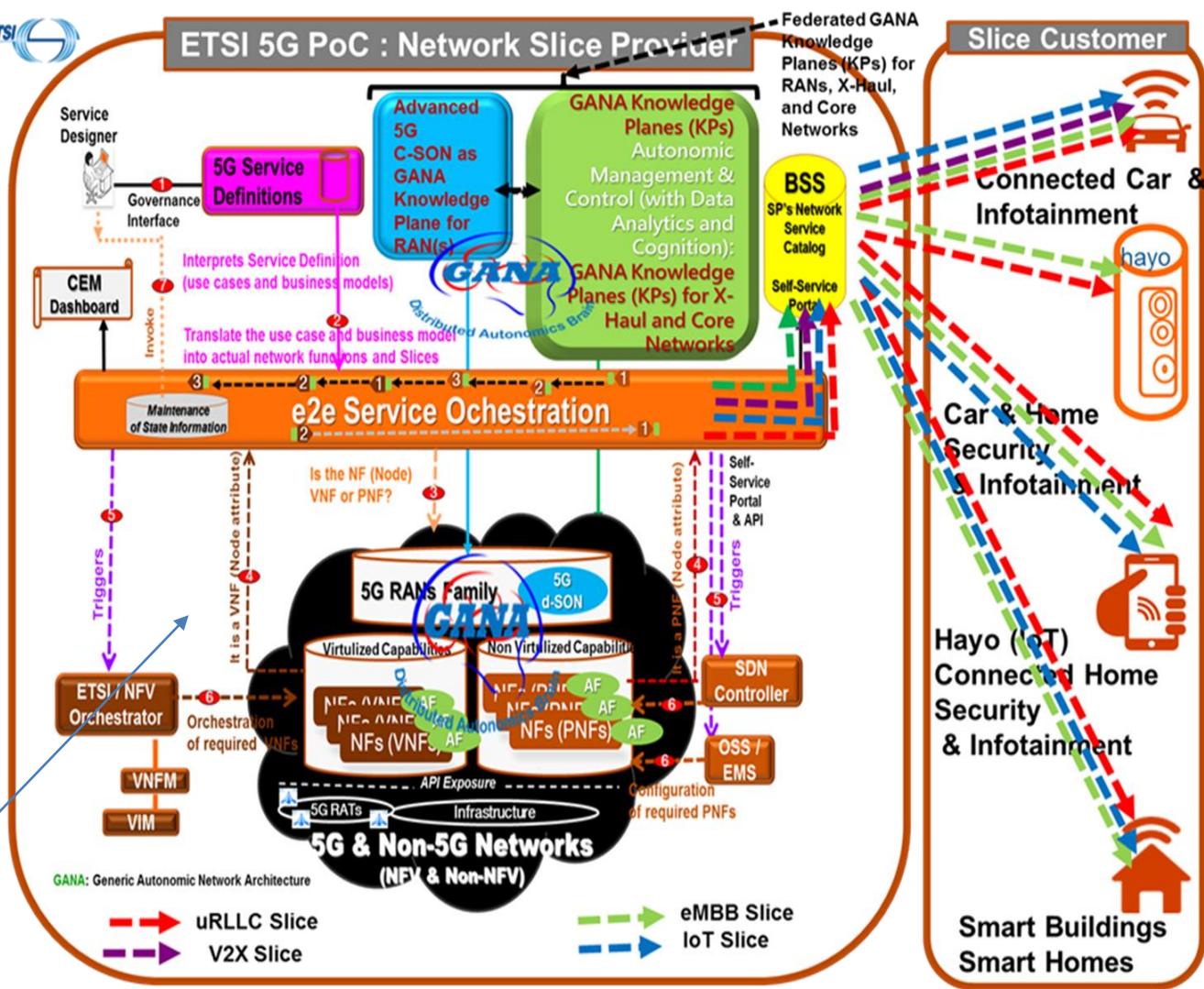
# Introduction to the ETSI INT AFI WG 5G GANA PoC and Consortium (Open to Join)



- Orange
  - Verizon
  - NTT
  - Telecom Italia
  - Altran
  - Asocs Networks
  - Cellwize
  - Huawei
  - Incelligent
  - QalyCloud
  - IPv6 Forum
  - Big Switch Networks
- 

**Remark on this ETSI PoC Consortium:** This PoC Consortium is not “closed-consortium”, and welcomes new members in the course of the PoC duration, which goes beyond 2019. This **Demo-3** is the **third Demo of a series of Planned Demos on various aspects** of the overall ETSI 5G Network Slicing PoC, and so more Demos are expected in the duration of the PoC over 2018/2019 and beyond.

**Note:** The processes indicated will be further reviewed and elaborated in the course of the PoC



GANA: Generic Autonomic Network Architecture

## White Papers Published:

Can be Downloaded from  
here:

[https://intwiki.etsi.org/index.php?title=Accepted\\_PoC\\_proposals](https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals)

- ***White Paper No.1: C-SON Evolution for 5G, Hybrid SON Mappings to the ETSI GANA Model, and achieving E2E Autonomic (Closed-Loop) Service Assurance for 5G Network Slices by Cross-Domain Federated GANA Knowledge Planes***
- ***White Paper No.2: ONAP Mappings to the ETSI GANA Model; Using ONAP Components to Implement GANA Knowledge Planes and Advancing ONAP for Implementing ETSI GANA Standard's Requirements; and C-SON – ONAP Architecture***
- ***White Paper No.3: Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring and Feeding of Knowledge into the ETSI GANA Knowledge Plane for Autonomic Service Assurance of 5G Network Slices; and Orchestrated Service Monitoring in NFV/Clouds***

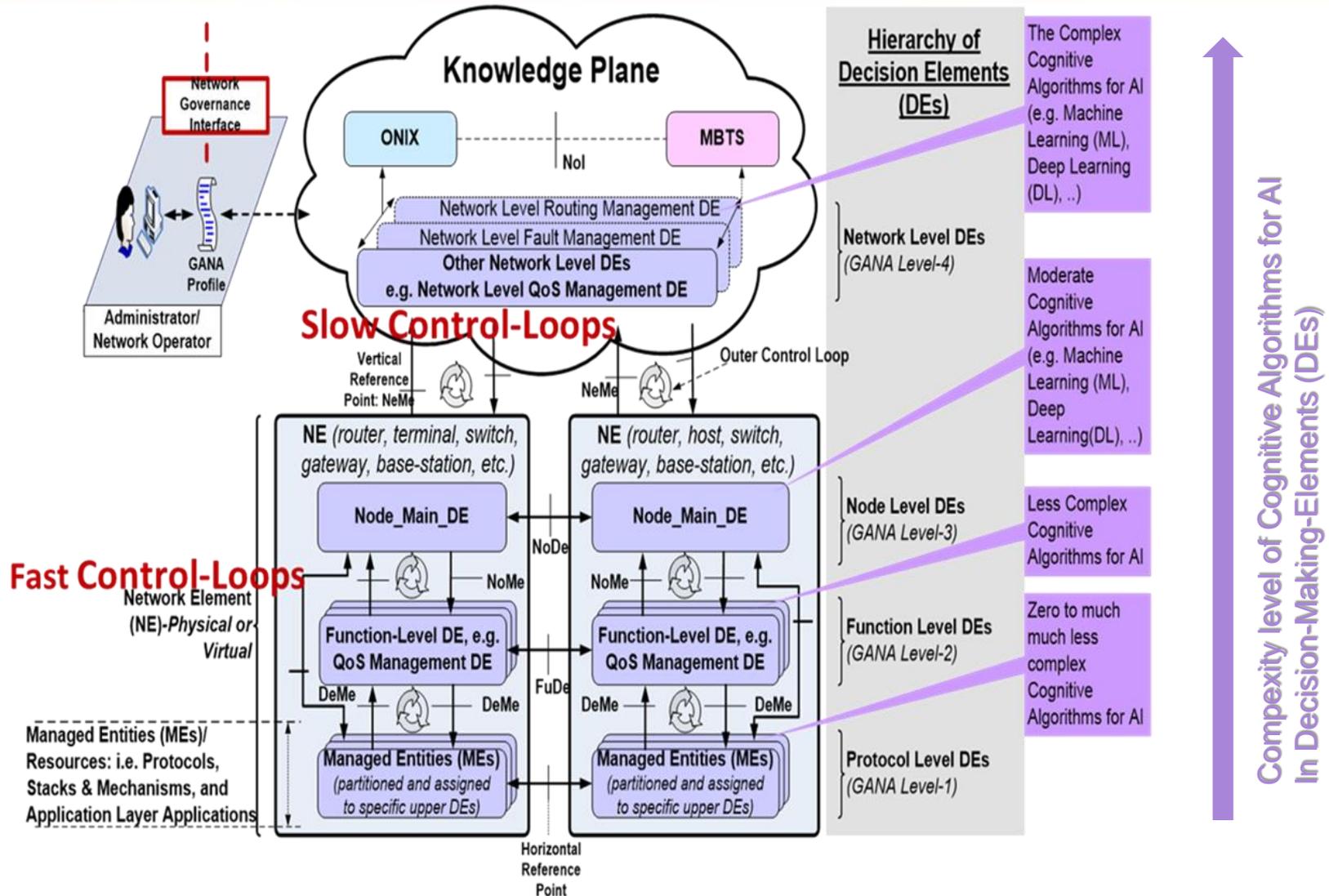


# Multi-Layer Autonomics and the Integration of the ETSI GANA Knowledge Plane (KP) with other systems, e.g. with Orchestrators, SDN Controllers, NFV MANO, and OSS/BSS or Configuration Management Systems

