Chapter 6
5G Network Programmability Enabling Industry 4.0 Transformation

George Makropoulos
NCSR Demokritos, University of Athens, Greece

Dimitrios Fragkos
NCSR Demokritos, University of Peloponnese, Greece

Harilaos Koumaras
Institute of Informatics and Telecommunications, Greece

Nancy Alonistioti
N.K. University of Athens, Greece

Alexandros Kaloxylos
University of Peloponnese, Greece

Vaios Koumaras
Infolysis P.C., Greece

Theoni Dounia
Infolysis P.C., Greece

Christos Sakkas
Infolysis P.C., Greece

Dimitris Tsolkas
Fogus Innovations and Services P.C., Greece

ABSTRACT

The 5G system aims at enabling innovative services of vertical industries by utilizing network programmability to its full extension. The 3rd Generation Partnership Project (3GPP) has already established the foundations to provide third parties with 5G Core's capabilities by introducing the Common API Framework (CAPIF) and Service Enabler Layer Architecture (SEAL) on top of the services offered by the Network Exposure Function (NEF). However, a scalable, robust, and secure ecosystem should be set for the verticals that exploit those capabilities. In this context, cloud native approach is becoming a key enabler for that ecosystem, taking advantage of the inherent cloud-native characteristics of the 5G Service-Based Architecture (SBA). The chapter presents the capabilities that 5G provides to verticals as well as the ecosystem that is built around the exploitation of those capabilities. As a matter of better justification and exemplification, Industry 4.0 vertical is targeted while developments related to Vertical Application Enablers (VAEs) for the factory of the future are provided.

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INTRODUCTION

We're at the dawn of the next industrial revolution, commonly known as Industry 4.0, which will deliver greater operational efficiencies and flexibility at lower costs. The transition towards Industry 4.0 will offer advances in every aspect, from remote monitoring to advanced analytics and maintenance. However, the key factor for Industry 4.0 is connectivity, so manufacturers are able to use data to gain insight about their assets, be informed and make decisions on how to optimise their processes.

The intense research work on 5G experimentation globally (Díaz-Zayas et al., 2020), has reached the point where the 5G capabilities and evolvements, are appealing to be the ideal enablers aiming to shape a new and dynamic ecosystem in mobile networks from both the technology and marketing perspectives (Kostakis et al., 2021). 5G networks are envisioned to achieve a wider variety of objectives in terms of higher multi Gbps data speeds, ultra-low latency, advanced reliability, increased network capacity and availability, as well as greater bandwidth and throughput (Koumaras et al., 2021). These characteristics are essential for effectively leveraging the various services that are taking place across the entire lifecycle of the operations and processes within the verticals related to Industry 4.0. Among these unique characteristics another crucial functionality that 5G networks provide and offers high business potential, is the network exposure, which can in turn enable new levels of programmability within core networks. The programmability provided by 5G networks will unveil a wide list of network capabilities and services to third-party developers allowing them to enhance existing use cases or even create new ones.

In the light of the above, the goal of this chapter is to advocate the optimal exploitation of the 5G technology towards the enhancement of the Industry 4.0 applications, and to present the new network architecture including the "open" core capabilities, as the new frontier for business innovation in industrial applications. Towards this direction, the first three sections of the chapter describe the capabilities that the 5G system will provide to the verticals along with the key concepts and services that are related to the 5G openness, whereas Section 4 introduces the Vertical Application Enabler concept related to the deployment of vertical applications. Section 5 introduces the realisation of the Non-Public Network (NPN) Infrastructure in the Industry 4.0, and Section 6 presents a Factory of the Future (FoF) use case in order to showcase the utilisation of 5G programmability and network exposure.

1. 5G CORE NETWORK CAPABILITIES TO VERTICAL INDUSTRIES

The enormous growth in connectivity, the high volume of traffic data and the broad range of business models nowadays, impose the need to move towards highly flexible infrastructures that are characterized by consistency in terms of performance and Quality of Service (QoS) provision. Moreover, given the fact that 5G networks will be the infrastructure leveraging a variety of verticals, the set of services per vertical industry, is mandatory to be able to meet a broad range of requirements. These requirements are related to the provisioning of enhanced capabilities in terms of programmability as well as efficient management of infrastructure resources (5GPPP, 2016).

In 2007, the telecom industry was upended by the launch of a new smartphone Operating System (OS) platform that disrupted the market by its unique openness features of programmability via the offered Application Programmable Interfaces (APIs). Exploiting the opportunity for innovation, third-party developers embraced the open Mobile phone OS and provided easy-to-use, programmable Software Development Kits (SDKs) and APIs to develop new apps and novel services (Ericsson, 2019). Due to