A Framework to Support the Role of Telecommunication Service Providers in evolving 5G Business Models

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Abstract. 5G networks will constitute a complete transformation in the ICT domain by enabling the deployment of vertical services within the network infrastructures, based on extensive use of network softwarization and programmability. This shift will trigger and facilitate the transformation of existing stakeholders' roles, as well as the interactions between multiple stakeholders from the traditionally separated markets. The 5G-PPP project MATILDA aims at delivering a holistic 5G end-to-end services operational framework, including 5G-ready applications lifecycle management from development to deployment over 5G network infrastructures. This paper aims at providing a refined and extended vision of the 5G business roles and their interactions and based on these at defining business applicability of the MATILDA project, with special focus on the project's value proposition addressing the Telecommunication Service Providers.

Keywords: 5G Business Roles; Verticals; Value Proposition; Telecommunication Service Provider.

1   Introduction

5G networks will go beyond performance enhancements of the existing telecommunication services, to a complete transformation of the ICT domain towards enabling the deployment of various vertical services (industry 4.0, automotive, multimedia, smart cities, eHealth, etc.) over the 5G infrastructures [7]. This shift will be based on extensive use of network softwarization and

programmability to provide an integrated logical infrastructure over multiple disaggregated physical resources (in practice telecommunication networks and compute facilities), making use of convergent technologies for both mobile and fixed access ([9],[10]). These technology advancements will trigger and facilitate the emergence of new business models involving a transformation of existing stakeholders' roles, as well as the interactions between multiple stakeholders from the traditionally separated markets.

To this end, a number of projects (EU, national funded, equipment vendor supported, etc.) are focusing on the technical realization of the aforementioned concepts, with MATILDA 5G-PPP project [1] aiming at designing and implementing a novel holistic 5G end-to-end services operational framework tackling the overall lifecycle of design, development and orchestration of 5G-ready applications from multiple vertical sectors, and 5G network services over programmable infrastructure, including intelligent mechanisms to increase automation in most of those processes. However, it is not always clearly defined how the various 5G-related projects and solutions can support the interaction between the stakeholders, and whom they address. This paper aims at defining the business applicability of the MATILDA project with respect to the related business roles (and involved stakeholders) and their interactions, with special focus on the value proposition that is addressing the Telecommunication Service Provider.

The paper is organized as follows: To start with the various business roles in the value chain of the 5G ecosystem are identified. In the next section, the MATILDA solution is briefly presented, to be followed by the description of the MATILDA framework including capabilities and functionalities to the benefit of the basic stakeholders along with the interactions among them. Based on this framework, the following section provides an analysis on the value proposition of MATILDA for the Telecommunication Service Provider that is the main customer targeted by MATILDA solution, while conclusions are drawn at the end.

2   Business Roles in the 5G Ecosystem

In general, the business roles that usually appear in the value chain of the future 5G business ecosystem have been drafted in a number of industry white papers ([7]-[9]), which however mainly adhere to existing business roles and stakeholders. Leveraging these initial definitions, MATILDA focuses on the refinement and extension on these business roles [2], which can be generalized for any 5G business ecosystem, irrespectively of the adoption of the MATILDA technical solution. These business roles definitions are described in this section.

At first, a principal role in the 5G ecosystem is that of the Telecommunication Service Provider (TSP)- (undertaken by Mobile and/or Fixed-network infrastructure providers), operating a programmable (5G) network infrastructure spanning from the radio and/or fixed access to the edge, transport and core

network. The network infrastructure can be either owned by the TSP or network resources can be leased (partly or completely) as a Network Service (NaaS) from an Infrastructure Provider.

The latter reveals another significant role, that of the Infrastructure Providers (IPs), putting infrastructure resources (network resources, storage space, compute resources) in place for the 5G-ready applications deployment. Depending on the nature of the required infrastructure resources and the assets of the stakeholders, this role can be split to further roles, performed by one or more stakeholders; namely:

- Network Infrastructure Providers (NPs) operating telecommunication infrastructures and offering network resources and services to end-users, verticals and/or (other) TSPs;
- Cloud Infrastructure Providers (CPs), operating centralized or distributed (in more than one location) cloud/edge deployments and offering compute and storage resources in a programmable way.