# ETSI GANA Reference Model; Instantiations onto various Network and Mngnt & Control Architectures



ETSI TS 103 195-2

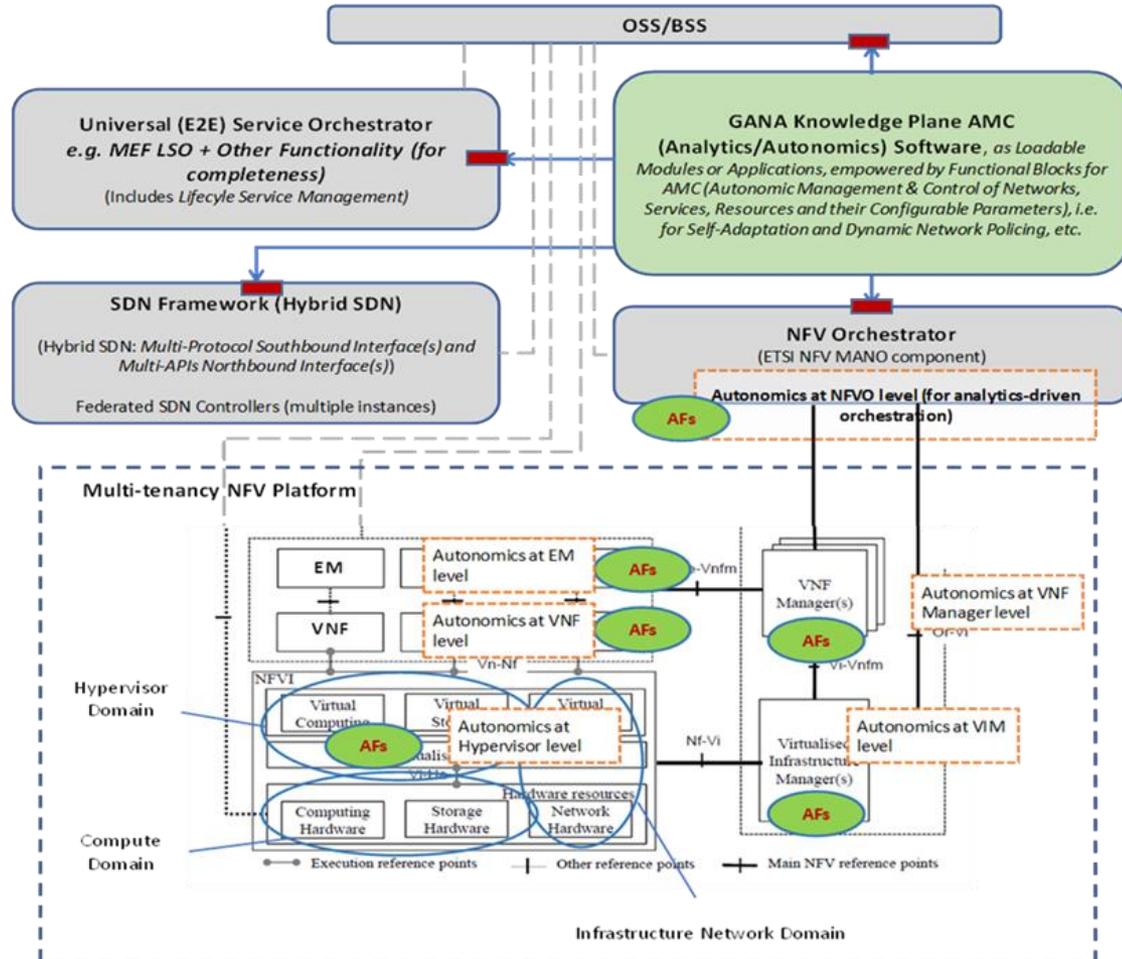


# Multi-Layer Autonomics and the Integration of the ETSI GANA Knowledge Plane (KP) with other systems



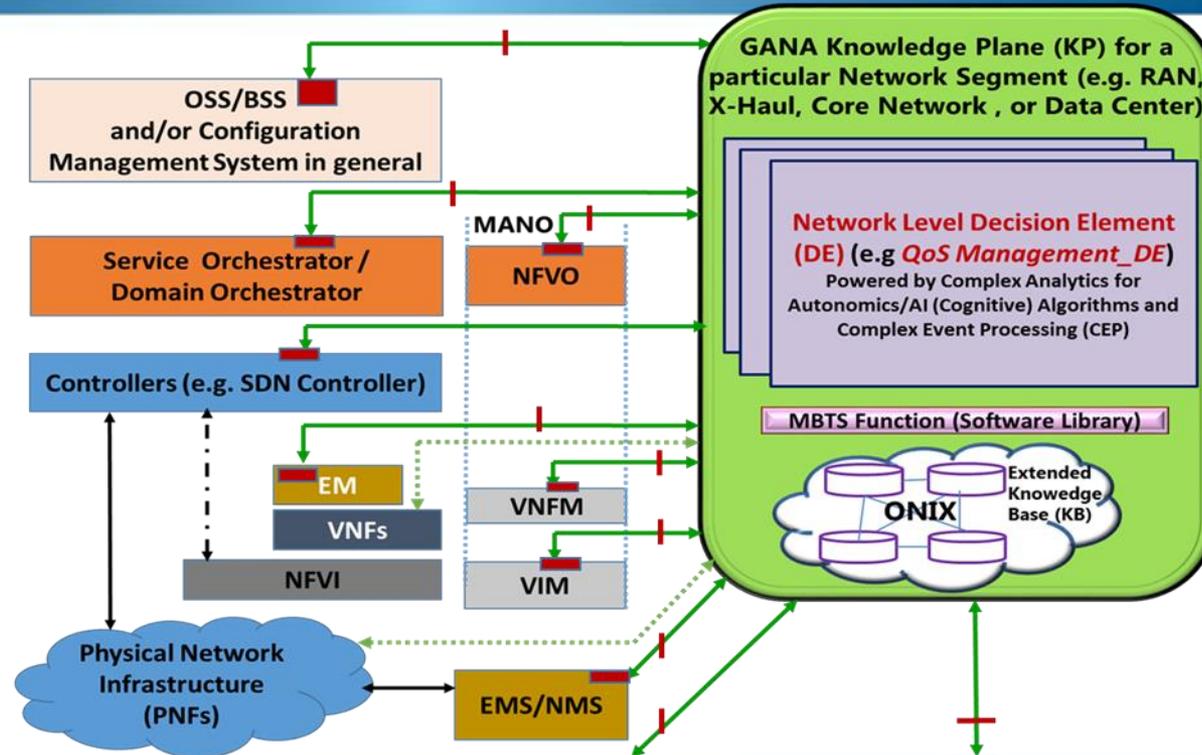
Enabling “Advanced Management & Control Intelligence” at various Layers of Abstraction through Autonomic Management & Control (AMC) Software with Real-Time and Predictive Analytics, as Loadable Modules or Applications

**Legend:**  
 = NBI (NorthBound Interface) implemented as an API (e.g. RESTful API) or Protocol. The GANA KP uses the NBI exposed by the entity to program the entity to export Data, Info, Knowledge, or Events to the GANA KP or other consumers



**Key:** AF = Autonomic Function (i.e. Decision-making logic that realizes a Control-Loop(s) over Managed Entities under its control)

# GANA KP's data sources diversity, events visibility and consumption into KP DEs; KP Integration Options



## Legend:

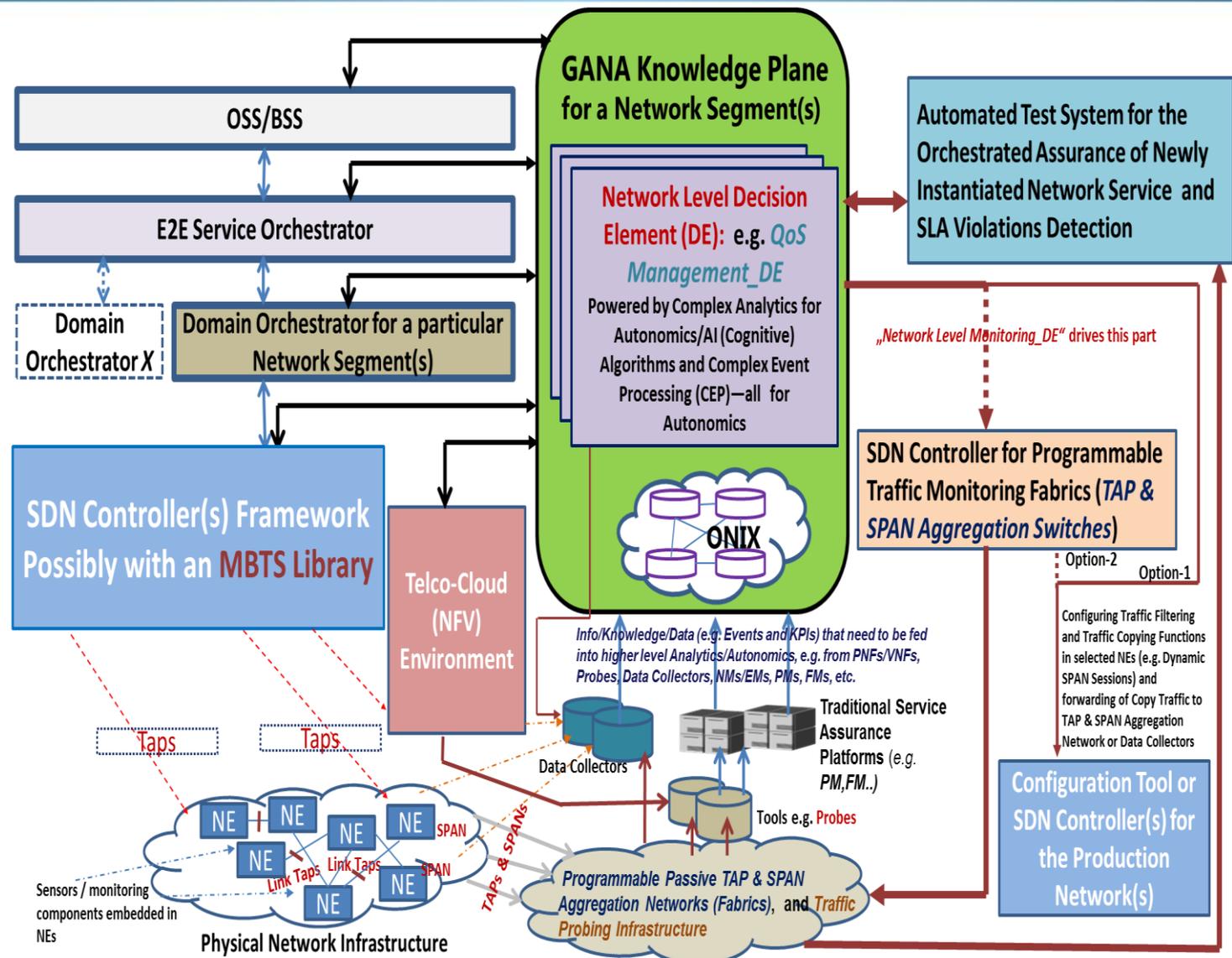
**■ = NBI (NorthBound Interface)** implemented as an **API** (e.g. RESTful API) or **Protocol**. The GANA KP uses the NBI exposed by the entity to program the network or services, or to configure the entity to export Data, Info, Knowledge, or Events to the GANA KP or other consumers

Certain **Big-Data Applications & other Applications** (e.g. Optimization Apps) that should interwork with the KP or can be invoked by KP— *if such Applications couldn't be implemented as integral parts of the KP* (either as embedded parts of DE logic or as Analytics Modules commonly shared by the multiple KP DEs)

## Other Types of Data/Info/Knowledge Sources & Event Sources:

- *Meta-Data from NEs/NFs; Syslog; SNMP; NetFlow/IPFIX/sFlow; Telemetry Data; Fault-Management (FM) and Performance Management (PM) Systems; Configuration Management (CM) Platform; Trouble Ticket Systems; Data Collectors; Topology Info; HealthScores Data; Config-Data; Service Definitions and any mappings to QoS Classes, SLA Definitions & Customer Identifiers Info/Data; Other Data/Info Sources;*

# ANA KP's data sources diversity, events visibility and Monitoring Data consumption into KP DEs



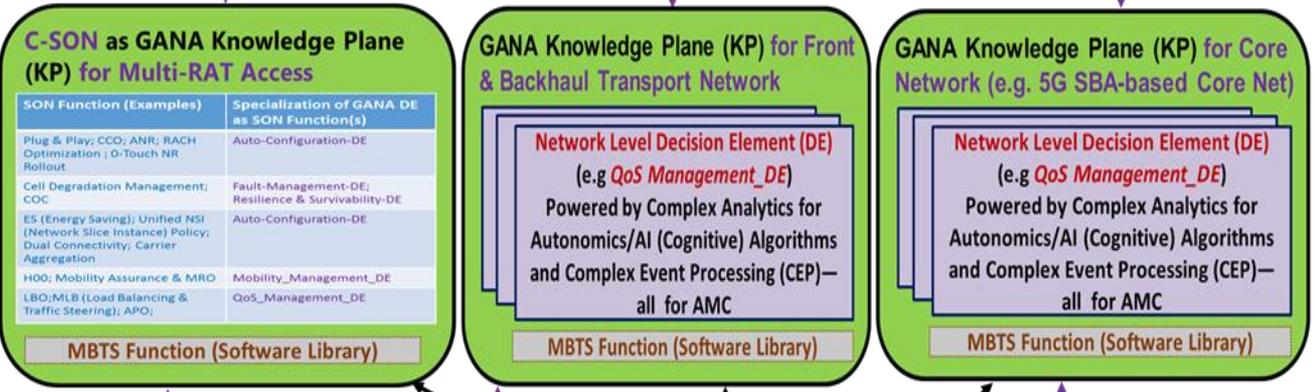


**Federation of GANA Knowledge Planes for E2E  
Autonomic (Closed-Loop) Service Assurance of  
5G Slices across the various network  
segments/domains**

# Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service Assurance of 5G Slices



Interworking/Coordination Reference Point for E2E Federation of the Knowledge Planes (KPs) for E2E Autonomic (Closed-Loop) Service Assurance

