ETSI TC INT/AFI "5G Network Slicing PoC Demo-3 Datasheet"

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

Demo-3 Name: ***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***

NOTE: This Demo 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. This Demo-3 and its Objectives are described in more details in **White Paper#3 [3]**. Outcomes from previous **Demos 1&2** are described in the **White Papers #1 and #2** in the References section. **Demo-1** covered *Smart Insurance Providers as Key Requesters and Consumers of "5G Network Slices Delivery Services" by Service Providers*. **Demo-2** covered *C-SON Evolution for 5G, Hybrid-SON Mappings to the ETSI GANA Model, and Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service Assurance for 5G Network Slices*

Date: April 11th 2019
Location: Demo-3 is hosted by Orange in Paris, France
Room: 1E-6-Big
Address: Orange Gardens, 40 - 44 AVENUE DE LA REPUBLIQUE / 92320 – CHATILLON
ETSI GoToMeeting Facility/Bridge for use by remote participants:
https://www.gotomeet.me/ETSIINT ; **Access Code**: 180-191-853 (See more details on local dial-in telephone numbers at the end of this DataSheet)

Demo-3 Agenda Sessions

Session-1: 09:30 -10:45

- **Opening** by **Mr Pierre Muller, VP, OSS (Orange Labs Network)**
- *Overview of the 5G PoC; Smart Insurance Providers Business View; 5G Network Operators Business View; and Vendors' Business view of the overall 5G PoC*
- *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*
- *Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service Assurance of 5G Slices across the various network segments/domains*

Coffee Break

Session-2: 11:00 -11:50

- *QoS Framework on Flow-Oriented (Flow-Level) Services & Telemetry Services delivered within a specific 5G Slice Type and varying in QoS Classes; Prioritization of Slices; and Definitions of QoS Classes and SLAs as inputs to Autonomic Service Assurance*

- *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*
- *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.*

Session-3: 11:50 -13:10

- *Problem Statement being addressed by Demo-3 of the ETSI TC INT/AFI 5G PoC*
- ***Capabilities of Big Switch Networks for Programmable Traffic Monitoring Fabrics** that meet the Outlined Telecom Operators' Requirements in line with the ETSI GANA Framework Principles: **Demo by Big Switch Networks:***
    1. *BigMon Fabrics Architecture and Components (BMF/BigMon Controller, Fabric Switches, Service Nodes, Analytics Node, Packet Recorders, etc.), their Capabilities and Programmatic Interfaces*
    2. *Packet Processing Functions: Packet Slicing, GTP Correlation, Packet Header Stripping, Packet Field Masking, Advanced Traffic Filtering, Packet De-Duplication, Packet Timestamping, Packet Replication, etc.*
    3. *Traffic Sampling in order to cope with huge traffic volumes on Tapped Links, On-Demand Meta-Data Generation and Dissemination to Data Lakes (Data Collectors) and Analytics Platforms (e.g. BigMon Analytics and the GANA Knowledge Plane Decision Elements(DEs))*
    4. *Knowledge Synthesis from Raw Data on Packet Recorders and Streaming of the Knowledge into the GANA Knowledge Plane(KP) for consumption by DEs*
    5. *The BigMon Analytics Node and the degree to which the BigMon Analytics Node can fulfil the role of a **Monitoring-DE part of the GANA Knowledge Plane (KP)**, and Scaling of the BigMon Analytics Nodes (as KP Monitoring-DEs) along with network segment/domain specific GANA Knowledge Planes(KPs)*
    6. *Orchestrated and Programmatic Monitoring of Traffic in NFV environments by Virtual Taps and Virtual SPANing and forwarding of the traffic to the Out-of-Band (OOB) Network*
    7. *Big Mon Controller Capability for achieving Integrated In-Line Monitoring and Out-Of-Band (OOB) Monitoring*
    8. *Implications of Integration of the BigMon Analytics Node (as a **Monitoring-DE part of the GANA Knowledge Plane**) with SDN Controllers for OOB, SDN Controllers for the Production Network, and a Test System for Orchestrated Assurance of Newly Instantiated Services (e.g. Service Chains in NFV environments) and SLA violations detections*
    9. *Dashboards of Big Mon Fabrics*

Lunch

Session-4: 14:00 -15:30

- ***Demos by Big Switch Networks (Continuation)***
- *"Knowledge Plane-Driven" Orchestration—based on Business Goal Incentives or Autonomic Remediation Strategies Execution by the KP; and Selective Multi-Layer Programming Targets by KP Autonomics*
- *Q&A and Key Take Way Messages*
- *Announcements of Plans for Demo-4 of the overall 5G PoC*

Table of Contents of the 5G Network Slicing PoC Demo-3 Datasheet

Problem Statement: *Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring and Feeding of Knowledge into the ETSI GANA Knowledge Planes for E2E Autonomic Service Assurance of 5G Network Slices*

It is desired that 5G Networks exhibit intelligence in the way they operate, through Self-Management Capabilities that can make 5G networks be characterized as "***Self-Driving Networks***" and "***Self-Aware***" Networks. Such capabilities can be implemented through the ***Concept of Autonomics***, and so Autonomics is a key requirement in 5G. The main desire of Telecom Operators is to move away from proprietary-based Autonomics solutions, which limit innovation, interoperability and integration with various components network operators may want to deploy, to solutions that are based on a standardized framework as described in ETSI White Paper No.16, due to the benefits outlined in ETSI White Paper No.16, such as the need to bring together various players in innovating autonomics software and algorithms. Therefore, Telecom Operators seek a Standardized Framework for Autonomic Management & Control (AMC) of Networks and Services. The AFI Working Group in ETSI's TC INT Technical Committee, as the leading group in the standardization landscape for AMC, provided a Reference Model or AMC called Generic Autonomic Network Architecture (GANA) that has now been instantiated onto various network architectures and their associated management and control architectures as described in [3] and ETSI TS 103 195-2.

In order to operate and deliver 5G Network Slices, the Telecom Operator should be equipped with a ***Framework for E2E Autonomic (Closed-Loop) Service Assurance for 5G Network Slices***. Such a Framework should be compliant to the ETSI Generic Autonomic Network Architecture (GANA) Model for reasons described in White Paper No.3 of this PoC [3]. Indeed, GANA autonomics is the enabler for the realization (implementation) of "***Self-Driving Networks***" that are "***Self-Aware***".

E2E Autonomic Slice Assurance shall be achievable by way of Federation of GANA Knowledge Planes for RAN (C-SON), MEC (Multi-Access Edge Computing) site, Front-/Backhaul and Core Network. The GANA Knowledge Plane implements the high level autonomics that needs to be complemented by lower level autonomics in NEs/NFs. This federated collaboration of the GANA Knowledge Planes helps to achieve "holistic multi-domain state correlation and dynamic/adaptive programming" of network resources (managed entities).

