Chapter 3
M3 Spaces in Internet of Things Environments

ABSTRACT

As we showed in the previous chapter, the M3 architecture supports the Smart Spaces concept with localization and interconnection of available resources, their semantics, and information-driven programming over this dynamic knowledge corpus (in the form of a semantic network). In this chapter, we consider the settings of IoT environments. The settings play an essential practical role, influencing the way how an M3 space and its applications are deployed on the existing networked equipment of a given IoT environment. Basically, IoT refers to the connection of physical objects. IoT technologies make all the devices of a spatial-limited physical computing environment interconnected as well as connected to the Internet. This ability leads to the consideration of notion of localized IoT-environments which now appears in many places of everyday life. Software agents running on devices turn the latter into "smart objects" that are visible in our daily lives as real participating entities. As a result, the next generation of software applications (smart applications) can be deployed in localized IoT-environments in the form of M3 spaces.

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INTRODUCTION

In contrast to Giant Global Graph of the Semantic Web, M3 spaces are of local and dynamic nature (Oliver, 2008). This property suits well for the Internet of Things (IoT) with its ubiquitous interconnections of highly heterogeneous networked entities and networks (Kortuem, Kawsar, Sundramoorthy, & Fitton, 2010). IoT becomes a feasible internetworking substrate on top of which M3 spaces can be deployed (Korzun, Balandin, & Gurtov, 2013; Kiljander et al., 2014; Balandina, Balandin, Koucheryavy, & Mouromtsev, 2015; Roffia et al., 2016). Autonomous everyday objects, being augmented with sensing, processing, and network capabilities, are transformed into smart objects that understand and react to their environment. It has led recently to revision of application programming techniques and met with new design challenges for development of IoT service infrastructures (Korzun, Kashevnik, Balandin, & Smirnov, 2015; Korzun, Nikolaevskiy, & Gurtov, 2015; Korzun, 2016a).

This chapter sorts out the following design challenges, which smart space deployment and in particular M3 space applications meet in IoT environments.

- **Interoperability:** How to manipulate with information in an open dynamic multi-device environment and to offer services to the users.
- **Information Processing:** How to reason over the information and to construct the services, despite of environment heterogeneity, volatility, and ad-hoc nature.
- **Security and Privacy:** How to provide integrity and confidentiality of processed data and communication as well as authentication of services and users.

We expect that these challenges are most crucial on the recent phase of M3 architecture realization. Other challenges are their instances to certain extent. That is, seamless device integration is connected to interoperability and security, knowledge exchange between services and understanding of the current situation are related to interoperability and information processing.

BACKGROUND

The advances in IoT technology lead to emergency of IoT environments in various application domains. Let us overview some of the most promising