On the Design of 5G End-to-End Facility for Performance Evaluation and Use Case Trialling

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***Abstract*—A focus area of phase 3 of 5G PPP is the design and deployment of a 5G end-to-end facility that can demonstrate that the key 5G network KPIs can be met, and which can be accessed and used by vertical industries. This poster paper presents key guidelines to implement such a 5G end-to-end facility.**

I. INTRODUCTION

5G aims to significantly improve the capabilities of network infrastructure in terms of the supported key performance indicators (KPI). The telecommunications industry has aligned itself to a number of KPIs, including "1000 times higher mobile data volume per geographical area", "10 to 100 times more connected devices", "10 times lower energy consumption" and "end-to-end latency of less than 1ms" [1]. The 5G network will be a key asset to support societal transformation, societal cohesion and sustainable development by empowering the vertical industries. In a number of white papers and publications the 5G PPP has described use cases and requirements of several vertical industry sectors, such as automotive, e–Health, energy, entertainment, manufacturing and others [2]. Achieving the above ambitions will be demonstrated based on an End-to-End (E2E) experimental 5G network, which is being designed and deployed taking advantage of the latest network research and innovation technologies and concepts.

Herein, we present key guidelines to implement a 5G E2E facility that is composed of several interworking 5G sites. We use the term *5G end-to-end (E2E) facility* to denote a unified set of network, compute and storage resources providing E2E services modelled according to 5G architecture [3].

Section II presents the conceptual architecture of the 5G E2E facility, while section III identifies the main technological areas of consideration for building it. The testing framework to validate KPIs and enable verticals to trial use cases is briefly presented in section IV. Finally we conclude in section V.

II. CONCEPTUAL ARCHITECTURE FOR E2E FACILITY

Fig. 1 depicts the conceptual E2E facility architecture and highlights the key elements. The various building blocks are organized in three levels; the *Service Level*, *Network Level* and *Resources and Functional Level* as in [3].

The *Resources and Functional Level* of the E2E facility are comprised of the Radio Access Network (RAN), Backhaul, Mobile Core and Cloud Computing facilities. They provide the physical resources to host the *Service Level and Network Level elements* such as the Virtual Network Functions (VNFs). These are interconnected to build dedicated logical networks, customized to support enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communication (mMTC) services.

The requirements derived from the diversity of the use cases and possible configurations introduce a whole new set of intra- and inter-domain interworking issues. Their resolution is currently being addressed in various SDOs and there is a pressing need for harmonization and validation under realistic conditions. The *Service Level E2E Facility* shall be the reference environment in which this validation can take place, using agreed test plans. The *Service Level E2E Facility* is an implementation of the Network and Service Management and Orchestration Plane defined in the 5G Architecture [3].

III. TECHNOLOGICAL AREAS

The main technological areas of consideration for building the 5G E2E facility are listed herein. Each of these areas presents its own technological challenges.

- 5G Radio access
- Reliability enhancements for urban Vehicle-to-Everything (V2X) communication
- Internet of Things (IoT) data fabric functions embedded into network slices
- E2E network service orchestration
- Edge computing support and IoT Edge slicing capabilities
- Satellite integration with 5G
- 5G network KPIs measurements and evaluations
- E2E slicing implementation and management
- Emergence of new Business models – Ecosystem

IV. TESTING CAPABILITIES OF THE E2E FACILITY

Advanced testing capabilities need to be embedded in the E2E facility to support performance evaluation and access for vertical industry applications. Fig.2 illustrates the testing