A decision on choosing to have a GANA Knowledge Plane designed and implemented for a specific network segment (or domain) rather than having a single large GANA Knowledge Plane that covers multiple segments may follow various incentives (based on technical or administrative or even business models reasons).

One of the ***Requirements*** for the Service Provider to be able to implement the desirable *Framework for E2E Autonomic (Closed-Loop) Service Assurance for 5G Network Slices* is the ***Deployment of Programmable Traffic Monitoring Fabrics that enables On-Demand Monitoring and Feeding of Knowledge into the GANA Knowledge Planes.***
At the same time, such Programmable Traffic Monitoring Fabrics should be designed and deployed as part of the *Telecom Operator's* ***Desirable Framework for Dynamic Probing for Orchestrated Assurance*** *and the* ***Integration/Convergence of Autonomic Service Assurance with the Orchestrated Assurance*** *of Newly Instantiated Network Services (e.g. Virtual Network Functions (VNFs), 5G Network Slices and Service Chains).* As described in White Paper No.3 of this PoC [3] *autonomic monitoring* (following GANA principles) should replace the *increasingly* complex and error-prone manual and static Traffic Monitoring approaches currently employed for networks and services performance monitoring.

The Network Operators' **Key Requirements** that belong to the Problem Statement that underpins the Demo-3 of the ETSI 5G PoC derive from the following enablers and questions pertaining to the desirable Programmable Traffic Monitoring Solutions for 5G Network Slices:

- *The role, logic and required intelligence of the GANA KP-level Monitoring DE (Decision Element) in the GANA Knowledge Plane in driving the Programming of Traffic Monitoring Fabrics (dynamic configuration of traffic monitoring services) through "SDN Controllers" specially designed for Programming Traffic Monitoring Fabrics*
- *Policy Control of Monitoring behaviors of Managed Entities(MEs) in NEs (Network Elements) w.r.t Traffic Monitoring and export of Traffic Traces to Storage Devices (Data Collectors) or to out-of-band TAP and SPAN Aggregation Networks by NEs. TAP stands for Test Access Point and SPAN stands for Port Mirroring on switches*
- *Policy control of monitoring behavior and the TAP & SPAN Aggregation network to enable timely (real-time or near real-time) decision making by monitoring data (or knowledge) consumers in the Knowledge Plane (e.g. the QoS Management-DE for autonomic(closed-loop) QoS Management of Network Slices within a particular network segment). The interactions of a Knowledge Plane Monitoring-DE and a Knowledge Plane QoS Management-DE*
- *SDN based Control of Traffic Streams in the Monitoring Fabrics: merging, traffic replication and forwarding to the Tools, and the application of advanced features in traffic capturing, source tagging for captured packets, slicing, Header-Stripping, etc., and dataflow-based distributed stream processing aspects*
- *Data Storage (Collectors) and Analytics Algorithms for Knowledge Derivation, and Scaling Data Collectors (e.g. Traffic Storage) based on Network Workloads Requirements*
- *Filtering of Data on Data Collectors and Dissemination to the GANA Knowledge Plane(s) and any other Tools that need the Traffic Data or knowledge synthesized from raw data on the collectors*
- *Knowledge Representation, Presentation and Feeding into the GANA KP DEs and ONIX by Cognitive Algorithms running on Data Collectors*
- *Interworking and Coordination of Monitoring DEs in the case of Federated GANA KPs for the Access (RAN), X-Haul Transport Network and Core Network*
- *Understanding Cost-Effective and Scalable Solutions for TAP and SPAN Aggregation Networks as Programmable Monitoring Fabrics and Distributed Nature of Programmable Monitoring Fabrics*
- *Performance and scalability of the Network Level Monitoring DE (the KP Monitoring DE with its complex analytics)*
- *SLAs Violation Detection by the Monitoring DE in collaboration with Automated Test System or Components*
- *Monitoring DE interface with Orchestrators for the need to trigger Orchestrated Assurance*
- *Orchestration and dynamic configuration of Traffic Monitoring Agents (Virtual Taps, Virtual Probes) in the Virtualized Environments (particularly the Telco-Cloud/NFV Environment) in response to service creation (i.e. Virtual Network Function (VNF) or a whole service chain, and dataflow-based distributed stream processing aspects*
- *Agility in scaling-up/scaling-down of monitoring agents and Monitoring-DE (scaling it with monitoring requirements/workloads) with cloud-native Telco-Cloud solutions and container-based virtualization*
- *The Interplay of Programmable Monitoring and Dynamic Probing with Service Fulfilment upon the completion of Network Slice Creation process, including the extent to which "slice awareness" is needed in monitoring requests and in the monitoring services themselves*
- *Slice KPIs (Key Performance Indicators) and interplay with the GANA Monitoring-DE in Knowledge Plane as orchestrator of monitoring functions(services)*
- *Network Links Density expected in 5G Fronthaul, Midhaul, Backhaul and Core Networks*
- *Consideration of dynamic resource management within a QoS framework built upon a 5G network slicing architecture to deduce the auto-tuning behavior expected on slice monitoring services*
- *Consideration of provisioning of end-to-end slices and behavioral modelling of services (including flow-level services, e.g. IP Flows) in a dynamic environment including resource allocation per slice, preemption and reprioritizing, resource adaptation per slice for maximal fairness, throughput, or SLA compliance, to deduce the impact of such dynamics on slice monitoring solutions*
- *Consideration of Autonomic Service assurance and SLA compliance of services based on their profiles and overall resource availability in the holistic network (end-to-end) in the shared resource pool, to deduce the impact on slice monitoring solutions*

- *The way QoS Classes and SLA definitions for E2E Slices are fed as inputs to the GANA Knowledge Plane for Autonomic Service Assurance of the Slices and possibly the need for a Standardizing a rich Model (as Template) that can be used by Service Providers for QoS Classes and SLA definitions for E2E Slices.*

Quotes from Network Operators on the value of the Demo-3 of this ETSI 5G PoC

"Traffic Monitoring and the Generation and Dissemination of Network Telemetry Data to Analytics Platforms like ETSI GANA Knowledge Planes that implement Closed-Loop (Autonomic) Service Assurance in 5G are key to enabling to operate 5G Networks. Monitoring solutions in 5G Network space should have minimum impacts on the production network. To overcome this challenge it is inevitable to deploy Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring. Indeed, this ETSI 5G PoC Demo-3 takeaways, lessons learned and best practices will help guiding Network Operators on their path to Self-Driving and Self-Aware Autonomic 5G Networks by leveraging standards. Orange is glad to host this ETSI 5G PoC as we did for Demo-1 and Demo-2"