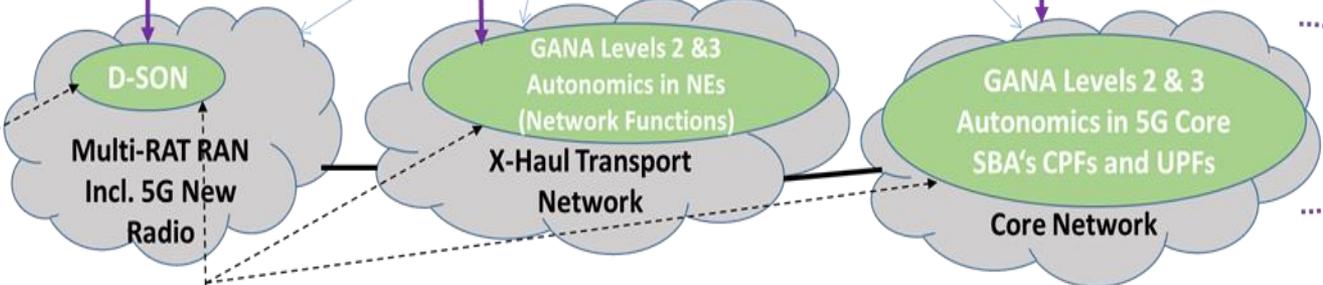
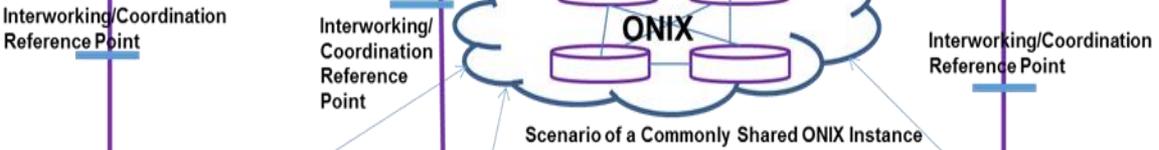


C-SON = GANA Knowledge Plane for RAN

Slow Control-Loops

Slow Control-Loops

Slow Control-Loops



GANA Levels 2 & 3 DEs for Network Infrastructure (e.g. RAN) Network Elements (NEs)

Fast Control-Loops (realized by GANA Levels 2 & 3 in NEs and in 5G Core SBA's CPS and UPS Services)

### GANA Hierarchy of Decision Elements(DEs)

**Network Level DEs (GANA Level-4)**  
 For Higher Level Autonomics Using the More Complex Cognitive Algorithms (e.g. Machine Learning and Deep Learning AI algorithms) that drive "Slow Control Loops" that operate on the wider network-wide views to Self-Adapt the underlying network services

**Node and Function Level DEs (GANA Levels 2 & 3)**  
 For Lower Level Autonomics Using the Less Complex Cognitive Algorithms needed to drive "Fast Control Loops" for local reaction within the NEs or Network Functions (e.g. 5G SBA's CPFs and UPFs)



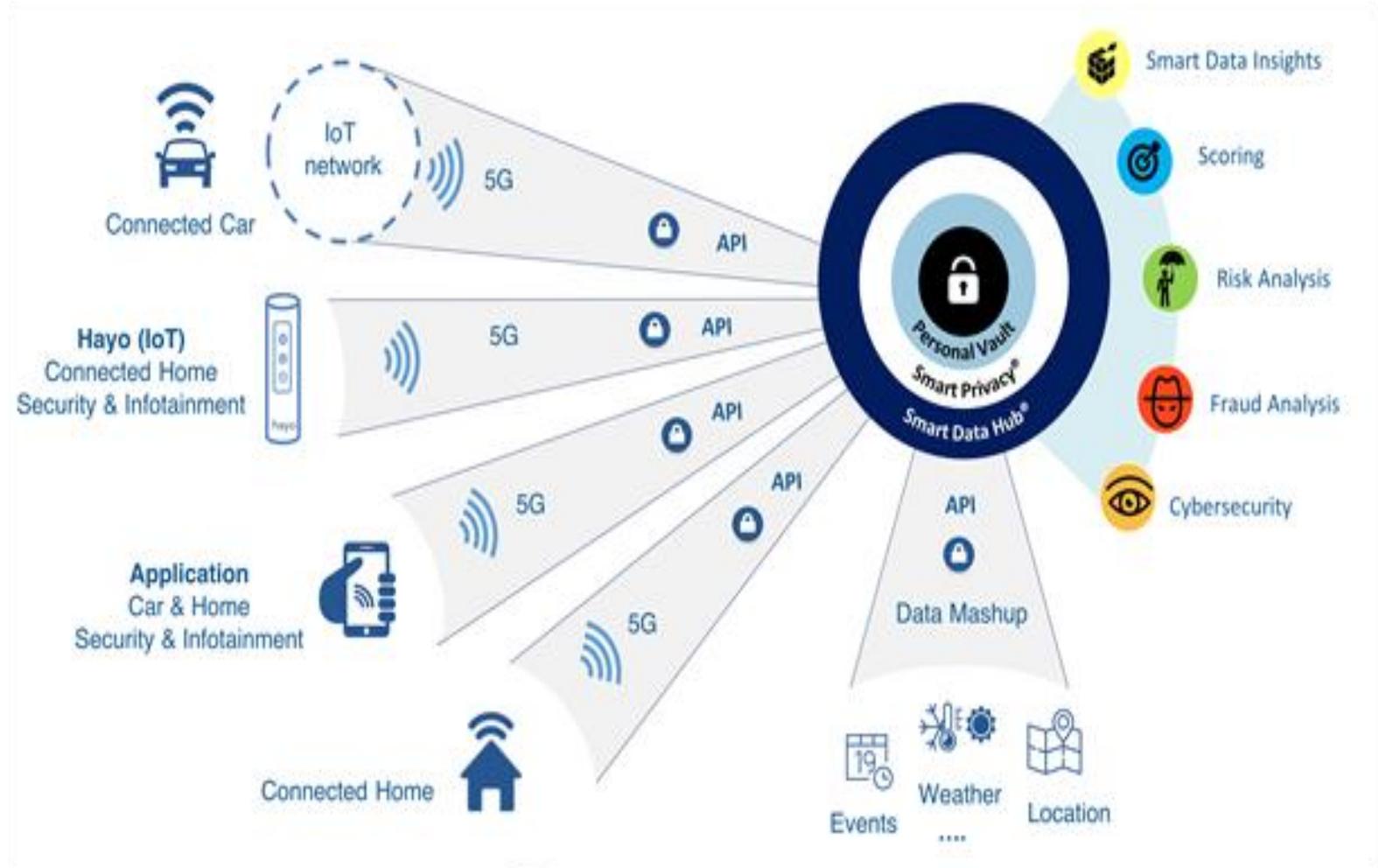
**Demos covered so far (Demo1, Demo2,  
Demo3)**

## Smart Insurance Providers as Key Requesters and Consumers of 5G Network Slices Delivery Services by Service / Slice Providers

Application	Network Slice Type required
Connected Car & Infotainment	<ul style="list-style-type: none"> <li>• eMBB (SST 1)</li> <li>• uRLLC (SST 2)</li> <li>• mIoT (SST 3)</li> <li>•</li> </ul>
Car & Home Security & Infotainment	<ul style="list-style-type: none"> <li>• eMBB (SST 1)</li> <li>• uRLLC (SST 2)</li> </ul>
Hayo (IoT) Connected Home Security & Infotainment	<ul style="list-style-type: none"> <li>• eMBB (SST 1)</li> <li>• muRLLC (SST 2)</li> <li>•</li> </ul>
Smart Buildings & Smart Homes	<ul style="list-style-type: none"> <li>• eMBB (SST 1)</li> <li>• uRLLC (SST 2)</li> <li>• mIoT (SST 3)</li> </ul>

# Demo-1 by QalyCloud: Smart Insurance Ecosystem

## QalyTrust® Smart Insurance





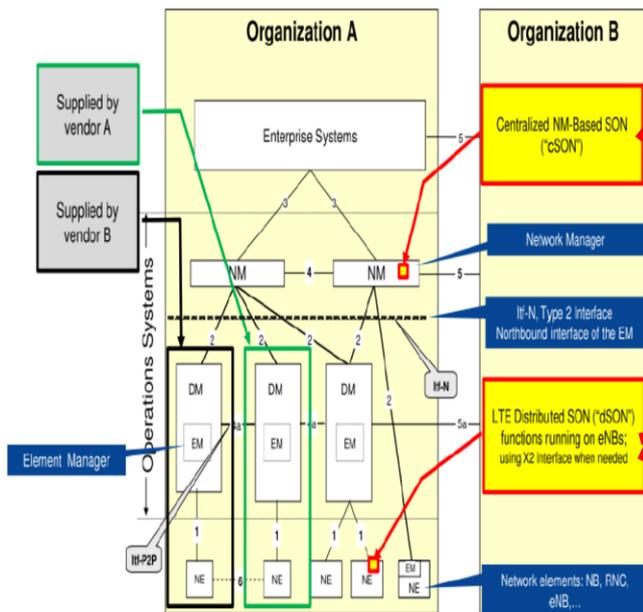
**C-SON Evolution for 5G, Hybrid SON Mappings to the ETSI GANA Model, and achieving E2E Autonomic (Closed-Loop) Service Assurance for 5G Network Slices by Cross-Domain Federated GANA Knowledge Planes**

# Hybrid-SON Model Mappings to the ETSI GANA Model

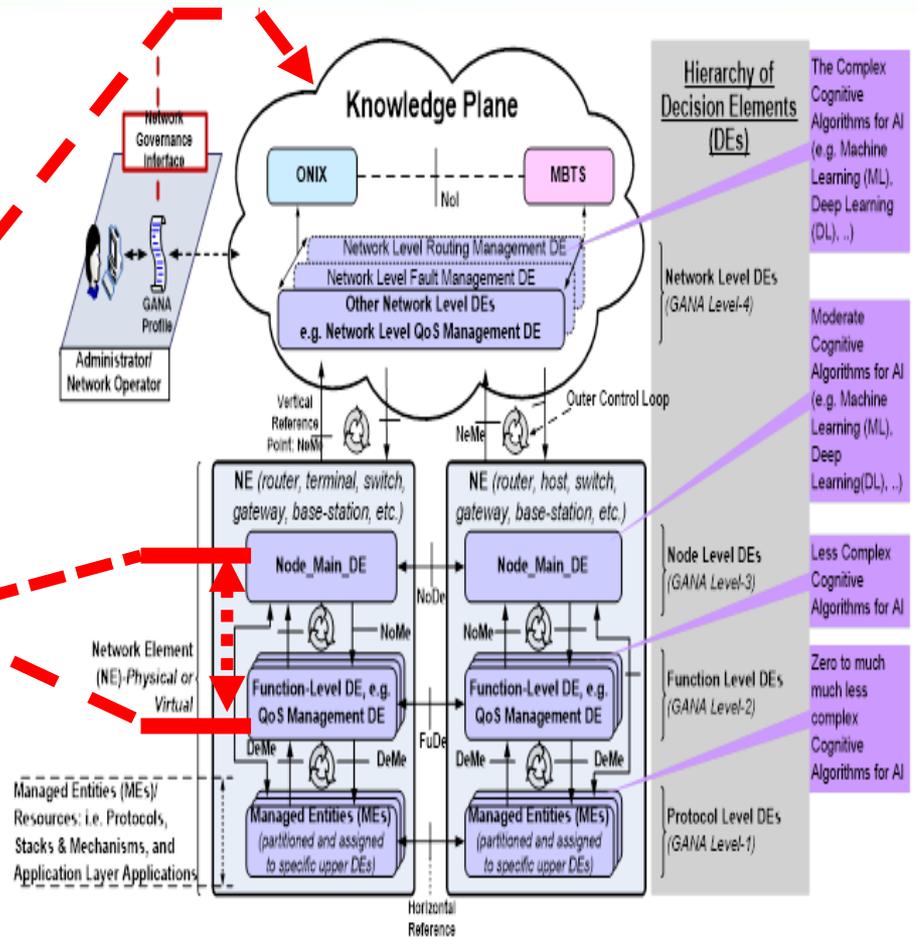


## 3GPP Management Architecture

Centralized SON and Distributed SON



RAN vendors normally supply NEs (RNCs, NodeBs, eNodeBs etc.) together with the Element Manager (EM)  
The only really standardized interface is the EM north bound (Type 2) interface; typically conformant with 32 or 28 series of 3GPP standard



