IoT-Based Smart Home Process Management Using a Workflow Approach

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ABSTRACT

The new concept of the Internet of Things (IoT) is bringing new forms of knowledge and applications that rely on smart objects able to sense and process the collected data on a remote workflow server in the perspective to generate automated decisions. In this context, one of the main problems is how to schedule the data flow circulating between objects, and between objects applications. The cooperation between these objects is a promising solution to meet this challenge. Business process management (BPM) is the most adapted way to carry out data management thanks to workflow processes. To this end, a new semantics operator which the authors call a gateway for intelligent process scheduling of IoT (GIPSIT) is proposed as a semantic gateway enabling the management of data flows circulating between the connected objects of IoT. The researchers validate their approach based on GIPSIT operator by implementing a realistic eHealth based-scenario in a Smart Home. The obtained findings showed clearly the importance of this new operator in the context of IoT.

KEYWORDS

BPMN, Internet of Things, Packet Tracer, SmartHome, Workflow

1. INTRODUCTION

Internet of Things is an innovation in the field of information and communication technology. It characterizes a set of people and intelligent devices connected and organized in a network (Luiz et al., 2018) that can be either connected between them or to the external environment (Gitanjali, Henning, 2018). It also allows new forms of communication between objects that are able to perceive the activities around them and to share exact information in a wireless way (Partha, 2018). Companies are just beginning to measure the unlimited potential of this new generation of objects.

Several recent works on data management in enterprises, like in (Zak, 2018; Idir, Hatem, 2013; Boudart & Bonfils, 2012; Mishra, Lin, & Chang, 2014) have chosen workflow processes to manage the information flow phase, and thus to benefit from the advantages like automation and prioritization of data flow, enhanced security by reducing the rate of human error. This can guarantee a reduction in the transmission time of the relevant data to the right destination and at the right time. The processing of data circulating in IoT is based on tools for querying, analyzing, and synthesizing such as with Hive, Hadoop (Gitosree, Anirban, Sabnam, 2019), etc. Nevertheless, these tools present difficulties for coping with data routing mechanisms, which are still a challenge when these tools do not manage the loss of data, automation or transfer priority (Dinh, & Lim, 2016).

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The smart objects are already an integral part of our daily life and are at the origin of the new way of interacting with the environment. But because connected objects cannot collaborate on their own initiative, business process-oriented applications can help them to cooperate, as stated in (Christian et al., 2017). Smart objects, when associated with business-process-oriented applications, can increase the intelligence of these devices. IoT allows interacting differently with the processes. For example, instead of going through a web page to trigger a process, it will be possible to trigger it automatically from another process.

IoT will certainly leave its imprint on applications-oriented business processes (or BPM), and vice versa. These applications are used to link individuals, processes, information systems, and automation. On the other hand, the process modeling methods used in the BPM concept, such as BPMN, are limited for managing data flow generated by connected objects in order to improve intelligent cooperation between connected objects, humans and systems.

Authors’ objective is to propose an effective workflow solution, which solves the problems raised by BPMN control operators facing the challenging related to data transfer for better management based on data importance circulating in the IoT area.

Hence, the main contributions of this article are to propose an adapted architecture to Smart Homes and BPM, thus, a semantics flow control operator called GIPSIT dedicated to smart objects is proposed as an extension for the BPMN concept, ensuring intelligent cooperation between connected objects via automated workflow processes to provide intelligent data transfer based on data importance. Authors equally propose an SPM platform, to simulate evaluate GIPSIT performance via a real scenario, offering intelligent assistance to sick people living in a connected environment such as Smart Home.

The rest of the paper is arranged as follows: In Section 2, we present the basic concepts related to this study, followed by an exhaustive state of the art on the main IoT challenges in Section 3. Section 4 details the proposed management approach based on forwarding data coming from smart connected objects using workflow processes. In Section 5, we implement and illustrate our approach using a use case dedicated to Smart Homes. Finally, we conclude the paper with the future work in Section 6.

2. MAIN CONCEPTS

In this section, the authors present the key concepts that are closely related to the development of their contribution.

2.1. Internet of Things

The concept of the Internet of Things was elaborated by Kevin Ashton in 1998, at a meeting where he states: if we are able to add RFID radio frequency identification, and sensors to objects of daily life, we can establish an Internet of Things and pose the foundations of a new era of the perception by the machines” (Ali, Ali, & Badawy, 2015). He concentrated on developing a system that connects objects with Internet.

Nowadays, many fields (Smart Home, smart transportation, smart health, etc.) are practiced with smart objects containing sensors that collecting data to outsource them thanks to their ability to be connected to the Internet. Depending on the application domain, there are many advantages (Yusuf, Kashiful, Firoj, & Mumdouh, 2019; Rathnakar & Jenith, 2017) as in the following. In the domain of e-health, thanks to biometric sensors, all the human body can be monitored. In the field of smart grids, smart public lighting saves up to 40% of electricity (Bhairi, Kangle, Edake, & Madgundi, 2017). In the agriculture domain, for example, increasing production and reducing the cost of works can be achieved through the integration of agricultural robots. Finally, in the domain of home automation, smart objects equipped with sensors can control the security of a Smart Home.
Case Study for Internal Users

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