Mr. *Pierre Muller VP, OSS, Orange Lab Networks (Orange)*

"This ETSI 5G PoC is helping Network Operators to understand how they can deploy Frameworks for the Integration of Dynamic Monitoring (Virtual Taps, Virtual Probes, Virtual Mediation, Virtual Analytics) with Automated Test System for Assuring newly instantiated services (e.g. 5G Network Slices) and Closed-Loop (Autonomic) Service Assurance of the services by ETSI GANA Knowledge Planes (KPs). The GANA KPs continuously use telemetry data and events obtained from the network as well as the orchestrated service probing instantiated in the NFV environments. SLA violation detected by the monitoring system, can trigger autonomic operations that remediate the problems in order to guarantee service SLAs. Moreover, the Integration of Programmable Traffic Monitoring Fabrics for Orchestrated Assurance within the broader picture of Telecom Operator's Framework is very important, as this facilitates components re-use for multiple purposes in the operations of autonomic 5G Networks—allowing reduction of costs of the operations"

Mr. Giulio Maggiore, TIM / Core, Transport & Network Service Exposure/ Technical Planning & Architectures/ Performance: ETSI INT TC Chair

"This ETSI 5G PoC is timely in helping intensify efforts in looking into the development of a rich Standardized Model/Framework (as a blueprint) that can be used by Service Providers for QoS (Quality of Service) classes definitions and their mappings to SLAs (Service Level Agreements) definitions for E2E 5G Slices. Those definitions are fed in as inputs to the ETSI GANA Knowledge Planes (KPs) for the Federated E2E Autonomic (Closed-Loop) Service Assurance of Slices (and the flow-level services they carry) across network segments/domains. Programmable Traffic Monitoring Solutions for 5G Slices (in the scope of Demo-3 of this 5G PoC) are best driven by the SLA definitions and their associated QoS Classes in generating slice specific events and KPIs needed by the GANA Knowledge Planes for their E2E Autonomic (Closed-Loop) Service and Security Assurance across the various network segments and domains. This lays the foundation for Autonomic Resource Management support in 5G Network Slicing mechanisms."

Dr. Muslim Elkotob, Solutions Design Architect, Vodafone

Smart Insurance Providers' Business View, and 5G Network Operators (5G Slice Providers) Business View

From Service Providers (SPs) point of view, the "Smart Insurance" market is of high interest because it is an opportunity to create high value added services for SP's existing customers (or new customers) and can trigger technical drivers to evolve an SP' infrastructures towards 5G arena in the way that can better monetize the SP's assets —thanks to the "Slicing" concept, and this transformation is bound to open up new business models—highly profitable and recurrent.
The 5G Network Slice "Factory" Service Providers are about to deploy in the coming years, is expected to deliver numerous Network Slice Types as described by 3GPP such as eMBB (SST 1), uRLLC (SST 2), mIoT (SST 3) which are the first standardized ones. Indeed, in the IoT world, existing technologies e.g. NB-IoT, LTE-M can partially answer this need. However, in Smart Insurance and infotainment (4K /8K, Augmented and /Mixed Reality), Autonomous Cars, Smart Factories, Smart Building / Smart Home, and others, 5G is expected to meet those eMBB, uRLLC, IoT,related characteristics. The ability of Service Providers (5G Slice Providers) to deliver those four key Slice Types and more in the future as enablers for such services or so to say "5G Slice as-a-Service (5G Slice aaS)" in terms of very large bandwidth and very low latency, will unlock some existing applications to new service models and pave the way for development of innovative applications we don't imagine today but will emerge in the future. Another important aspect for consideration at this juncture in 5G developments is the need to intensify efforts in looking into the development of a rich standardized model/framework (as a template) that can be used by Service Providers for QoS (Quality of Service) Classes definitions and their mappings to SLAs (Service Level Agreements) definitions for E2E Slices so as to feed those definitions as inputs to GANA Knowledge Planes for the Federated E2E Autonomic Service Assurance of Slices (and the flow-level services they carry) across network segments/domains. As such 5G Network Operators need to put in place a QoS Framework that addresses the following: Flow-Oriented (Flow-Level) Services & Telemetry Services delivered within a specific 5G Slice Type and varying in QoS Classes; Prioritization of Slices; and Definitions of QoS Classes and SLAs as inputs to Autonomic Service Assurance. Thanks to autonomics, a 5G Slice provider shall be able to manage Customer Experience (SLA violations, claims and trouble tickets) in an automated, proactive and predictive manner by tacking advantages of Autonomic and Cognitive Service Assurance Closed Control Loop(s) implemented at various layers of the GANA Framework and interworking together to drive an *Autonomic E2E 5G network*.

The overall 5G PoC is looking into the practicalities of delivering Smart Insurance in complex digital environments while protecting user privacy, and while also taking into consideration Smart Insurance Providers as Key Requesters and Consumers of "5G Network Slices Delivery Services" by Service Providers. Smart Insurance creates a fully customer-oriented ecosystem, centered on a platform that connects every stakeholder in the insurance business – insurance companies, brokers and their customers — in order to digitize, secure and automate all transactions.

The ecosystem covers the complete 'Business to Business' (B2B) and 'Business to Business to Consumer' (B2B2C) process management, from the stakeholder to the customer, including customer onboarding, contract management, claims handling and extending as far as confidential medical records management.

The 'Smart Insurance' lifecycle is further enhanced by connected devices, including the connected car, which allows offering flexible coverage perfectly adapted to every customer.

Vendors' Business View of the Overall PoC: *Suppliers of GANA conformant Software for E2E Closed-Loop Service Assurance for 5G Network Slices; and Suppliers of Programmable 5G Slice Traffic Monitoring Solutions that Feed Knowledge into GANA Knowledge Planes*

The ETSI White Paper No.16 describes the two categories that determine the actors or players the GANA model is addressing, namely: Suppliers (vendors) of GANA Functional Blocks (FBs); and Provider of assets required by the developers of GANA Functional Blocks (FBs). The business value described in ETSI White Paper No.16 for Suppliers (vendors) of GANA Functional Blocks (FBs) concerns both ISVs (Independent Software Vendors) and Networking Equipment Manufacturers—both of which can be providers of GANA Autonomic Management & Control (AMC) software such as Decision Elements (DEs) and their vendor differentiation autonomics Algorithms (e.g. Artificial intelligence for dynamic configuration and control of resources and parameters) ; GANA MBTS; GANA ONIX; and GANA Knowledge Plane Software in general.

Remark-1: **Demo-2** mainly focused on Suppliers of GANA conformant Autonomic (Closed-Loop) Service Assurance pertaining to the **GANA Knowledge Plane for the RAN as realized by C-SON (Centralized Self-Organizing Network) implementation** and as illustrated in the framework in [1] that captures the need for **low-level (micro) autonomics** (**D-SON** (Distributed Self-Organizing Network)) that needs to be policy controlled by higher-level (macro) autonomics (i.e. C-SON) in a holistic model that can be instantiated/adapted to the 5G context as well.

