Chapter 2
The M3 Architecture for Smart Spaces

ABSTRACT

In accordance with the previous chapter, a particular class of smart environments is created by Smart Spaces, where many devices participate using information-driven and ontology-oriented interaction. In this case, a smart space is developed based on models from multi-agent systems and knowledge manipulation technologies from the Semantic Web. In this chapter, we consider this particular approach for creating such smart environments. The M3 architecture (multidevice, multivendor, multidomain) aims at development of smart spaces that host advanced service-oriented applications. We introduce the theoretical background of the M3 architecture in respect to its open source implementation—the Smart-M3 platform. The latter forms a technology for creating M3-based smart spaces (M3 spaces) as heterogeneous dynamic multi-agent systems with multi-device, multi-vendor, multi-domain devices and services. We further consider the concept models of space computing that enable the studied class of smart spaces, derive the generic properties that an M3 space design requires, and describe the basic software components of M3 architecture that realize the generic design properties in accordance with the concept models.

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INTRODUCTION

As we showed in the previous chapter, the smart spaces paradigm aims at application development for advanced computing environments, when participating objects acquire and apply knowledge for service construction in order to enhance user experience, quality and reliability of the provided information (Balandin & Waris, 2009; Augusto, Callaghan, Cook, Kameas, & Satoh, 2013). Each participating object is represented with a software agent—an autonomous information processing unit, which is not necessarily attached to a fixed device. Software are of adjustable autonomy agents (Ball & Callaghan, 2012). They run on various devices of the environment and represent smart space participants acting as knowledge processors for semantic-driven information sharing (Kiljander, Ylisaukko-oja, Takalo-Mattila, Etelapera, & Soininen, 2012). A service is constructed by joint activity of interacting agents (Balandin et al., 2010). The interaction is indirect, in contrast to the communication level provided by the IoT technology (i.e., no need in direct agent-to-agent communication). Agents joint activity creates a service construction chain. At the end of the chain a meaningful information value is shaped to deliver it as a service to the users (Korzun, 2014).

In this chapter, we consider the M3 architecture to applying smart space paradigm for interaction of different devices and information & computation resources on the interoperability level (Korzun, Kashevnik, Balandin, & Smirnov, 2015). The abbreviation “M3” stands for Multidevice, Multivendor, and Multidomain. The M3 architecture is based on the disruptive technologies coming from two innovative concepts: the Semantic Web (SW) and the Internet of Things (IoT). SW concept was born to drive the Web towards the original Tim Berners Lee’s vision, the so-called web of data (Berners-Lee, Hendler, & Lassila, 2001). The SW technology stack is primarily composed by technologies allowing the representation (RDF, RDFS, OWL) and retrieval (SPARQL) of semantically annotated data (Gutierrez, Hurtado, Mendelzon, & Perez, 2011). The IoT concept is a large-scale evolution of the innovative vision of Mark Weiser about ubiquitous computing (Weiser, 1991): the Internet, in addition to personal desktops and mobile computers, is also populated with billions of heterogeneous interconnected smart devices, which represent (and advance) physical things. Everyday life objects, alongside traditional computers, become smart objects—data processors and service constructors to their users (Kortuem, Kawsar, Sundramoorthy, & Fitton, 2010; Gubbi, Buyya, Marusic, & Palaniswami, 2013).

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