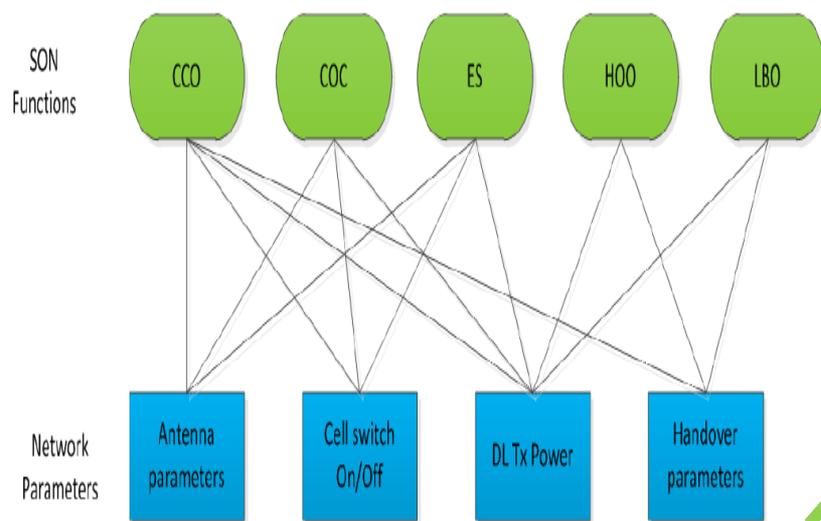
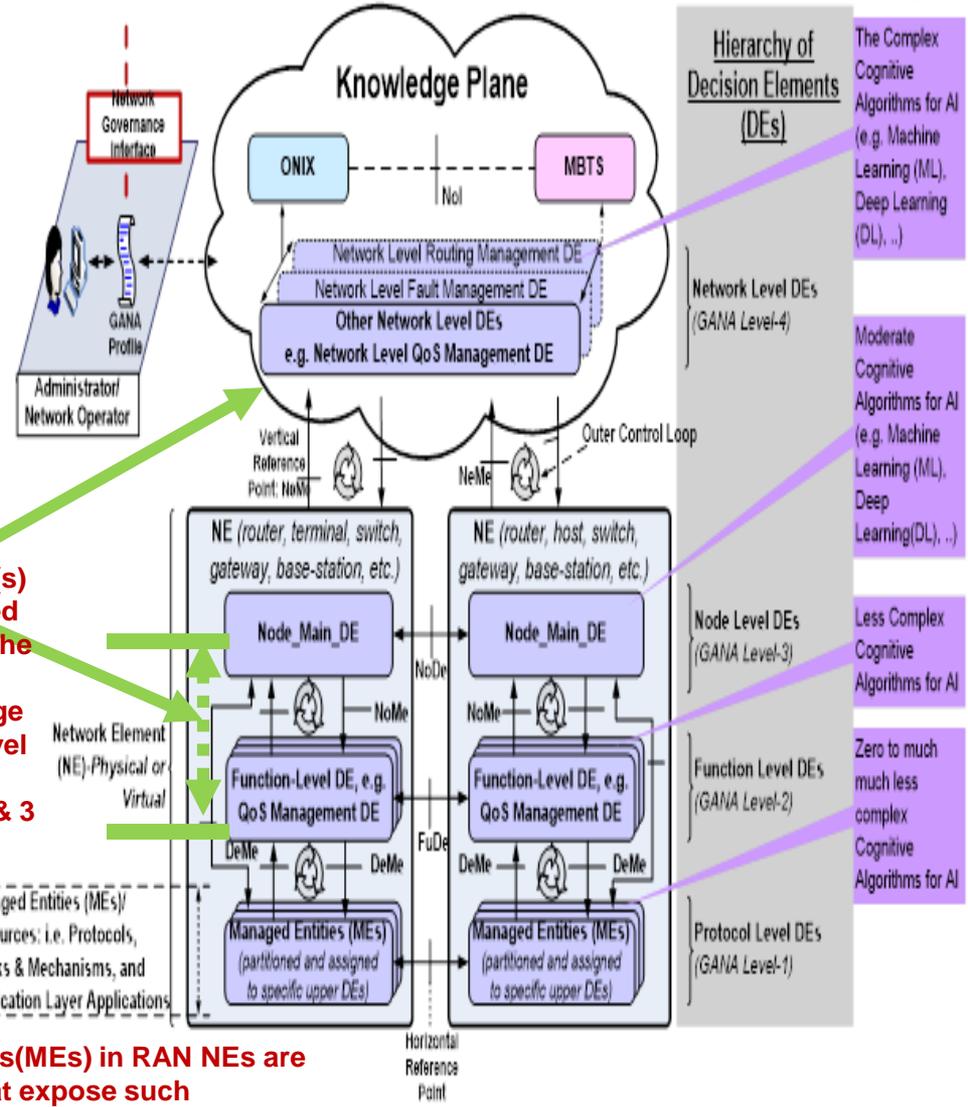
**GANAs for the RAN is realized by Hybrid SON (C-SON (cognitive) complemented by D-SON in eNBs)**  
**SON Function = GANA Decision Element (DE)**  
**C-SON with Cognitive SON Functions = GANA Knowledge Plane for the RAN**

# SON Mappings to the ETSI GANA Model;

## D-SON = GANA Levels 2 and 3 DEs Implementation



SON Function	Specialization of GANA DE as SON Function(s)
Plug & Play; CCO; ANR; RACH Optimization ; 0-Touch NR Rollout	Auto-Configuration-DE
Cell Degradation Management; COC	Fault-Management-DE; Resilience & Survivability-DE
ES (Energy Saving); Unified NSI Policy; Dual Connectivity; Carrier Aggregation	Auto-Configuration-DE
H00; Mobility Assurance & MRO	Mobility_Management_DE
LBO;MLB (Load Balancing & Traffic Steering); APO;	QoS_Management_DE



**SON Function(s) introduced either in the GANA Knowledge Plane Level or GANA Levels 2 & 3**

**Managed Entities (MEs) in RAN NEs are NE's entities that expose such Configurable Parameters**

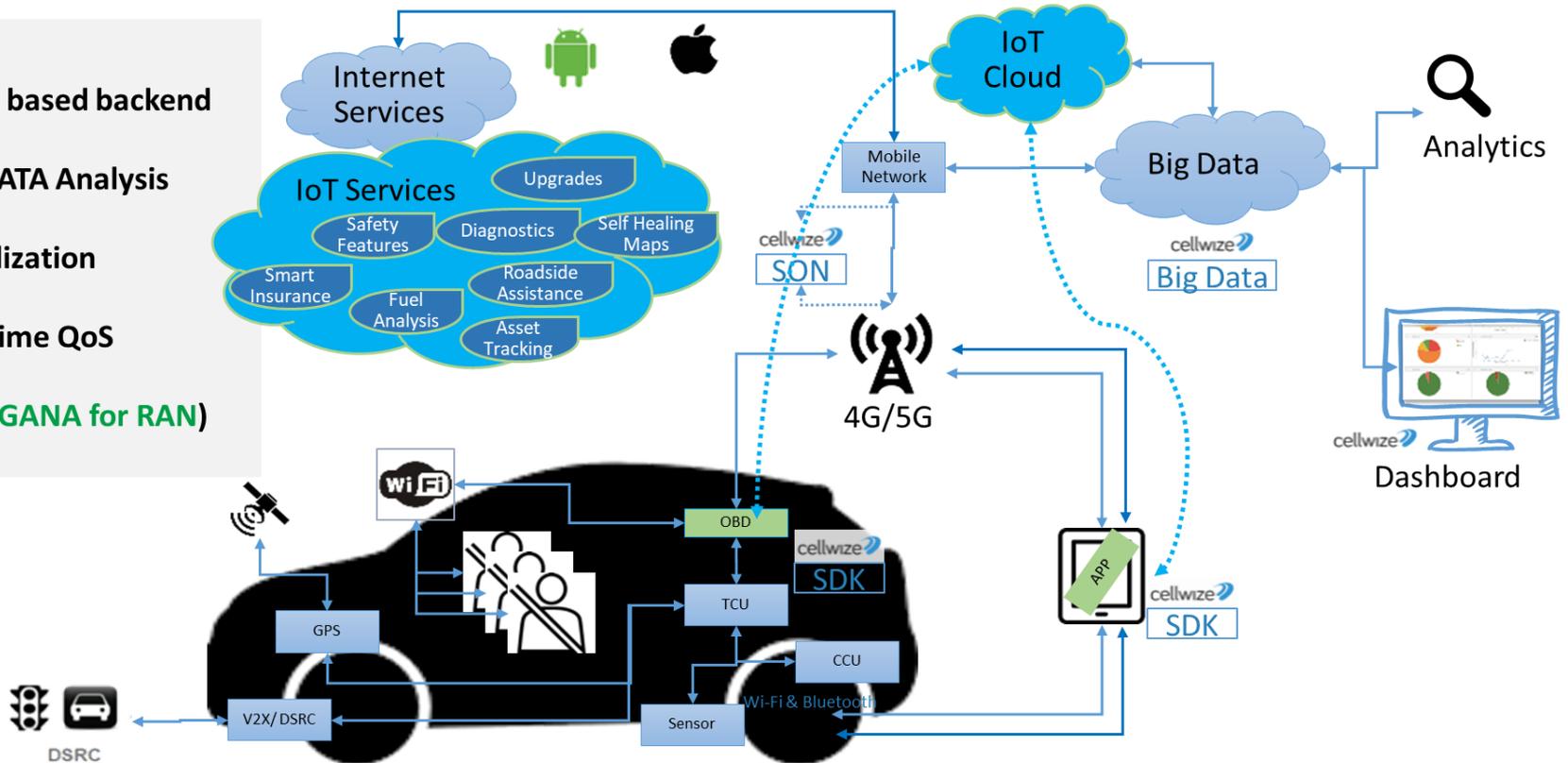
# GANA Knowledge Plane Level Autonomics vs. Lower Level Autonomics on the Example of C-SON