Remark-2: This **Demo-3** is mainly focused on Suppliers of ***Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring and Feeding of Knowledge into the GANA Knowledge Plane for Autonomic Service Assurance of 5G Network Slices; and Orchestrated Service Monitoring in NFV/Clouds (i.e. Virtualized Network Environments)***.

Demo-3 Scope: *Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring and Feeding of Knowledge into the GANA Knowledge Plane for Autonomic Service Assurance of 5G Network Slices; and Orchestrated Service Monitoring in NFV/Clouds*

This Demo-3 of the PoC is aimed at addressing the aspects outlined in the Problem Statement. The figures below (**Figures 1-4**) provide insights on the Architectural Framework that captures the aspects targeted for Demo-3.

Remark: The figures are extracts from the White Paper No.3 [3] (downloadable from https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals), which describes in more details the articulation of the key components that may all be involved in playing a role in delivering Autonomic (Closed-Loop) Service Assurance of 5G Network Slices, i.e. the components listed below:

- *GANA Knowledge Plane for a specific network segment(s);*
- *SDN-Driven Programmable Traffic Monitoring Fabrics;*
- *Network Elements (PNFs/VNFs);*
- *Traffic Monitoring Probes;*
- *Data Collectors;*
- *NMs/EMs (Network Managers/Element Managers);*
- *PMs (Performance Managers);*
- *FMs (Fault-Managers);*
- *Automated Test System for Orchestrated Assurance and SLA Violations Detection;*
- *SDN Controller Framework for the production network;*
- *OSS;*
- *Configuration Management Tools that complement an OSS that may be in place or are deployed to play a role that in some cases is simply played by an OSS platform that covers the full spectrum of FCAPS functions*
- *Service and Domain Orchestrator systems.*

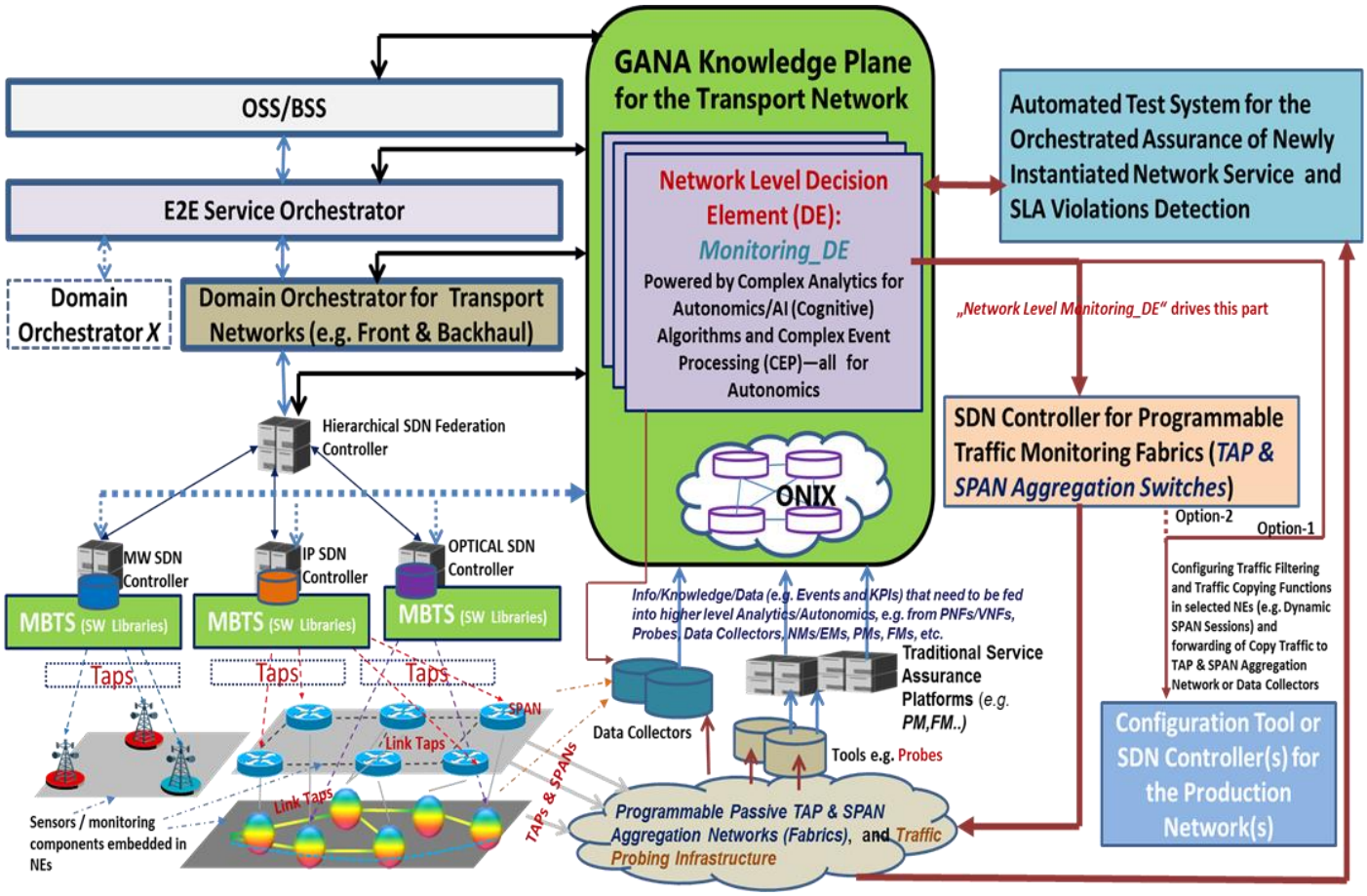
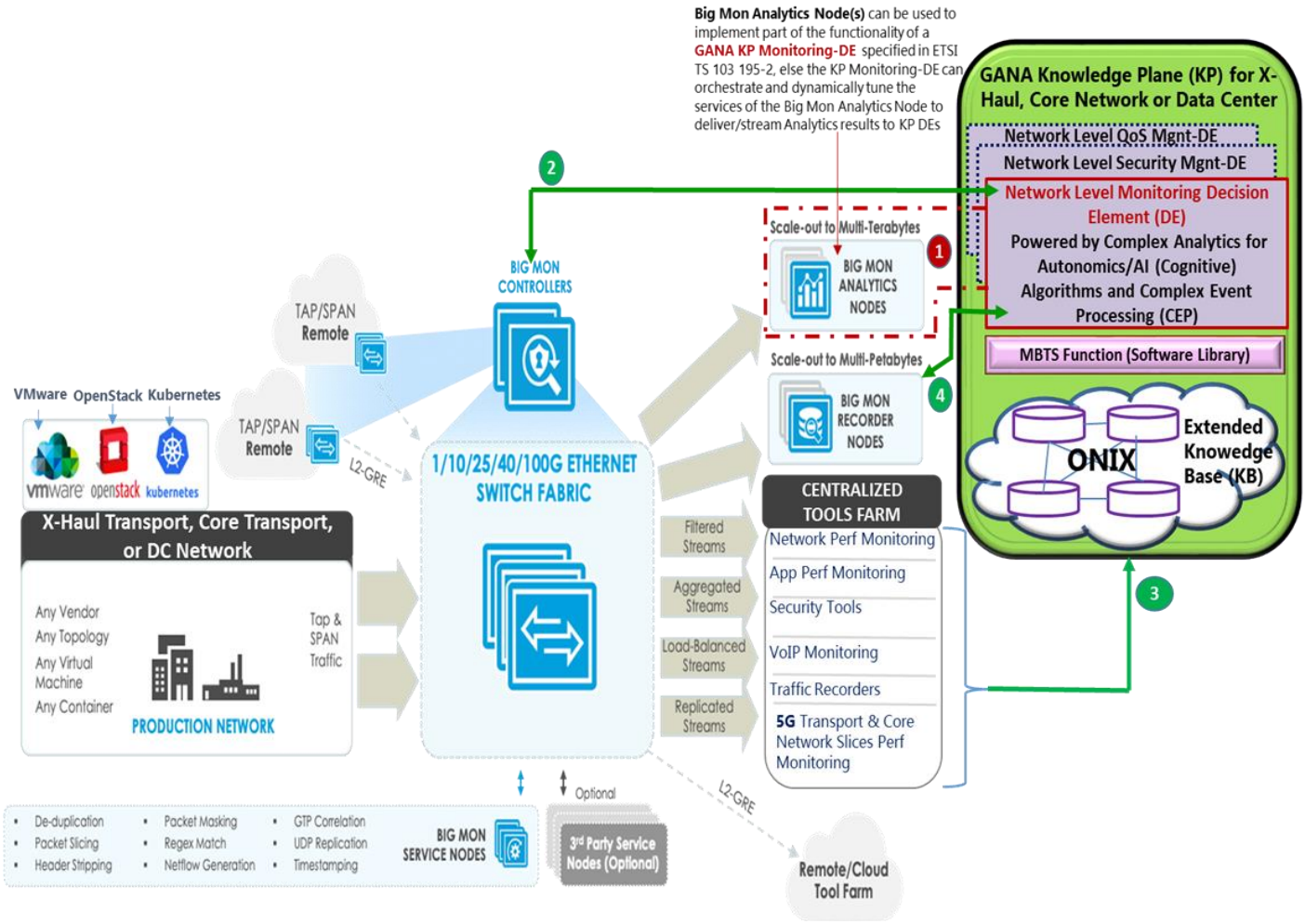