The Equipment Vendors' role traditionally providing hardware equipment, now is moving to providing software telecom equipment (i.e. VNFs), thus practically implementing programmable network layer functions and delivering these components/ functions to the stakeholders in charge of their operation.

At this point, we can distinguish the Operation/Business Support System (OSS/BSS) providers' role which consists in designing and developing 5G OSS/BSS systems, towards supporting the multiple, new interactions among the various stakeholders (e.g. TSPs and the Service Providers). Although OSS/BSS providers' role can be undertaken by traditional equipment vendors, there is plenty of room for new businesses to undertake this role.

System integrators undertake the role of supporting the design and development of end-to-end orchestration platforms, at network and application level.

The role of software developers is key in the 5G ecosystem, and includes:

- VNF developers, designing and developing Virtual Network Functions.
- Cloud application developers, designing and developing cloud-applications (e.g. micro services-based applications based on cloud-native principles)
- (Vertical) application developers, designing and developing any type of application combining cloud and network concepts (e.g. Mobile Edge Computing-oriented functionalities).

(Vertical) Application/Service Providers (AP/SP) provide applications/ services to end users and aim at enhancing their portfolio and optimising service provisioning.

Finally, Service Consumers/ End Users are the individuals or corporate users to consume the 5G applications/ services while being static and/or on the move. Vertical industries fall into this category.

The described 5G value chain composed of the aforementioned large number of business roles is depicted in Fig.1, where the stakeholders primarily addressed by MATILDA are marked in purple.
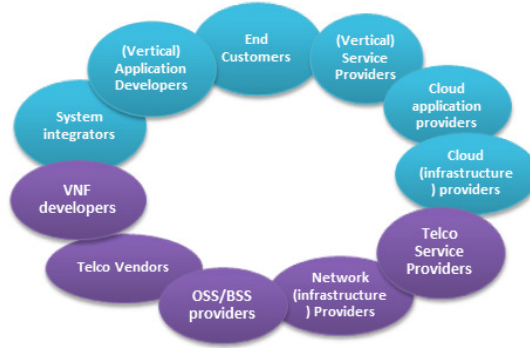
Fig. 1. 5G Ecosystem and Stakeholders addressed by MATILDA

In a real 5G business environment (especially one adopting the MATILDA concepts) a stakeholder may undertake more than one role, or a stakeholder's role may be assigned to more than one stakeholder depending on the nature of the 5G application/service and the resources that it requires. For instance:

- The NPs may also undertake the role of the CPs depending on their infrastructure assets, or in some cases even the role of the AP/SP
- The Application Developers' and AP/SP's roles could be played by the same stakeholder
- The SP role can be undertaken by a vertical or by a software house providing, while
- Many stakeholders can be considered as Service Consumers, depending on the nature of the applications, e.g. customers of the verticals or the verticals themselves can be Service Consumers, and so on.

3 MATILDA Framework and Users

3.1 MATILDA Solution

The vision of MATILDA [3] is to design and implement a novel holistic 5G end-to-end services operational framework tackling the overall lifecycle of design, development and orchestration of 5G-ready applications and 5G network services over programmable infrastructure. For this purpose MATILDA devises a unified programmability model and a set of control abstractions serving as interface between the 5G applications/ services and the 5G infrastructure layers, while incorporating intelligent and unified orchestration mechanisms for the automated

placement of the 5G-ready applications and the creation and maintenance of the required network slices. A non-exhaustive list of MATILDA solution capabilities include:

- Enforcement of deployment and runtime policies through a set of mechanisms establishing deployment plans based on high-level objectives and runtime adaptation of the application components and/or network functions;
- Deployment on multi-site/ multi-domain infrastructures;
- Extraction of network and application-oriented analytics;
- Management of network services defined in the form of VNF graphs through a multi-site NFV Orchestrator (NFVO).

