The Key Impacts of Softwarization in the Modern Era of 5G and the Internet of Things

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ABSTRACT

Fascinating technologies, such as software defined networking (SDN), network function virtualization (NFV) and mobile edge computing (MEC) among others, have introduced software-enabling capabilities to telecommunications, mobile and wireless communications. To depict this systemic evolution, various terminologies, such as system cloudification, network programmability, advanced computing and most popularly, softwarization, have been used by numerous scholars. Softwarization is now becoming a fully established phenomenon, especially in the new era of the rapidly evolving Internet of Things (IoT), artificial intelligence (AI) and the looming 5G technology. Away from the research and development (R&D) focus on the technological capabilities of softwarization, this article highlights the main stakeholders in softwarization and underlines a tripartite influence of the systemic evolution i.e. technical, social and economic impacts, all of which will be vital in ensuring a sustainable 5G technology and beyond.

KEYWORDS

5G, IoT, NFV, R&D, SDN, Softwarization

1. INTRODUCTION

In general, if software (i.e. code, machine logic, scripts, etc..) or a computer programming functionality is introduced to, and implemented within, a generic network or system, then we may infer that a “softwarized” system has been given birth to. Today, software underpins the operation of every industry. Even at an individual level, there exists the use of some kind of software functionality or an application (app). A new world of apps, mobile ubiquity and many more feats in information and communication technology (ICT), there cannot be a better time for extensive software solutions to be created to satisfy the never-ending user demands, always desiring more flexible, scalable, secure and user-friendly software-enabled solutions. Smart technology, machine-to-machine (M2M), IoT, etc., are no longer buzz phrases or hypes, they have found real- life applications. Similarly, softwarization is well underway, gradually coming of age in the era of 5G. To put it simply, everything is becoming progressively softwarized.

Softwarization in 5G networks will be demonstrated by a paradigm shift from service provisioning via controlled ownership of infrastructure to a more centralized control framework, achieved by the

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virtualization and programmability of multi-tenant networks, services and applications, which are powered by a hyper-converged infrastructure (Manzalini, 2014; Eluwole et al., 2018; Manzalini, 2016).

If softwarization has been driven mainly by advances in ICT, alongside interdependent socio-economic and techno-economic variables, such as plunging costs of hardware, widespread dispersion of ultra-broadband access, increased availability of open-source software platforms, etc., then it is vital to look beyond the promising technological capabilities in order to achieve its sustainability, especially in today’s hyper-connected world (Manzalini, 2014; Manzalini, 2016). This paper therefore underscores the technical, social and economic effects of softwarization.

Further sections of the paper are organized as follows: In section II, softwarization is briefly described and diagrammatically illustrated, including highlights on its key components, benefits, and stakeholder analysis. Section III, Section IV and Section V focus on the technical, social and economic impacts of softwarization respectively while Section VI concludes the paper.

2. SOFTWARIZATION – KEY ELEMENTS, BENEFITS AND THE MAJOR STAKEHOLDERS

2.1. Key Elements and Benefits

Hypothetically, softwarization is rooted in the term software, it is then energized through the design, architecture, engineering, development, prototyping, testing and application of it in specific, tailored contexts, such as the IoT, AI and 5G. Network softwarization centres on the design, development, implementation, deployment, optimization, management and maintenance of network systems, equipment, components and applications via the use of software programming (Yi et al., 2018).

From the manifold research activities already undertaken regarding softwarization, SDN and NFV are often mentioned, which makes the duo some of softwarization’s main technology components. It is no surprise that one of the best descriptions was provided by Manzalini et al. (2016), where softwarization was viewed as a radical convergence of SDN, NFV, cloud, edge and fog computing into a single systemic transformation capable of finding tangible exploitations in 5G systems. In sharing the above view, and using the analogy of science, engineering and technology (SET) in their pictorial representation, where a point of intersection, often called innovation (R&D) exists, softwarization can thus be diagrammatically depicted as the convergence of SDN, NFV and computing as shown in Figure 1.

In NFV, network functions (NFs) are decoupled and separated from the underlying dedicated hardware resources, and are instead, implemented in the form of virtualized software components (called virtual NFs (VNFs)). There are two distinct aspects, the NFs (software-driven) and the VNFs (cloud-driven). In SDN, a centralized network controller (CNC, a software application) is used to decouple the data plane (DP), sometimes called the forwarding plane (FP), from the control plane (CP). The CP relates to the software aspects of the softwarized system and its main functions include traffic routing and allocation to network elements while DP relates to the hardware aspect, providing a key function of packet forwarding. NFV complements SDN by providing the infrastructure upon which the latter operates (Yi et al., 2018; Zaidi et al., 2018, Manzalini et al., 2016; Nguyen et al., 2017; (Bizanis & Kuipers, 2016; Thembelihle et al., 2017; Tavernier et al., 2015; Ojo et al., 2016).

Several technical challenges exist in enabling softwarization within traditional networks. For example, implementation challenges in SDN can include how to manage unanticipated interactions with other deployed networks, how to achieve seamless integration with legacy networks that do not necessarily support the OpenFlow protocol and how to minimize errors whilst emulating SDN beyond certain frontiers (Horvath, Nedbal, & Stieninger, 2015).

Nevertheless, softwarization certainly offers multiple benefits. A key benefit is the ability to deliver vendor-agnostic solutions. An abstraction of the underlying network infrastructure can be used for orchestrating applications and services, whilst also reducing the overall hardware footprint.
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