Figure 1: *The roles played by the Monitoring Decision Element (DE) in the GANA Knowledge Plane, SDN Controller for Programmable Traffic Monitoring Fabrics, Programmable Passive TAP & SPAN Aggregation Networks (Fabrics), Automated Test System for Orchestrated Assurance and SLA Violations Detection, and Configuration Tool or SDN Controller(s) for the Production Network(s)*



KEY:

1. Big Mon Analytics Node can be used to implement part of the functionality of a GANA KP Monitoring-DE (KP Mon DE) specified in ETSI TS 103 195-2, or can be employed by KP Mon DE to deliver analytics results to KP DEs
2. KP Mon-DE programs and configures Big Mon Controller (SDN Controller for OOB Monitoring Network) to disseminate some Data / Event/ Knowledge into the KP, and/or it installs/modifies forwarding rules in the Big Mon Controller to cause the Controller to program the OOB fabric switches to forward certain traffic streams to specific Analytics Tools (on-demand) that in turn feed KPIs to the KP
3. Supply of Info/Knowledge/Data (e.g. Events and KPIs) into the KP by the various Tools
4. KP Mon-DE programs and configures Big Mon Recorder to disseminate some Data /Event/ Knowledge into the KP

Figure 2: *The Big Switch Networks' SDN Programmable Traffic Monitoring Fabric (TAP & SPAN Aggregation Switches) and integration with Centralized Tools Farm (Traffic Analyzers) and Packet Recorders (Collectors) that can generate "knowledge" from raw traffic and feed it into the GANA Knowledge Planes*

