

# Chapter 18

## Using a Use Case Methodology and an Architecture Model for Describing Smart City Functionalities

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### ABSTRACT

*The development of complex software and hardware systems has increased in recent years. One reason is the continuous development in information and communication technologies sectors that enable a smooth and seamless connection of single components or systems. Another reason is the changed way of life, e.g. urbanization leads to new challenges in city planning to deal with large crowds, high-energy consumption, or big garbage quantities. The future or rather present city planning focuses on the concept of these complex systems (alias smart city). Information technologies interconnect smart city components and enable several smart city sub-systems like smart grid, smart building, supply/waste management, smart traffic, smart government etc. A definition of component functionalities and interfaces is needed to demonstrate their interconnections and information flow. Therefore, alternative techniques can be utilized to specify these both component and system requirements.*

### 1. INTRODUCTION

The rapid economic development of cities and the rising immigration into cities accelerate urbanization (Tacoli, 2012). Limited space in cities makes it difficult to meet all requests and requirements of people living there. New solutions need to be found to keep the quality of life. Cities can become smarter using new information and communication technologies (ICT), which link and combine different systems. A combination, connection, and integration of systems and infrastructures in cities, which improve the

DOI: 10.4018/978-1-5225-7030-1.ch018

quality of life, describes the concept of smart cities (Nam & Pardo, 2011). Further definitions and ideas for smart cities by various authors and institutes exist. Another definition by the International Telecommunications Union (ITU) describes smart cities as “*an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects*” (ITU, 2015; Anthopoulos, 2015). Both definitions follow the same scope: using ICTs to connect systems to fulfil complex tasks that involve multiple areas in the context of a city.

Hence, smart city sub-systems are smart grid, smart building, supply/waste management, smart traffic, smart government etc. and affect all areas of life. For example, smart grids facilitate the integration of distributed energy resources, smart buildings support people in daily activities, regarding heating, cooling, and lighting (Gottschalk et al., 2014), and smart traffic reduces the air pollution in cities (DKE, 2014a). These systems are currently under development just as smart cities (DKE, 2014b). For a smoothly development of all these complex systems, an approach is needed which helps to describe the complete functionality and architecture of these systems to guarantee interoperability between them.

Interoperability is an important topic for standardization, because one objective of standardization organizations is to enable a smooth and seamless collaboration between systems and their components. Hence, the German standardization organization for Electrical, Electronic, and Information Technology tries to collect the complete functionality of systems under development with known techniques from software engineering to get uniform and comparable system requirements; in this case, a use case methodology is used (Uslar et al., 2013). On the other hand, these requirements depict a basis for new standards and architecture decisions due to the uniform description of systems (DKE, 2013; DKE, 2012; DKE, 2014a; Uslar et al., 2012). This approach can support the development of further smart city standards that have not been completed yet.

Additionally, the uniform description can help to create architecture models that can be applied as reference architecture models for future manufacturer. Thus, aim of this work is to present alternative techniques to support the specification of component and system requirements and to answer the research question: *Can the use case methodology be applied for specifying smart cities structure and information exchange*. The answer to this research question is relevant for various research projects and standardizations bodies. It depicts basics for the use case methodology and the possibility to apply this methodology in different areas. Moreover, this chapter demonstrates how architecture models can be used and how these techniques can be adapted to new areas.

The paper is structured as follows: First, an overview on the theory of complex systems and related work is given in Section “2. Background”. It depicts difficulties to describe complex systems, the definition of complex systems, and the presentation of the use case methodology as well as further requirements engineering techniques for describing system requirements. Secondly, the use case methodology, integration profiles, and architecture models are introduced in Section “3. Research Methodologies and Tool Support”, in order to explain how these can assistance the planning and development of smart cities. Additionally, a web-based tool is presented to provide a platform, which supports these methodologies. Section “4. Conclusion” gives an overview on future work and concludes this contribution.

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