A detailed description of the MATILDA architecture and technical innovations are provided in [3], [5] and [6]. Businesswise, the MATILDA framework consists in the following three major layers: (a) the 5G-Ready Application Layer, (b) the 5G-Ready Application Orchestration Layer and (c) the Network Slice Management Layer (Fig.2).
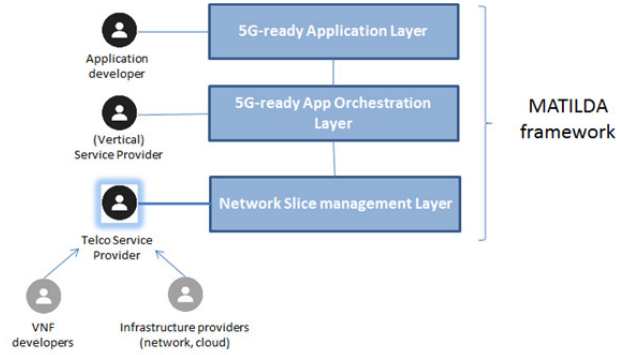

Fig. 2. 5G Ecosystem and Stakeholders addressed by MATILDA

3.2 MATILDA Framework Users and Interactions

The interactions that can be realized between the MATILDA stakeholders and the MATILDA framework layers are defined as follows [2]:

(a) The MATILDA 5G-ready Applications Layer is primarily oriented to software developers, to support the design and development of 5G-ready applications, that are distributed-by-nature, consisting of cloud native components relying on a service mesh as a means of network abstraction. This layer also enables the definition of the critical configuration parameters for application components' initial deployment and runtime, their chainable interfaces among them

(for the creation of a service graph), quantitative metrics with regard to the required QoS, in terms of compute and network performance functionalities, soft or hard constraints that have to be fulfilled, and so on. The latter is based on the conceptualization of a metamodel (application graph metamodel), to declare information and requirements.

(b) The 5G-Ready Applications' Orchestration Layer is oriented to (vertical) AP/SPs, to support the life-cycle management (deployment and runtime management) of the 5G-ready applications across the available multi-site programmable infrastructure, using a set of optimisation schemes and intelligent algorithms to provide the needed resources. Through their interaction with this MATILDA layer, AP/SPs are also able to specify policies and configuration options on a per application deployment (instance) basis; in other words to formulate the slice intent for the creation of the appropriate application-aware network slice that has to be provided by the TSP. Considering the business landscape, the role of the (vertical) AP/SP can be undertaken by the TSP.

(c) The Network and Computing Slice Management Layer is oriented to TSPs, to support the 5G application-aware network slice instantiation and management during the overall lifecycle of the application, after having got the application deployment request by the 5G-Ready Application Orchestrator. It includes functionalities such as: compute and network slice instantiation and management, network services and mechanisms activation and orchestration, as well as monitoring streams management and runtime policies enforcement. This layer includes an OSS/BSS system, a NFVO and a resources manager to handle the network and compute resources deployment.

It becomes obvious that although the business roles in the value chain benefiting from MATILDA are many, three of them only will be directly interacting with the MATILDA technical layers, namely the 5G-Ready application developers, the (Vertical) AP/SPs and the TSPs.

In the end, the technical benefits that the MATILDA framework users can anticipate are: flexibility for application/ VNF developers in the design, development and distribution of 5G-ready applications and VNFs by easy-to-access tools, capability for the vertical SPs of putting policy-based configurable network-agnostic slice requests, capability of full lifecycle management for application-aware network slices over multi-site programmable infrastructure for the TSPs.

4   MATILDA Value Proposition Analysis for Telecommunication Service Providers

The main customer segment targeted by MATILDA is the TSP that by acquiring, operating and maintaining the MATILDA solution will be able to improve its business offerings towards vertical customers and software developers. The value proposition of MATILDA to TSPs "bridging the existing gap in end-to-end

orchestration solutions and delivering an easy and flexible environment for integration of vertical applications into a 5G ecosystem" has been analysed on the basis of the Value Proposition Canvas [4] (Fig. 3); the latter identifying how the "pains" of a specific Customer can be relieved and how the "gains" expected by the solution can create revenues and added value for the Customer.
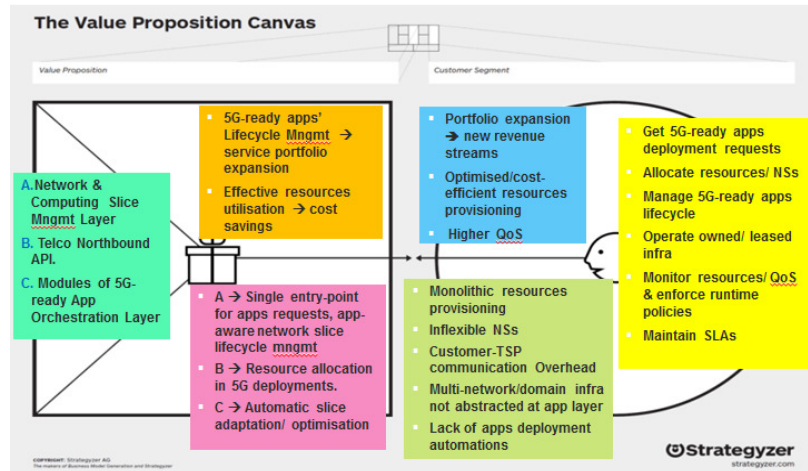