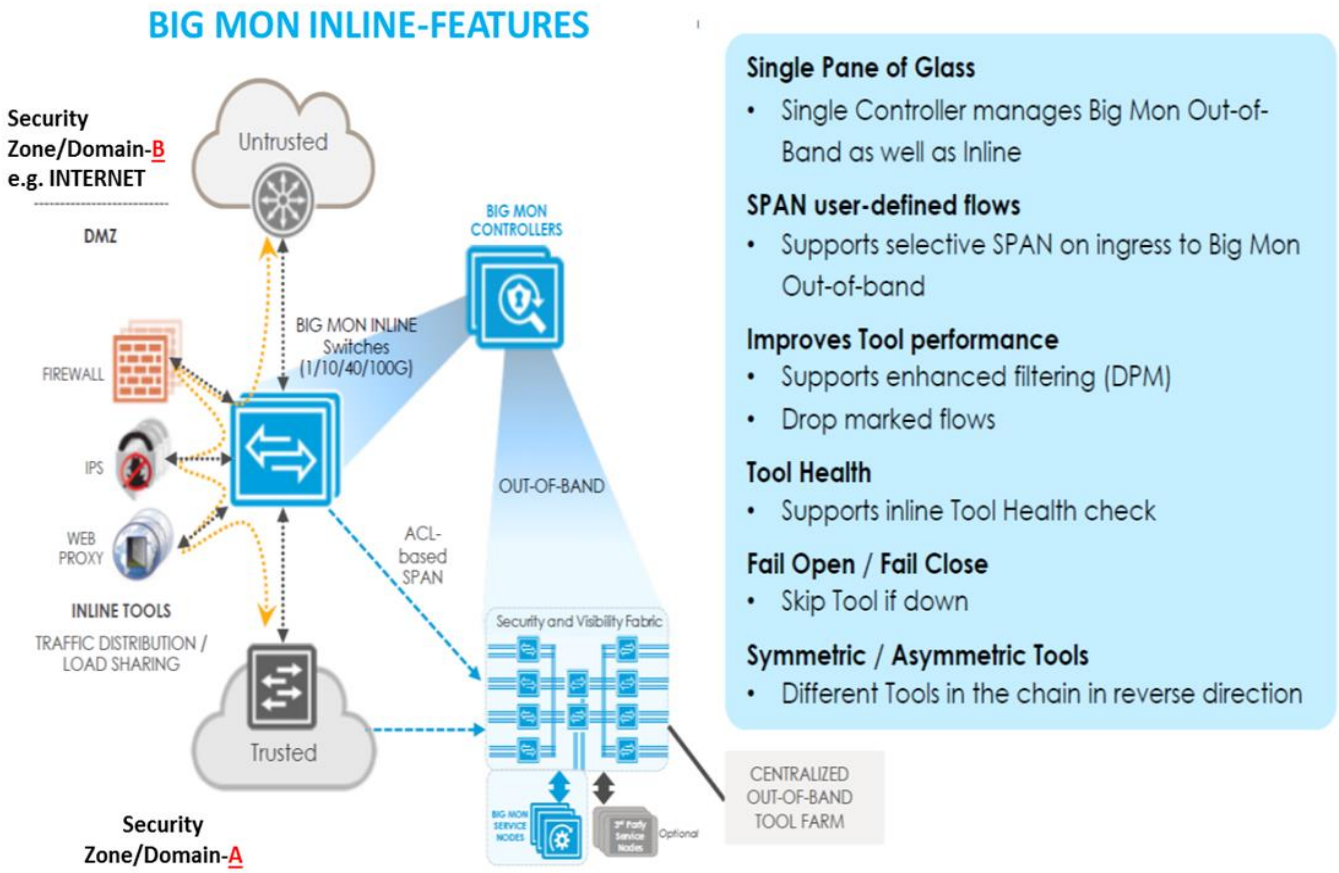
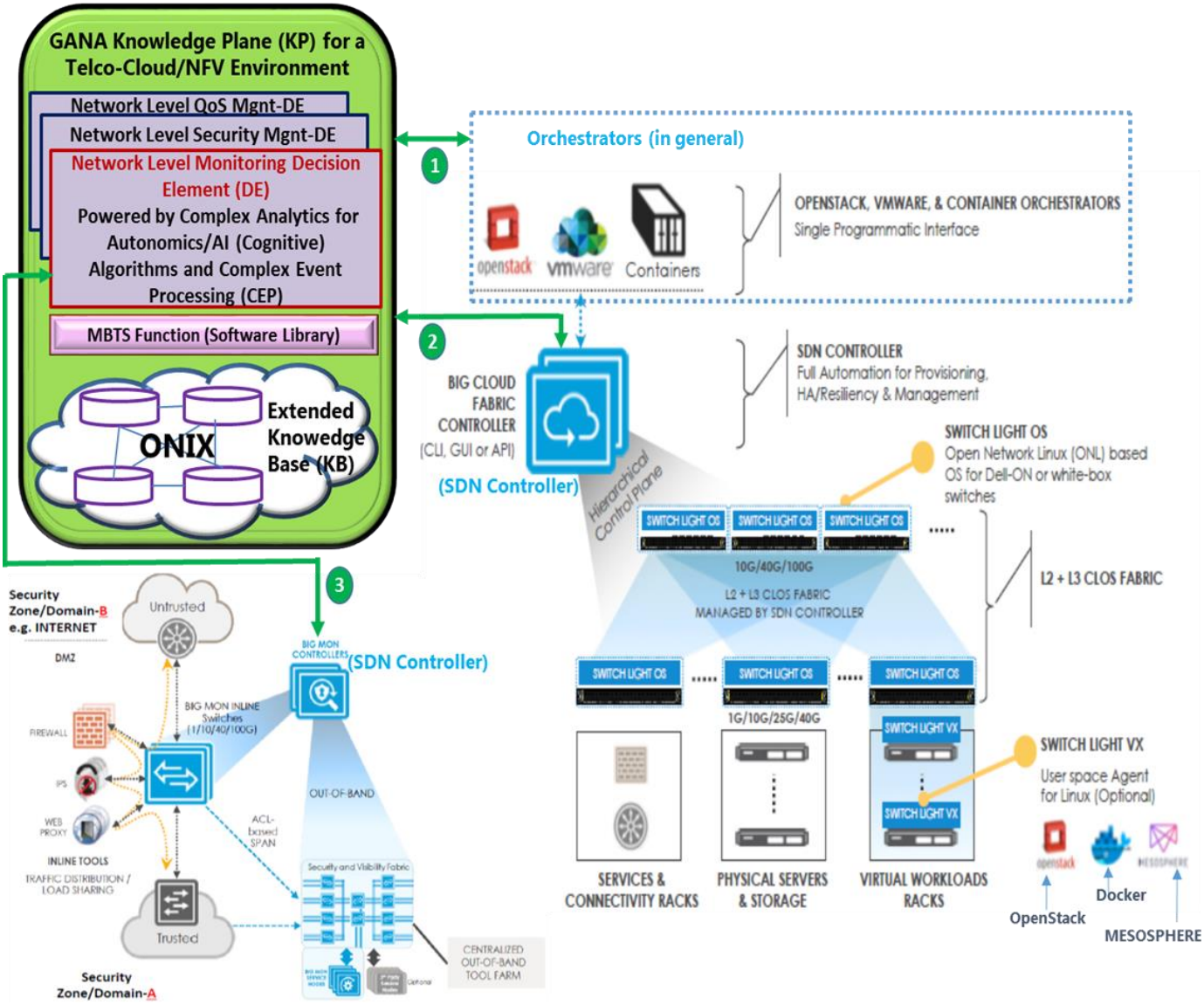


Figure 3: *Big Switch Networks' Big Mon Controller Capability for Integrated In-Line Monitoring and Out-of-Band Monitoring*



KEY:

1. Event consumption and processing by the Knowledge Plane (KP), and Execution of Orchestration of Services/Resources as Autonomic Remediation Strategies that should be driven through commanding the Orchestrators—for both reactive and proactive Resilience in service delivery by the network
2. Event consumption and processing by the Knowledge Plane (KP), and Execution of Autonomic Remediation Strategies that should be driven directly through commanding the SDN Controller—for both reactive and proactive Resilience in service delivery by the network
3. KP Mon-DE programs and configures Big Mon Controller (SDN Controller for OOB Monitoring Network) to disseminate some Data / Event/ Knowledge into the KP

Figure 4: *Big Switch Networks' SDN Controllers (Big Mon and Big Cloud controllers) Capability for Programmability by the GANA Knowledge Plane and Orchestrators*

Apart from providing a platform for discussing and addressing the issues outlined in the problem statement, Demo-3 will also present and showcase the following aspects based on Big Switch Networks' Capabilities:

- *BigMon Fabrics Architecture and Components (BMF/BigMon Controller, Fabric Switches, Service Nodes, Analytics Node, Packet Recorders, etc.), their Capabilities and Programmatic Interfaces*
- *Packet Processing Functions: Packet Slicing, GTP Correlation, Packet Header Stripping, Packet Field Masking, Advanced Traffic Filtering, Packet De-Duplication, Packet Timestamping, Packet Replication, etc.*
- *Traffic Sampling in order to cope with huge traffic volumes on Tapped Links, On-Demand Meta-Data Generation and Dissemination to Data Lakes (Data Collectors) and Analytics Platforms (e.g. BigMon Analytics and the GANA Knowledge Plane Decision Elements(DEs))*
- *Knowledge Synthesis from Raw Data on Packet Recorders and Streaming of the Knowledge into the GANA Knowledge Plane(KP) for consumption by DEs*
- *The BigMon Analytics Node and the degree to which the BigMon Analytics Node can fulfil the role of a **Monitoring-DE part of the GANA Knowledge Plane (KP)**, and Scaling of the BigMon Analytics Nodes (as KP Monitoring-DEs) along with network segment/domain specific GANA Knowledge Planes(KPs)*
- *Orchestrated and Programmatic Monitoring of Traffic in NFV environments by Virtual Taps and Virtual SPANing and forwarding of the traffic to the Out-of-Band (OOB) Network*
- *Big Mon Controller Capability for achieving Integrated In-Line Monitoring and Out-Of-Band (OOB) Monitoring*
- *Implications of Integration of the BigMon Analytics Node (as a **Monitoring-DE part of the GANA Knowledge Plane**) with SDN Controllers for OOB, SDN Controllers for the Production Network, and a Test System for Orchestrated Assurance of Newly Instantiated Services (e.g. Service Chains in NFV environments) and SLA violations detections*
- *Dashboards of Big Mon Fabrics*
- *Standards Gaps being revealed in the Implications of Integration of the Monitoring-DE of the GANA Knowledge Plane with SDN Controllers for OOB, SDN Controllers for the Production Network, and a Test System for Assurance of Newly Instantiated Services (e.g. Service Chains in NFV environments) and SLA violations detections*

Remark: Four Applications are considered in the Overall PoC's Network Slicing Use Cases. Whereby, each application (e.g. Smart Insurance Application) is ordering the required Network Slices via an order API (service order placement API) interacting with Network Slice Provider's BSS. The table below depicts the mapping of PoC targeted Applications to required Network Slice Types.

Application	Network Slice Type required
Connected Car & Infotainment	• eMBB (SST 1) • uRLLC (SST 2) • IoT (SST 3) • V2X
Car & Home Security & Infotainment	• eMBB (SST 1) • uRLLC (SST 2)
Hayo (IoT) Connected Home Security & Infotainment	• eMBB (SST 1) • uRLLC (SST 2) • IoT (SST 3)

Smart Buildings & Smart Homes	• eMBB (SST 1) • uRLLC (SST 2) • IoT (SST 3)

Technical view of the Overall 5G PoC

The plan is to use this 5G Network Slicing PoC as an instrument for the following aims:

(1) Enabling the "Telecom Operators" to provide a clear holistic picture to "Solution Suppliers" as to how their 5G networks would look like and the complementary roles to be played by the following technologies/paradigms in 5G: ETSI GANA components for Closed-Loop (Autonomic) Management & Control of network resources and parameters in Autonomic (Closed-Loop) Service Assurance of Network Slices; SDN; NFV; E2E Orchestrators; Big-Data Analytics for Autonomic/Cognitive Management & Control; SON (Self-Organizing Networks); specialized interfaces (including the network governance interfaces); Network Automation; and GANA intelligence software for Autonomic/ Cognitive management and control of networks and services (i.e. Software for Autonomic (Closed-Loop) Service Assurance); and the Telecom Operator's Desired Framework for Dynamic Probing for Orchestrated Assurance and the Integration/Convergence of Autonomic Service Assurance with the Orchestrated Assurance of Newly Instantiated Network Services such as 5G Network Slices and Service Chains.

(2) Breaking from silos on standards and R&D efforts linked to the complementary emerging networking paradigms, by promoting and progressing the Unifying and Harmonizing Architecture that integrates the ETSI GANA, SDN, NFV, E2E Orchestration, and specialized Big Data Analytics for Autonomic / Cognitive Management & Control;

(3) Enabling "Solution Suppliers" of the following solutions/components and other players to use the PoC instrument to identify gaps in standards and initiate activities (e.g. in ETSI TC INT AFI Working Group) to close any gaps in Autonomic Management & Control (AMC) standards that may be identified during the PoC. "Solution Suppliers" of the following solutions/components are being engaged in the 5G PoC and the various Demos being planned for the 2018/2019 timeframe and beyond:

a. SON (both C-SON and D-SON)—i.e. Centralized SON and Distributed SON (Self-Organization Network);
b. SDN (Software Defined Networking);
c. NFV (Network Functions Virtualization);
d. GANA Knowledge Plane (with the Autonomics/Analytics Algorithms, Knowledge Synthesis and Representation from raw monitoring data, and the dynamic application of various forms of Knowledge obtained from diverse data/information sources by the GANA Knowledge Plane's Decision-making-Elements (DEs) in realizing the *Self-Adaptation (e.g. Self-Optimization) management and control operations for Network Resources and Parameters for the overall Closed-Loop Assurance of Network Slices)*;
e. Probing and Service Assurance Platforms that should act as data/information sources to the GANA Knowledge Plane's DEs,
f. Data Analytics required to be performed or exploited by GANA DEs instantiated (injected) in the network infrastructure Network Elements (physical or virtual) and in the GANA Knowledge Plane;
g. Network Infrastructure Network Elements (Physical and Virtual Network Functions);
h. RAN elements Cloudification Vendors.
i. Traffic Monitoring Solutions Suppliers for Programmable Traffic Monitoring Fabrics that enable On-Demand Monitoring and Feeding of Knowledge into the GANA Knowledge Planes for E2E Autonomic Service Assurance of Network Services (including 5G Network Slices), and Components/Solutions for Orchestrated Service Monitoring in NFV/Clouds
j. Management and Control Systems such as OSS/BSS, EMS/NMS that may be required with the GANA Knowledge Plane as described in the White Paper No.3 [3].

The Figure below (Figure 5) depicts high level design principle of the PoC ecosystem and associated main actors/roles relationships and interactions. Two main actors are considered at 5G operation time (run-time):

- a) **Network Slice Provider (SP)** with its associated partners (5G RAN Vendors, 5G X-Haul Network Vendors, 5G Core Network Vendors, 5G OSS & Network Slice Management Software Vendors, Programmable Traffic Monitoring Fabrics Vendors, Probing Vendors, GANA Algorithms and Software Components Developers and Suppliers, 5G BSS Vendors, 5G SON Vendors, …) whose components are required by an SP in creating, delivering, operating and assuring the four Network Slice Types: eMBB (SST 1), uRLLC (SST 2), IoT (SST 3), V2X

- b) **Network Slice Customer** or Network Slice Consumer who orders/ Self-Orders via a dynamic Ordering API the required Network Slice Types according to dynamic SLAs per Network Slice Type by interacting with the Network Slice Provider's BBS (Network Slice Self-Care Portal)