	D-SON (GANA Levels 2&3)	C-SON (GANA Level 4)
Network View	Micro edge network view limited to the equipment vendor eNodeBs	Entire Network (bigger picture) view spanning across vendors and technologies
Data Accessibility	D-SON functions have access to a limited data set of the edge eNodeB and its local neighbourhood	C-SON has access to a wide data set covering all node types (eNodeB, NodeB and BTS) and external data sources (e.g., analytics and crowdsourcing)
Operational Restrictions	D-SON functions operate with knowledge limited to local surrounding environment and only control own node. Local execution at the network edge.	C-SON functions operate with complete visibility of all nodes and control the entire cluster. Centralized execution at the OSS level.
Multi-Vendor	D-SON only works on own equipment	complete Multi-Vendor support
Cross Technology	4G only (*) Proprietary D-SON solutions exist in 3G (ANR, Scrambling Code collision detection)	2G, 3G, 4G
Customization flexibility	Proprietary "black-box" functions with limited (complex) flexibility	High degree of flexibility, simple to adapt to MNO policies
HetNet Orchestration	Islands of D-SON functions	Entire network orchestration & coordination covering both C-SON and D-SON functions across vendors, technologies and network layers
Data Correlation	limited to eNodeB data	Multi-dimensional data
Cycle time	Short cycle time (mSec) - Real Time use-cases	longer cycle time (min) - Near Real Time use-cases
Performance Load and Coordination	UEs required to read CGI of neighbouring cells, hence can impact inter-node communication (LTE X2 I/F). Coordination overhead increases as the network is densified creating possibility of inconsistencies/conflicts (e.g., PCI confusion)	C-SON collects centralized information through existing North Bound Interfaces (NBI) and has no impact UE performances. High degree of coordination across a wide geographic area including D-SON islands.
CCO (Antenna tilt Optimization)	Not available	Multi-band & technologies CCO supported
PCI	PCI collision detection (only)	PCI detection and automatic correction
Policy enforcement	Not available	Seamless policy enforcement and consistency management
Inter-RAT	Not available (e.g., ANR IRAT)	Cross technology support LTE to/from UMTS & GSM
RACH Optimization	Not available (RSI & Cell Range)	RSI & Cell Range optimization use-cases supported
Integrated into eNB RRM activities (layer3)	Utilized by D-SON MLB & MRO edge functions	Infeasible for a centralized architecture
Swap/Rehomng process	limited support as D-SON functions utilize 3GPP CGI as the unique identifier of each node	C-SON flexibility allows for MNOs custom node identifier to be utilized for equipment swap or rehomng procedures
Cell Outage Detection and Compensation (CODC)	ANR based compensation	Cluster level ANR and CCO based compensation with embedded rollback mechanism triggered when outage has seized

# Connectivity Eco System for Connected Cars

- Cloud based backend
- BIG DATA Analysis
- Visualization
- Real time QoS
- SON (GAN for RAN)



# Connected Car Service Assurance



## Slice Management & Optimization

Network Intelligence



Network Design  
& Area Density



Control Mobility  
Parameters



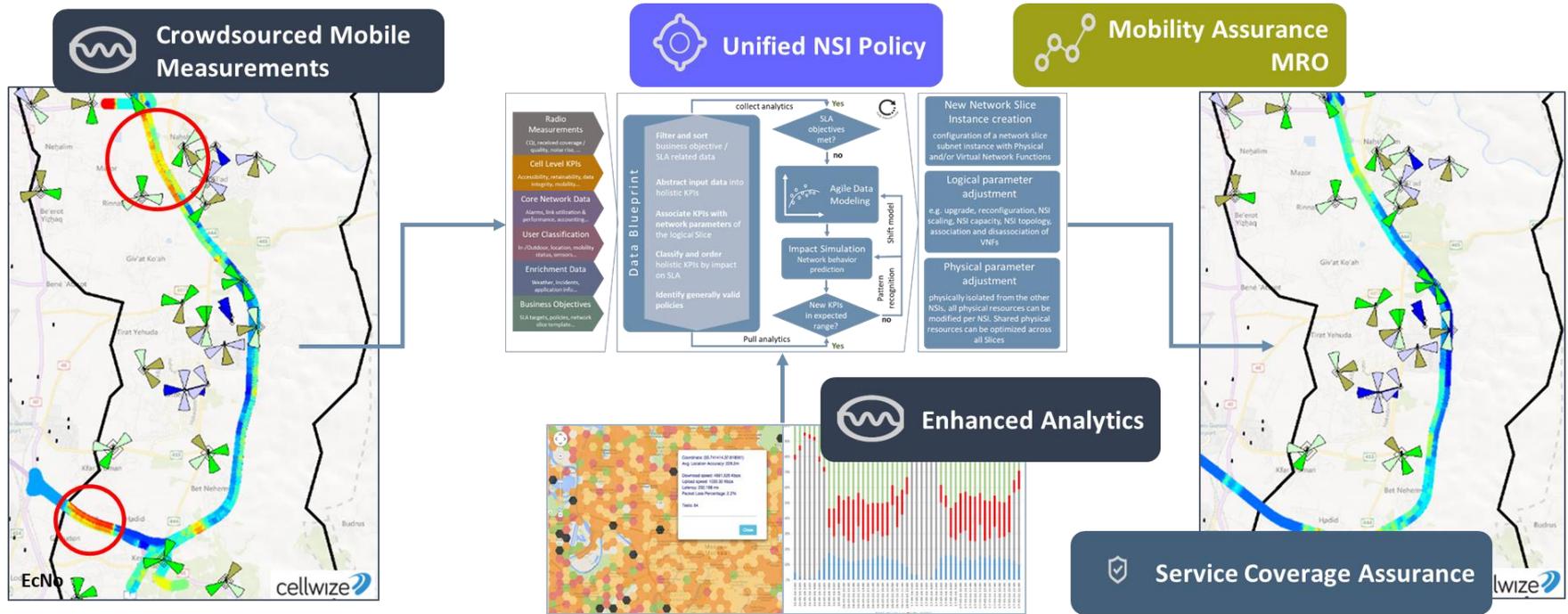
Network Guard



- In-Car Entertainment
- Insurance
- Autonomous Driving
- Emergency Call
- Upgrades
- Traffic Routing
- Sensors / Diagnostics
- Slice As A Service

Connected Cars Slices

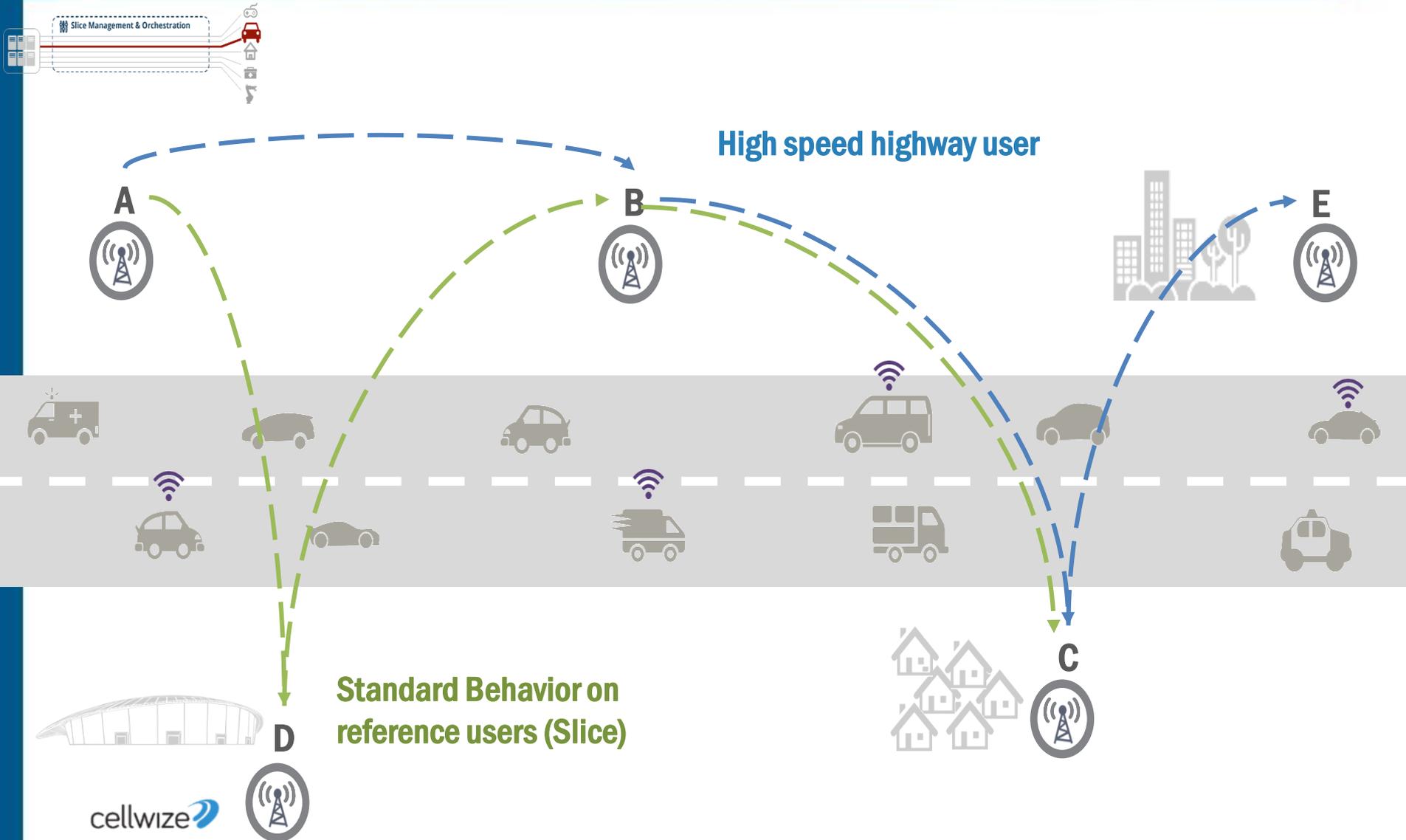
# Cellwize Solution for Connected Cars | Highway Use Case



## Demanded NSI Service Level performance can be assured through:

- The orchestration of enhanced big data analytics in combination with immediate access to unified policies and real time provisioning of NSI modification actions
- The Federation of GANA Knowledge Planes (KPs) for Radio Access-, X-Haul- and Core Networks, and strong interfaces with OSS, EMs/NMs, Orchestrators, SDN, .. for prompt access to knowledge for the KPs

# In 2015 Cellwize successfully executed its first connected cars trial

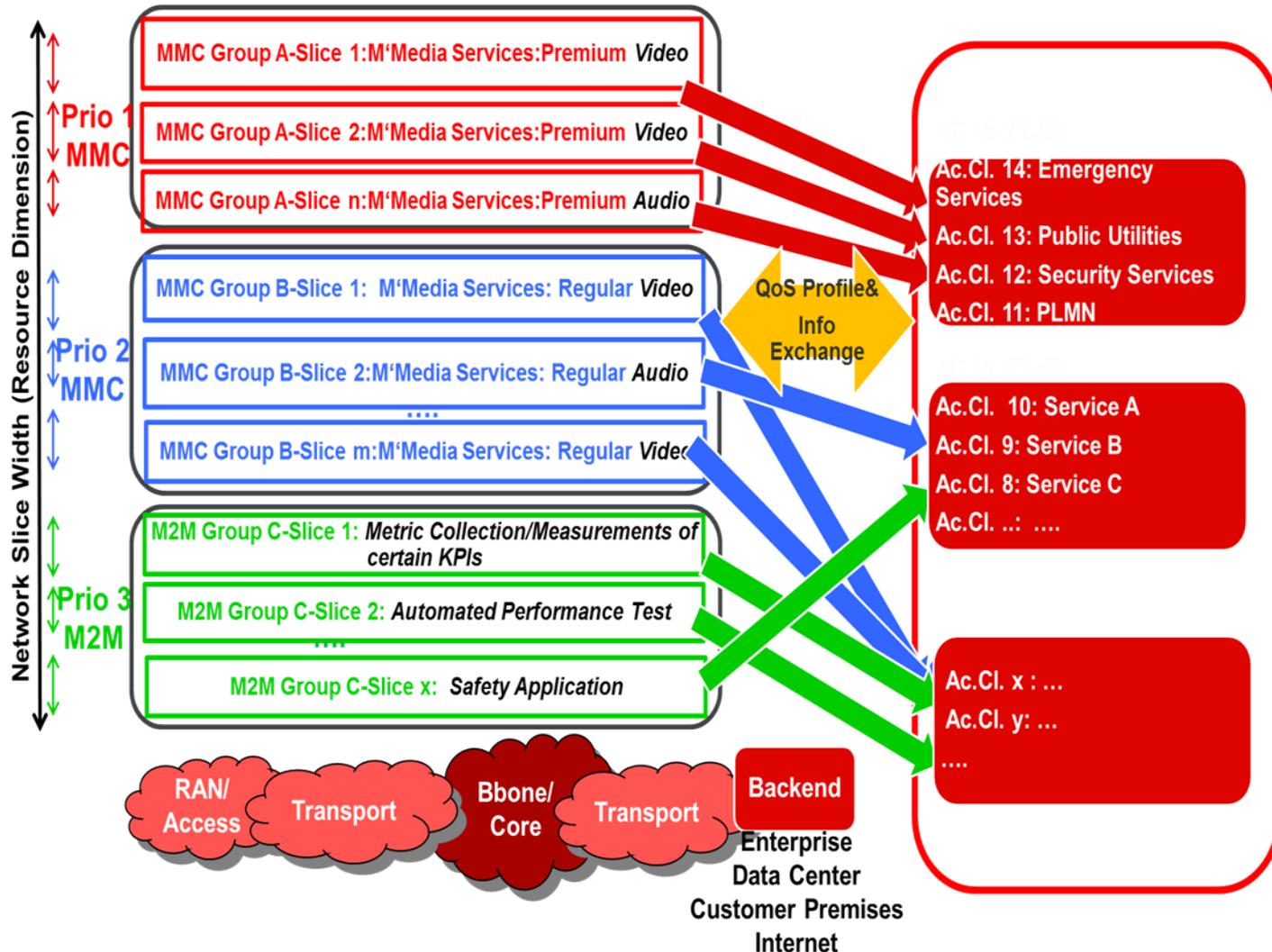




## **Demo-3: QoS Framework for Services delivered within a specific 5G Slice Type:**

**QoS Classes; Prioritization of Slices; and Definitions of QoS Classes and SLAs as inputs to Autonomic Service Assurance**