Fig. 3. Overview of MATILDA Value Proposition to TSPs

Considering the Customer Profile, that is the TSPs profile, the "jobs" of the TSPs with regard to the provisioning of 5G-ready applications, include the following processes:

- Receiving customers' requests for advanced telecom services to support 5G-ready applications and manage the lifecycle of the microservices' graph they consist of.
- Analysing/Resolving customers' requests (service graphs along with other data) in terms of identifying infrastructure resources' availability for the provisioning of these services and suitable network functions.
- Allocation of infrastructure resources in a dynamic/flexible/efficient way, so as to optimise their utilisation and fulfil the requested QoS.
- Acquiring infrastructure resources (either own or obtained as a Service from 3rd party Infrastructure Providers) and network functions and providing them to the requested 5G-ready applications (customers). In 5G this process corresponds to efficient slicing of infrastructure resources.
- Continuous monitoring of infrastructure, resources and QoS, and adjusting to runtime policies adherent to each 5G-ready application(s) deployment, following a continuous match-resolve-act approach.
- SLAs' Maintenance.

Existing application deployment frameworks cannot sufficiently support the deployment of 5G-ready applications, because application deployment procedures are detached from underlying network systems and resources. In particular, TSPs have to face a number of challenges, which constitute their main "pains" in the 5G-ready application deployment procedure, the most critical ones being the following:

- Currently, the provision of network resources cannot be modified at runtime because it is performed in a monolithic way, that is on a per-connection and per-technology (fixed or mobile) basis with fixed QoS attributes.
- Network services (NSs) are fixed and at a certain level pre-defined on a per-network technology basis.
- Currently, no automated infrastructure optimisation framework exists with regard to applications/ application components' placement; especially in multi-network/ multi-domain/ multi-Point of Presence (PoP) infrastructure deployments.
- Multi-network/ multi-domain/ multi-PoP infrastructure deployments are not easily abstracted at application/ service layer, and resource provisioning is handled on a per customer case.
- For advanced infrastructure services, direct communication between the customer and the TSP personnel is required.

These "pains" result in significant human and infrastructure resources and cost overheads as well as lack of deployments' flexibility. To relieve part of these "pains" for the TSPs in the deployment of the 5G applications, MATILDA builds a value proposition around an advanced holistic framework [3] consisting of the following products and services:

- The Network and Computing Slice Management Layer (especially the OSS/BSS, the Slice Manager and the NFVO parts).
- The Telco Northbound API, facilitating the translation of slice intent requests to application-aware slice creation and management.
- Modules of the 5G-ready Application Orchestration Layer, including Execution Manager, Policy Engine and Optimisation Engine components.

More specifically, the MATILDA products and services are considered as "pain relievers" in the following ways:

- The MATILDA Northbound API, Vertical Application Orchestrator (VAO), OSS/BSS and NFVO support simplicity, homogeneity, flexibility by providing: (a) a single point/interface for receiving requests from various customers for various 5G-ready and common applications, (b) the means to interpret the advanced resource requirements of the 5G-ready applications' in the service graph in a homogeneous and automatic way without requiring direct communication between the customer and the TSP, as well as (c) the functionality to set up and manage the 5G-ready application deployment and operation over an application-aware network slice (that can abstract technologies/domains/PoPs), thus going beyond the existing monolithic way of services/resources provisioning.