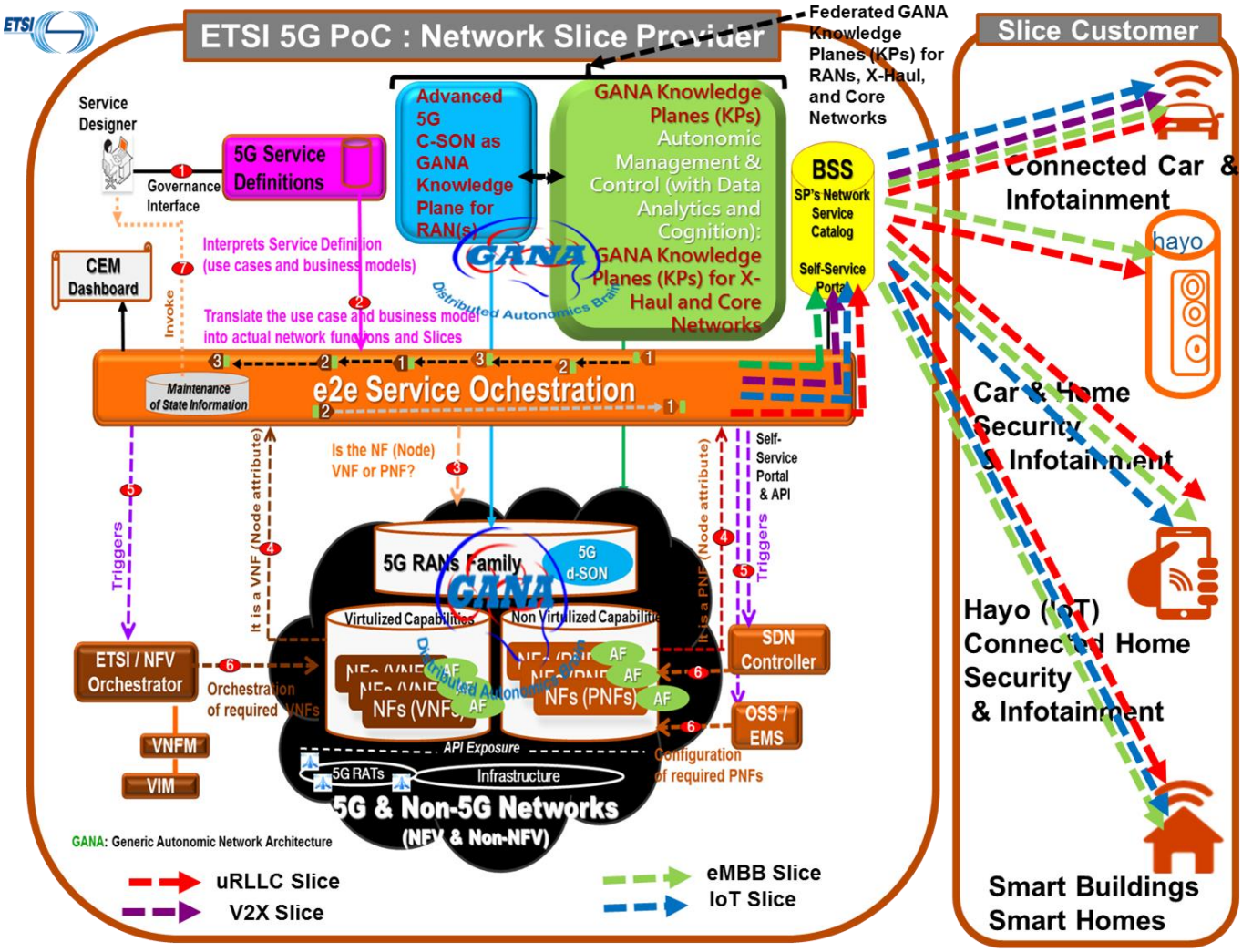


Figure 5: *The depiction of the high level design principle of the 5G PoC ecosystem and associated actors / roles relationships and interactions*

Description of the Network Slice Life Cycle Management (choreography):

1) Slice Designer (Human Operator), via the Governance API, accesses its 5G Slice Design / Service Definition Tool-Chain (pink box) and stores the Network Slice Template once populated, in a repository. **NOTE:** This process is automated in the case of a self-care portal through the BSS that can be used by external customers
2) Network Slice Template is pushed to the E2E Service Orchestrator
3) E2E Service Orchestrator interacts with ETSI MANO components, SDN Controllers and Legacy OSS to translate the content of the Template onto required VNFs / PNFs (RAN ones (including MEC (Mobile Edge Computing) ones) and Core Network ones) which are stored in the Virtualized Capabilities (Network Functions) Repository and in the Non-Virtualized Network Functions Repository (for Core Network). The diagram shows a dedicated Repository for RAN capabilities. All those capabilities are executed on the substrate layer (Hybrid Infrastructure: Black Cloud)
4) The descriptions (descriptors) of the identified (the required) VNFs and PNFs are sent to E2E Service Orchestrator
5) E2E Service Orchestrator launches Network Slice Life Cycle Management process
6) The Network Slices ordered by the customers via Service Provider's BSS (Yellow Box) are instantiated, configured and delivered to each of the four Customers (represented by the 5G applications) at the right hand side of the diagram.
7) GANA Knowledge Plane and "Distributed GANA" (Green boxes) DEs embedded in the VNFs and PNFs as AI / ML/ Cognitive algorithms along with Hybrid SON (Centralized and distributed: Blue Boxes) take care of configuration of the NEs (Network Elements, i.e. PNFs and VNFs) in the infrastructure if not already performed through the traditional management systems, and then proceed to perform E2E federated Autonomic (Closed-Loop) and Cognitive "Service Assurance" of each Network Slice Instance a Customer is consuming.
8) BSS (Yellow Box) embeds the Network Slice Billing System that shall offer billing capabilities per Network Slice Instance, enabling the billing of each Network Slice Instance individually, in the same way as a 5G OSS that shall offer management capabilities per Network Slice instance as an "Individual (sole) Network Slice Instance Manager"

ETSI-GANA Model as key holistic Enabler for Autonomic Management & Control (AMC) in 5G: High Level Design Principle

NOTE: For more details on ETSI-GANA Model as key holistic Enabler for Autonomic Management & Control (AMC) in 5G, the readers are encouraged to read the White Papers [3][1] in particular (while [2] also provides additional insights on how Open Source products can be exploited to implement GANA Knowledge Plane concept).

References

[1] **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*
Downloadable from here: https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals

[2] **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*
Downloadable from here: https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals

[3] **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*
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- Verizon
- NTT
- Telecom Italia
- Altran
- Asocs Networks
- Cellwize
- Huawei
- Incelligent
- QualyCloud
- IPv6 Forum
- Big Switch Networks

Contact

ETSI NTECH 5G PoC wiki: http://ntechwiki.etsi.org/;
https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals
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