# QoS Framework for Services delivered within a specific 5G Slice Type

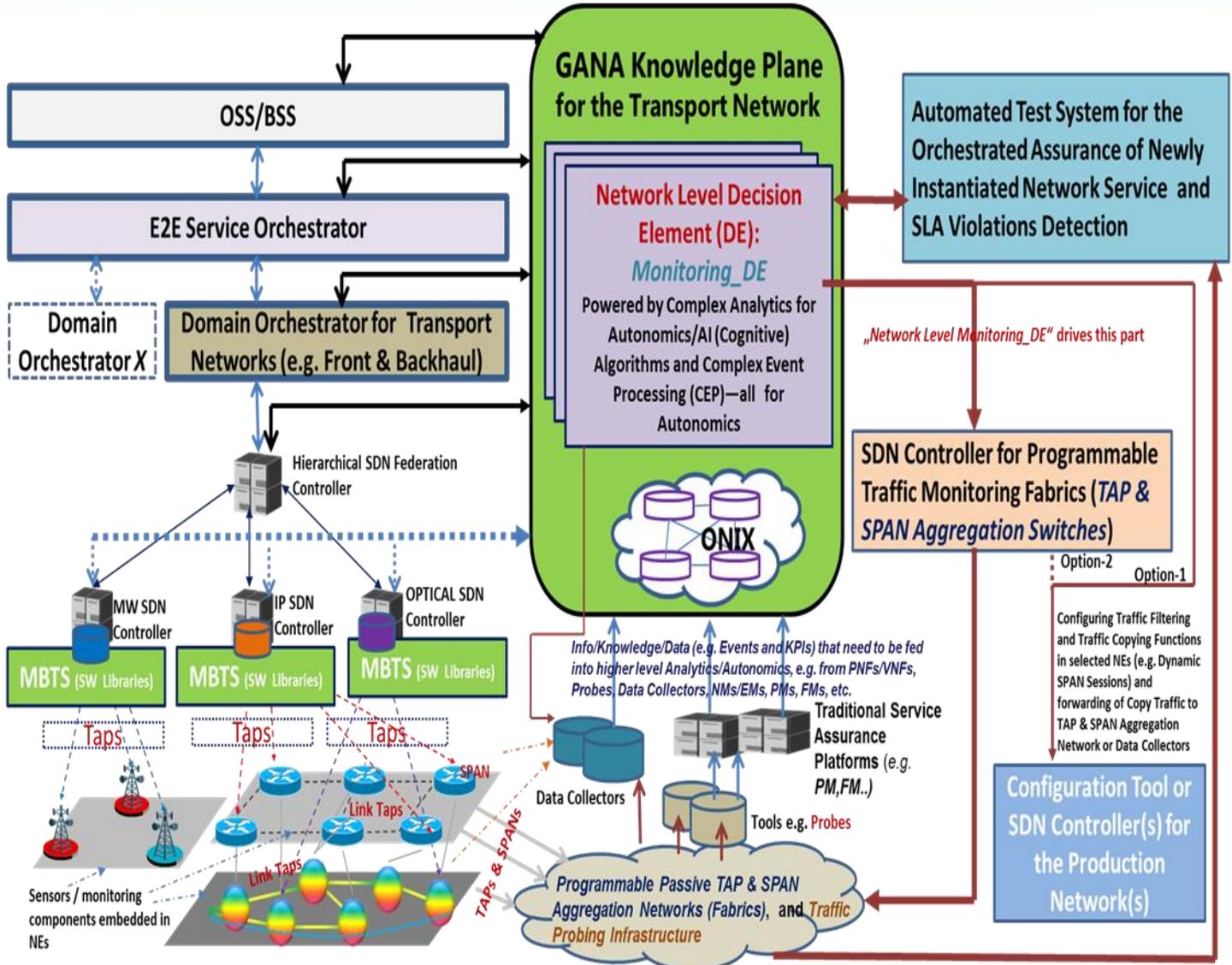


## **Demo-3: Autonomic Monitoring and Programmable Traffic Monitoring Fabrics**

**Enable On-Demand Monitoring and Feeding of Knowledge into the ETSI GANA Knowledge Plane for Autonomic Service Assurance of 5G Network Slices**



# Programmable Traffic Monitoring Fabrics, Automated Test System for Orchestrated Assurance, SDN Controller(s)

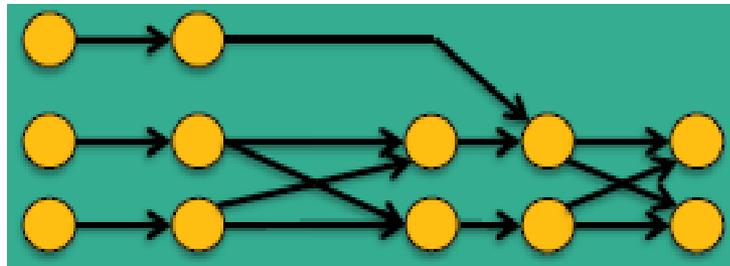


## Demo-3: DataFlow Computing Models

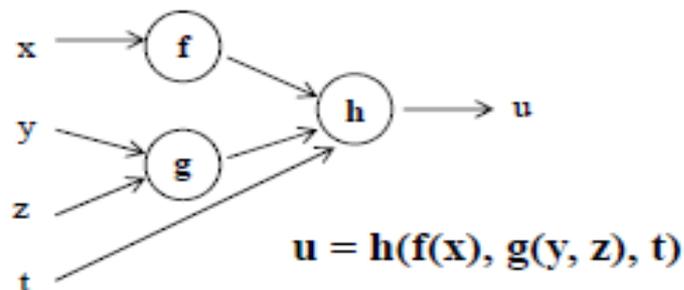
As becoming mainstream approach of event stream processing and distributed monitoring in presence of large amount of data with real-time constraints

## Monitoring with dataflow streams

- Dataflow computing vs. control flows
- Distributed dataflows as DAGs, with functions to process data streams



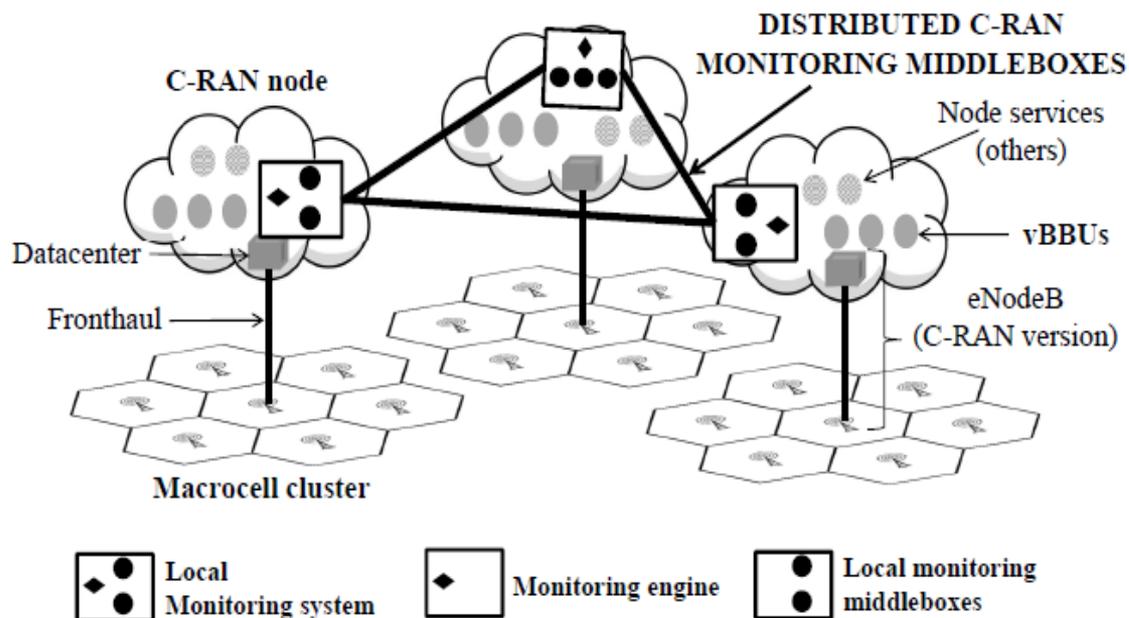
## Functional programming



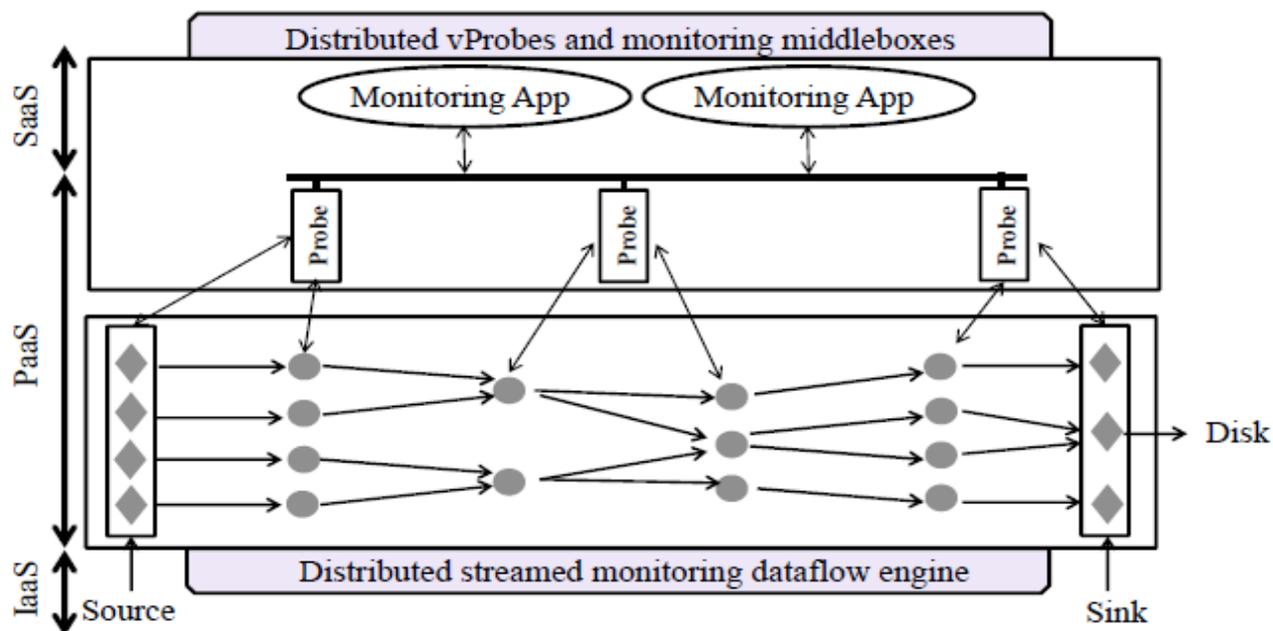
## Objectives

- Framework for 5G RAN monitoring VNFs (cloud-based)
- Support for large numbers of monitoring middleboxes and event sources
- Openness, event streams (real-time), programmable dataflows