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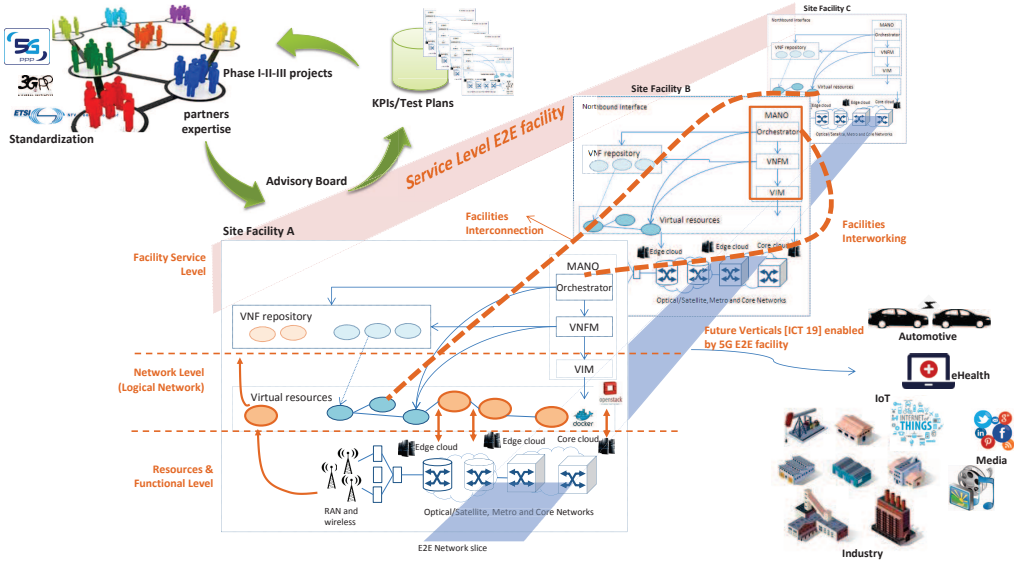

Fig. 1. High level conceptual architecture for the 5G E2E facility

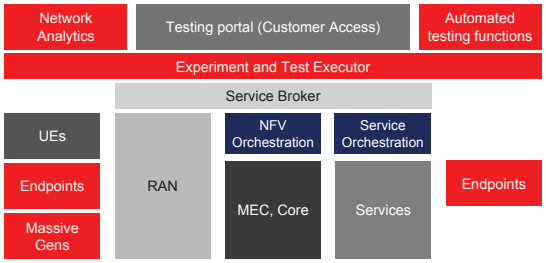

Fig. 2. Testing Framework

framework and its functional blocks. These are overarching across the entire facility and are based on the presence of an *Experiment and Test Executor* layer for connecting to the appropriate infrastructure components via open APIs.

The testing capabilities of a facility in the scope of the new 5G infrastructure must address the following areas:

- 5G-specific test methodology encompassing test cases from component integration to E2E performance tests, including benchmarking,
- test cases that can be recognized as industry reference for 5G network validation and testing,
- detailed test plans for validation of 5G network KPIs via execution of test campaigns,
- develop, deploy, and maintain an industry reference testing framework and infrastructure,
- validate customers' use cases by customizing and executing suitable test campaigns.

The combination of a comprehensive test framework, the multiple inter-working 5G RAN, 5G core infrastructures, and zero-touch E2E service orchestration provide a unique platform for performance testing and for trialling industry use cases. The platform facilitates the rapid on-boarding of vertical industry applications by exposing network life-cycle management functions through open APIs. The vertical application developers will be able to easily create, manage and de-commission network services thereby shortening their innovation cycles.

V. Conclusion and Future Directions

The role of a next generation operator is evolving and the current industry trend has bound this role with the capabilities and performance of the new 5G network infrastructure. This inspires the 5G E2E facility to take a number of emerging 5G technologies and introduce them into infrastructure instances to prove that the practical implementation of 5G networks is possible while meeting the 5G PPP network KPIs. It endeavours to demonstrate that the cumulative capabilities of the 5G innovations, such as Network Slice as a Service, Network Function Virtualization, new Radio Access Networks and Zero Touch Management will make the complex 5G infrastructure reliable, usable and deliver the expected performance. Showcasing the capabilities of the facility will help to unleash and accelerate the industrial advancement and uptake of 5G by demonstrating that 5G works and is fit for the services.

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