Chapter 8

The NovaGenesis Smart Cities Model

Antonio Marcos Alberti
Inatel, Brazil

ABSTRACT

Smart cities encompass a complex, diverse, and rich ecosystem with the potential to address humanity’s biggest challenges. To fully support society demands, many emerging technologies should be gracefully integrated. Current architectures and platforms frequently address specific topics, requiring intricate coordination of partial solutions. In this context, interoperability of technological solutions is mandatory. Examples include interoperability of IETF standards (e.g., 6LowPAN, RPL, CoAP to other IEEE standards, such as 802.15.4, and Bluetooth). Designs based on these protocols are being largely employed worldwide. However, they have some limitations that deserve our attention. Recent examples, such as ransomware and DDoS attacks, are concerning many people on the suitability of our current stacks. NovaGenesis (NG) is an alternative architecture for TCP/IP that has been already proofed. In this chapter, the NG model for smart cities is explored, presenting its benefits. Recent results in NG are summarized and discussed on the proposed scope.

INTRODUCTION

Smart cities are a hot topic nowadays, with thousands of examples worldwide. They have the potential to successfully address the most important problems of our time, such as: sustainability of natural resources, energy fingerprint, global warming, public safety, transportation, pollution, etc. Large sensor networks can bring relevant information on water spend and leakage, electricity consumption, air quality, traffic condition, lighting effectiveness, among many other use cases. However, smart cities require an unprecedented level of technology integration, orchestration and synergy.

Smart city architectures encompass several layers, from physical devices up to information objects. The visible portion of a smart city includes: sensing devices (temperature, humidity, etc.), actuation devices (switches, engines, valves, etc.), Internet of things (IoT) gateways, cables, fibers, antennas, switches, routers, buildings, data centers, computers, racks, etc. Cloud or fog (edge) computing is required to support...
IoT services and applications. A common approach is to employ service-oriented architecture (SOA) to orchestrate (coordinate) software-as-a-service (SaaS). Network function virtualization (NFV) is also required to improve flexibility, emulating hardware as services in the data center (Alberti et al., 2017c). Network programmability is another ingredient, since the quantity of networks and systems involved is very large. Scalability and elasticity of smart city services is also a pre-requisite. Scalability means to keep solution safety as scales increase, while elasticity means to increase or decrease services instances as the load changes. All these requirements and technologies should be gracefully integrated to provide future-proof solutions. A big engineering challenge!

Internet scale and role have changed considerably from its original purposes in the 1970’s. Current Internet is growing in scales since it was opened to the general public, giving rise for plenty of applications. Many patch-work solutions were applied to extend its scope, e.g. IPSec, mobile IP (MIP) and IPv6, as well as the most recent ones focused on connecting constrained devices to the Internet, such as constrained application protocol (CoAP), IPv6 over low power wireless personal area network (6Low-PAN) and routing protocol for low power and lossy networks (RPL). These evolutionary extensions aim at fulfilling the IoT and smart cities vision, which can be defined as the efforts to bring billions of ordinary things to the Internet. In this context, the current Internet technologies will be inadequate to fully support these multifaceted exponential growths on the number of devices, mobility, interactivity, content, security and privacy issues.

The newspapers are full of examples were IoT solutions fail to deliver what consumers are expecting. Examples of malfunctioning and security threats are given in a daily basis. However, many smart cities projects assume current technologies are completely ready for such challenges. In the mean time, those that work in the information and communications technology (ICT) department certainly know the limitations of the current technologies. In this context, several initiatives have emerged worldwide to reshape the Internet under the banner of future Internet (FI) research (Alberti, 2013). NovaGenesis (NG) is one of them. NG is a “clean slate” FI architecture that has been developed since 2008. It considers IoT, virtualization, programmable networks, self-organization, SOA, cloud computing and many other ingredients since the beginning of its design (Alberti et al., 2017a).

In this chapter, NovaGenesis potential as a smart city architecture is explored. It starts with an overview of NovaGenesis proposal, its main concepts and current implementation. Then, a first glance discussion on a NovaGenesis smart city is provided. The advantages NovaGenesis offer for this aim are presented and illustrated. The chapter continues with a discussion on recent results for a future Internet of things (FIoT) with NovaGenesis (Alberti et al., 2017c). A concrete and scientifically proofed scenario is explored. Finally, some final remarks are given.

**NovaGenesis**

NovaGenesis\(^1\) is a “clean slate” architecture aimed at integrating: packet networking, cloud computing, Internet of things, Internet of people, service-oriented architectures and self-organizing technologies. NovaGenesis means new beginning. The motto question of the project is: what if there is no Internet now? How could it be designed and deployed? This question has been motivating many research projects under the banner of “Future Internet” (FI) research (Alberti, 2013). In this context, NovaGenesis proposes a novel information architecture aimed at offering an alternative to current ones, e.g. TCP/IP,