## Cloud-RAN services and monitoring middleboxes



## Engineering cloud-RAN monitoring middleboxes



## PROPOSAL

- PoC with one cloud-RAN node and cloud-native software
- Extension to multiple cloud-RAN nodes
- Extension to other network segments

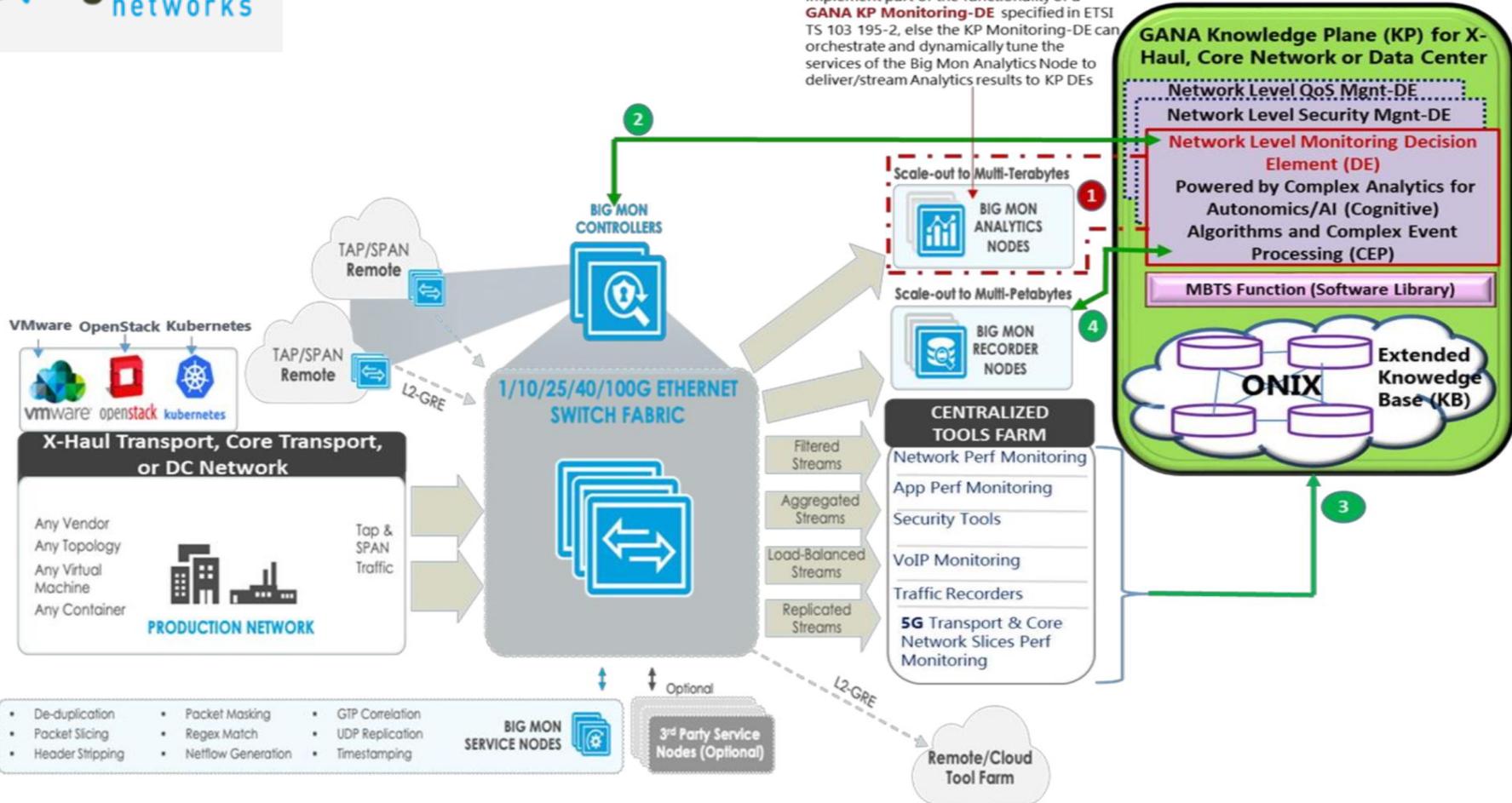


# Demo by Big Switch Networks: Capabilities of Big Switch Networks for Programmable Traffic Monitoring Fabrics *(in line with the ETSI GANA Framework)*

# Big Monitoring Fabric Architecture – disaggregated programmable and scalable monitoring fabric, API-centric, slice-aware, providing metadata



Big Mon Analytics Node(s) can be used to implement part of the functionality of a **GANA KP Monitoring-DE** specified in ETSI TS 103 195-2, else the KP Monitoring-DE can orchestrate and dynamically tune the services of the Big Mon Analytics Node to deliver/stream Analytics results to KP DEs



- De-duplication
- Packet Slicing
- Header Stripping
- Packet Masking
- Regex Match
- Netflow Generation
- GTP Correlation
- UDP Replication
- Timestamping

**BIG MON SERVICE NODES**

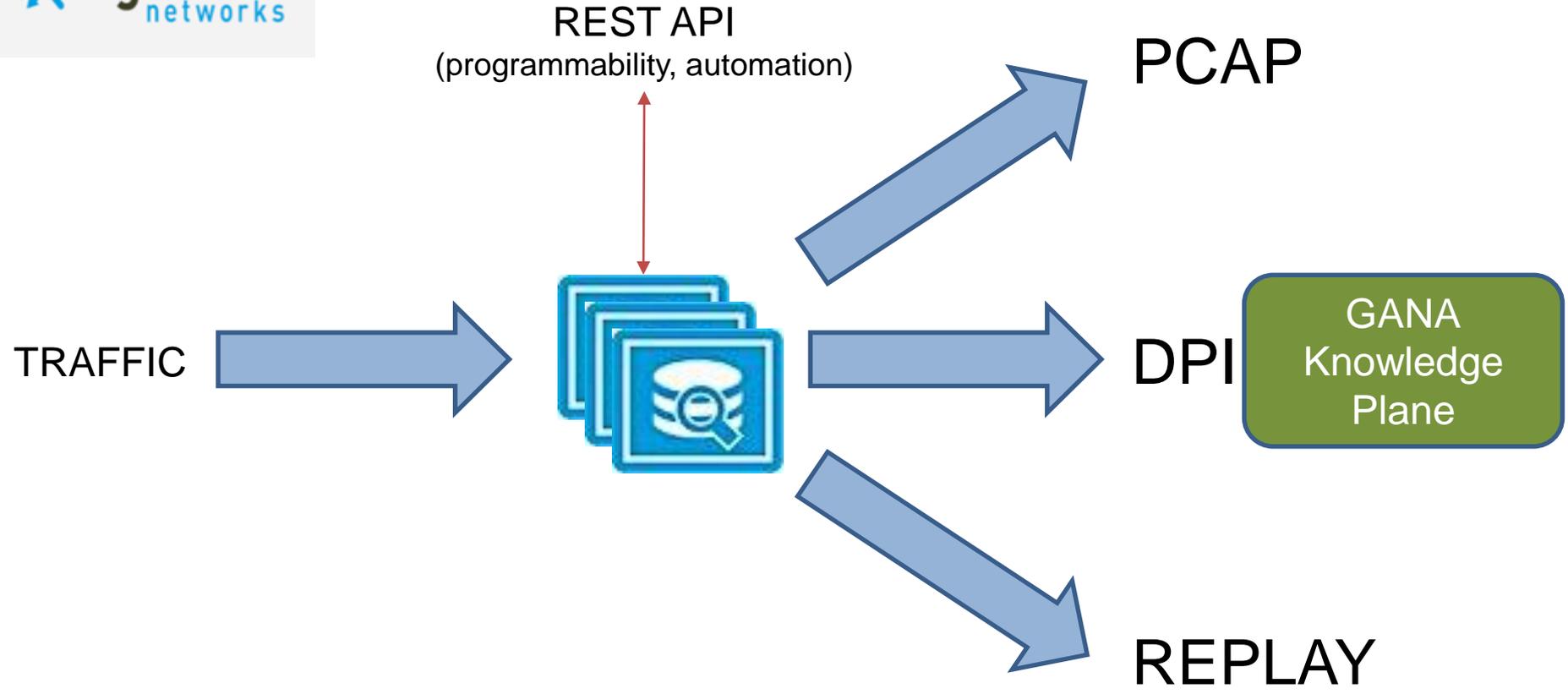
Optional  
**3rd Party Service Nodes (Optional)**

Remote/Cloud Tool Farm

**GANA Knowledge Plane (KP) for X-Haul, Core Network or Data Center**

- Network Level QoS Mgmt-DE
- Network Level Security Mgmt-DE
- Network Level Monitoring Decision Element (DE)  
Powered by Complex Analytics for Autonomics/AI (Cognitive) Algorithms and Complex Event Processing (CEP)
- MBTS Function (Software Library)
- Extended Knowledge Base (KB)  
**ONIX**