- The MATILDA VAO and Mobile Edge Orchestrator (MEO) include functionalities that offer optimised infrastructure resource allocation in multi-network/ multi-domain/ multi-PoP infrastructure deployments.
- The Execution Manager, the Policy Engine and Optimisation Engine modules of the 5G-ready Application Orchestration layer, along with the solution monitoring mechanisms, provide the required continuous monitoring functionality of infrastructure, resources and QoS, and enable the adjustment of resources to runtime policies adherent to each 5G-ready application(s) deployment, following a continuous match-resolve-act approach. They consist of components that are supporting vertical applications and services management, however in continuous interaction with the telco network management mechanisms.

At the same time, the following capabilities of the MATILDA products and services comprise "gain creators" for the TSPs:

- Capability of setting up and managing 5G-ready application deployments and operation over an application-aware network slice; necessary for the fast expansion of the TSP's service portfolio in various vertical markets;
- Effective utilisation of network resources and optimisation of resource allocation and application components' placement also leading to cost savings.

As a result, the "gains" for the TSPs from the MATILDA framework in 5G services deployment are the following:

- Fast and cost efficient expansion of their service portfolio in various vertical industries for the generation of new revenue streams.
- Optimisation of 5G network resources provisioning leveraging the latest technological advancements in telecommunications and computing domains, well before or aligned with the competition.
- Cost-efficient utilisation of infrastructure resources (either own ones and/or obtained as a Service), while maintaining high QoS for advanced services.

5   Discussion

This paper deals with the refinement and extension of the commonly identified business roles in the 5G ecosystem, to be driven by the foreseen transformation in the ICT domain in the forthcoming 5G era. It also discusses the roles/stakeholders interactions on the basis of the business framework to be supported by the 5G-PPP project MATILDA solution. The role of the Telecommunication Service Provider (TSP) in the 5G ecosystem is analysed with respect to the "pains" that are foreseen in the process of delivering 5G services, especially in terms of integrating vertical applications within the 5G (in general programmable) infrastructure, and the "gains" that are expected by these activities. The ways in which these "pains" can be relieved and the expected "gains" can be achieved is analysed in the context of

MATILDA's value proposition to TSPs which consists in bridging the existing gap in end-to-end orchestration solutions and delivering an easy and flexible environment for integration of vertical applications into a 5G ecosystem.

References

1. MATILDA H2020 5G-PPP Project, http://www.matilda-5g.eu/
2. MATILDA, Deliverable D7.4, "Market Analysis, Business Plan, Sustainability Model & Innovation Management", September 2018.
3. MATILDA, Deliverable D1.1 "MATILDA Framework and Reference Architecture". December 2017
4. Value Proposition canvas template https://strategyzer.com/canvas/value-proposition-canvas
5. P. Gouvas, A. Zafeiropoulos, C. Vassilakis, E. Fotopoulou, G. Tsiolis, R. Bruschi, R. Bolla, F. Davoli, "Design, Development and Orchestration of 5G-Ready Applications over Sliced Programmable Infrastructure", First International Workshop on Softwarized Infrastructures for 5G and Fog Computing (Soft5 2017), co-located with the 2017 29th International Teletraffic Congress (ITC 29), Genoa, Italy, 2017, pp. 13-18
6. P. Gouvas, A. Zafeiropoulos, E. Fotopoulou, T. Xirofotos, R. Bruschi, F. Davoli, A. Bravalheri, D. Simeonidou, "Separation of concerns among application and network services orchestration in a 5G ecosystem", EuCNC Workshop on "From Cloud ready to Cloud Native Transformation: What It Means and Why It Matters", Ljubljana, Slovenia, 2018.
7. 5G-PPP Program, European Commission, "5G empowering vertical industries", white paper, 2016/ URL: http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=14322
8. IEEE 5G Initiative, "5G an Beyond Technology Roadmap", White Paper, October 2017, URL: https://futurenetworks.ieee.org/images/files/pdf/ieee-5g-roadmap-white-paper.pdf
9. Next Generation Mobile Netoworks (NGMN) Alliance, "NGMN 5G White Paper", https://www.ngmn.org/fileadmin/ngmn/content/images/news/ngmn_news/NGMN_5G_White_Paper_V1_0.pdf
10. 5G-PPP View on 5G Architecture, Version 2.0, 2017, https://5g-ppp.eu/wp-content/uploads/2018/01/5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf
11. 3GPP, Technical Report, TS 28.530, "Management of 5G networks and network slicing; Concepts, use cases and requirements", Release 15.