# BMF Recorder Node – continuous slice-aware packet capturing for further processing and replaying



**Slice-aware**

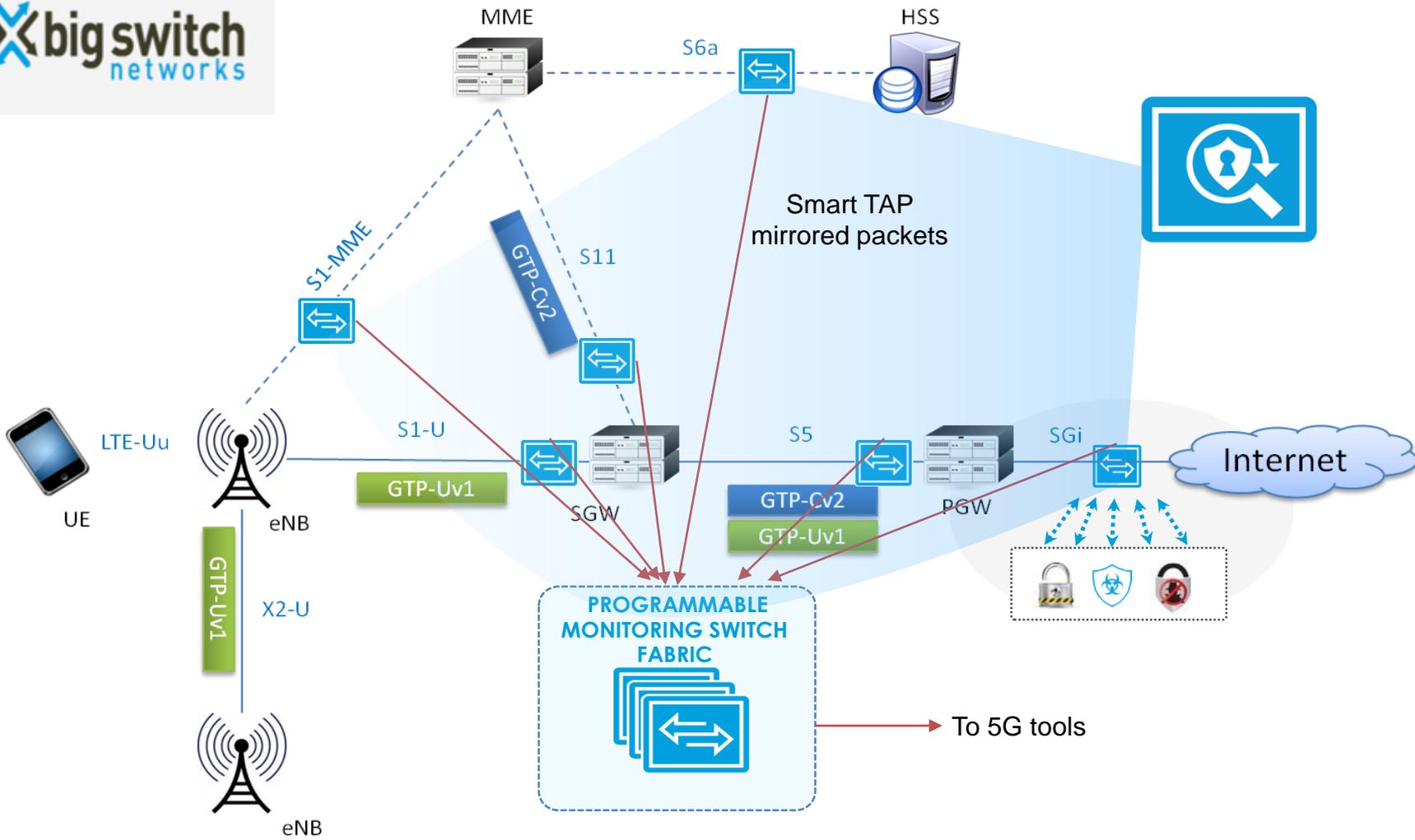
**API-centric**

**Scalable**

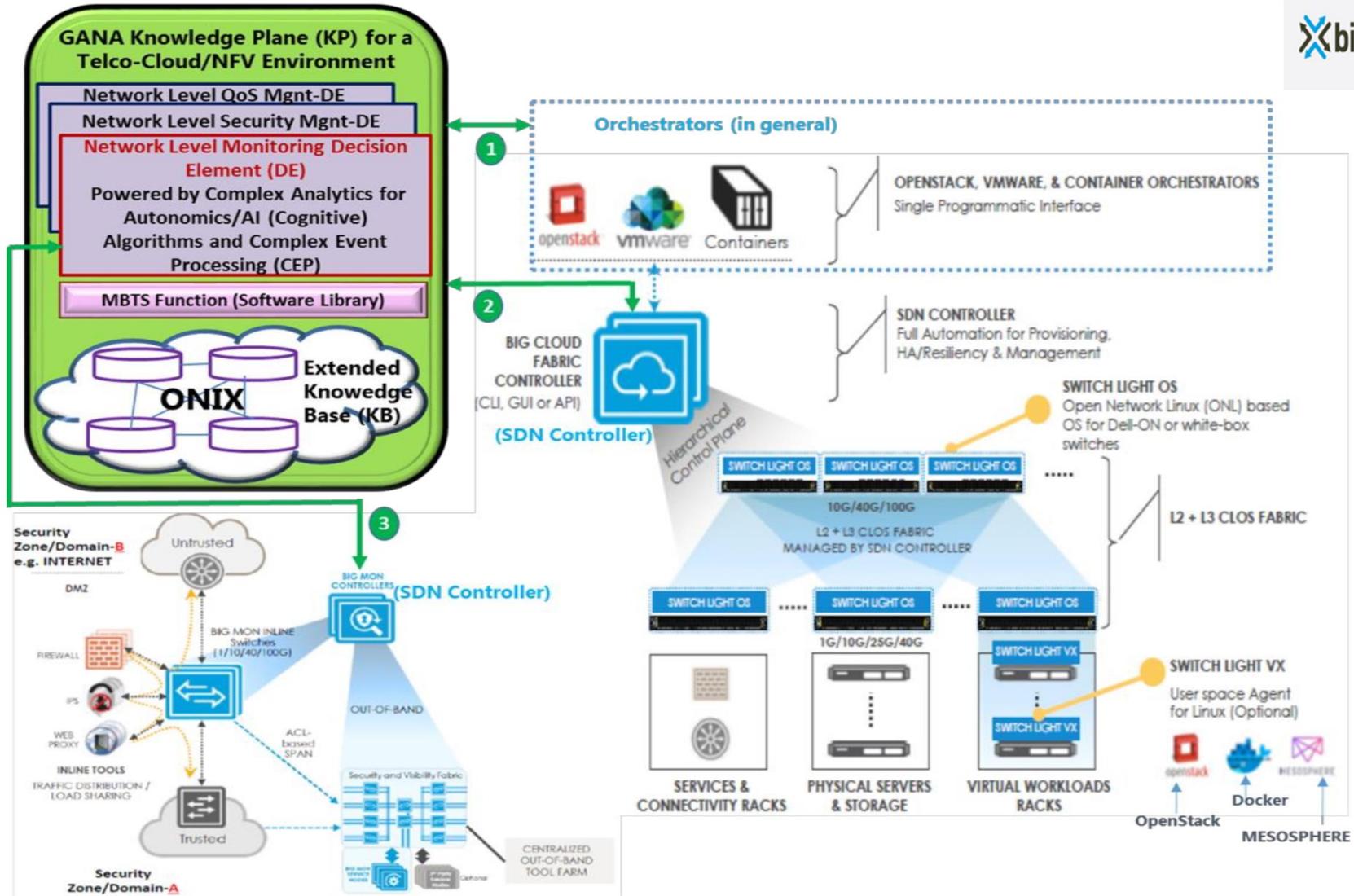


## Big Monitoring Fabric Inline

# BMF Inline Architecture - Smart TAPs/Broker in the Network, reconfigurable by API; Service Chaining for network security



# GANA Knowledge Plane-Driven Orchestration: Big Switch Integration Capabilities



# Examples of Potential Demos invited for: 5G Fixed & Wireless Access (FWA) based on the ETSI TR 103 473 V1.1.2



Interested Organizations or Projects are invited to run showcase Demos based on the ETSI TR 103 473 V1.1.2 (downloadable from here:

[https://www.etsi.org/deliver/etsi\\_tr/103400\\_103499/103473/01.01.02\\_60/tr\\_103473v010102p.pdf](https://www.etsi.org/deliver/etsi_tr/103400_103499/103473/01.01.02_60/tr_103473v010102p.pdf) )

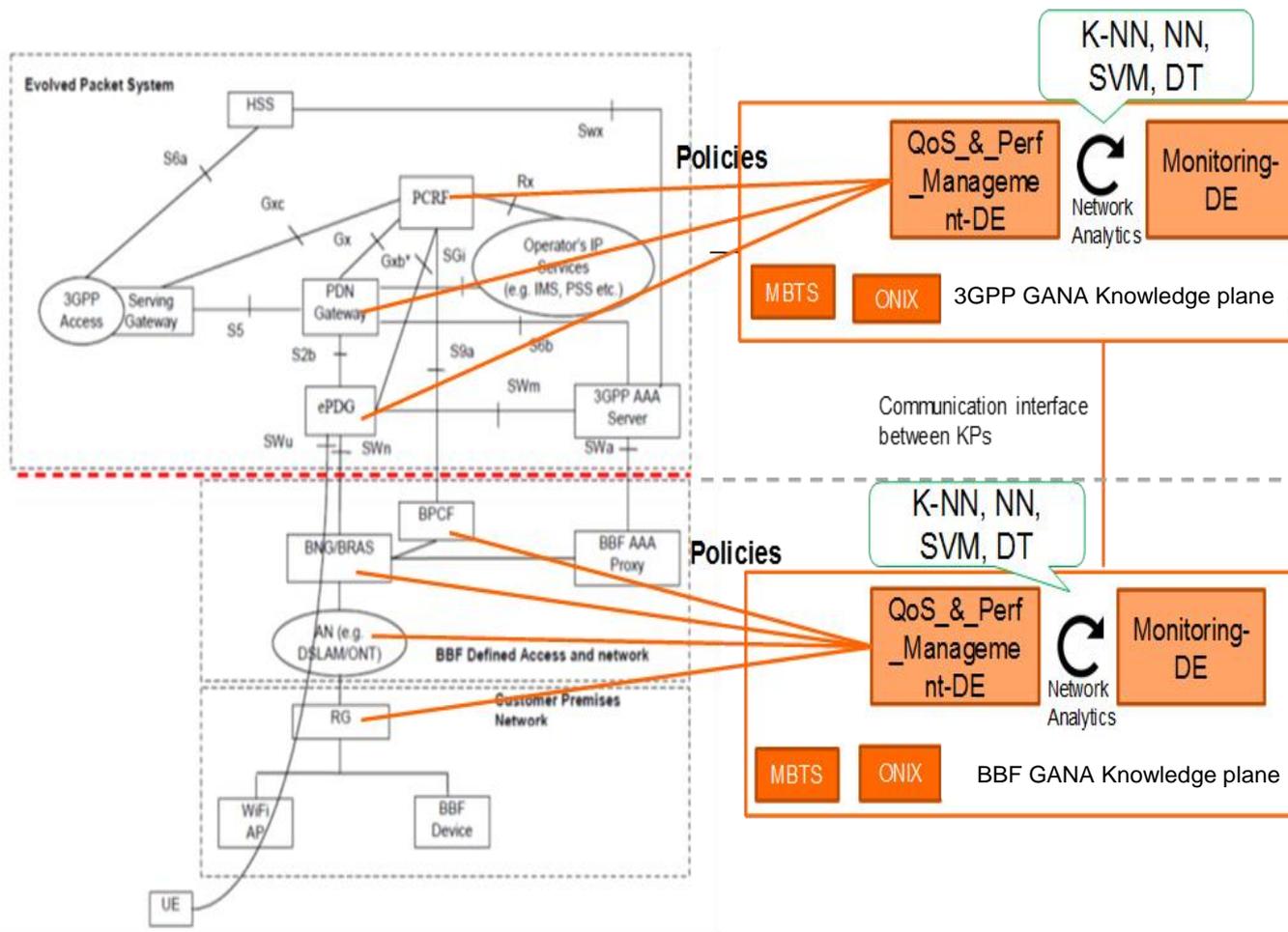
Examples of Topics that can be addressed by Demos are (but not limited to these):

- **Autonomics/Self-Management (Autonomic FCAPS) in a Network Element (NE) and by Distributed DE(s) (Decision Element(s)) Algorithms (including Artificial Intelligence (AI) Algorithms) within the network infrastructure's collaborating NEs**
  - **GANA empowered **Autonomic BNG****
  - **GANA empowered **Autonomic CPE****
  - **GANA empowered **Autonomic Access Node (AN)****
  - **GANA empowered **Autonomic SDAN (Software-Defined Access Network)****
- **Autonomics/Self-Management (Autonomic FCAPS) through Centralized DE Algorithms in the GANA Knowledge Plane for a particular Network Segment**
  - **GANA Knowledge Plane for an **Autonomic 5G Backhaul****
  - **GANA Knowledge Plane for an **Autonomic 5G Fixed Access Network****
  - **GANA Knowledge Plane for an **Autonomic 5G Fixed Core Network****
- **Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service Assurance across BBF and 3GPP Domains**

# Federated/Interworking GANA Knowledge Planes for BBF Domain and 3GPP Domain



ETSI TR 103 473 V1.1.2



# Joining the Consortium, Contact Details, Materials for Downloading



## Contact Details of PoC Leader (contact to join the consortium)

Tayeb Ben Meriem, PhD : Orange: Paris, France

[tayeb.benmeriem@orange.com](mailto:tayeb.benmeriem@orange.com)

Other contact: Ranganai Chaparadza, PhD: [ranganai.chaparadza@altran.com](mailto:ranganai.chaparadza@altran.com) ;

All PoC Materials (White Papers, Reports, Slides, etc) are accessible here:

[https://intwiki.etsi.org/index.php?title=Accepted\\_PoC\\_proposals](https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals)

- Orange
- Verizon
- NTT
- Telecom Italia
- Altran
- Asocs Networks
- Cellwize
- Huawei
- Incelligent
- QalyCloud
- IPv6 Forum
- Big Switch Networks



# Thank you!