Information Processing for Generating Recommendations Ahead of Time in an IoT-Based Environment

Alexandros Bousdekis, Information Management Unit (IMU), Institute of Communication and Computer Systems (ICCS), National Technical University of Athens (NTUA), Athens, Greece
Nikos Papageorgiou, Information Management Unit (IMU), Institute of Communication and Computer Systems (ICCS), National Technical University of Athens (NTUA), Athens, Greece
Babis Magoutas, Information Management Unit (IMU), Institute of Communication and Computer Systems (ICCS), National Technical University of Athens (NTUA), Athens, Greece
Dimitris Apostolou, Information Management Unit (IMU), Institute of Communication and Computer Systems (ICCS), National Technical University of Athens (NTUA), Athens, Greece & Department of Informatics, University of Piraeus, Piraeus, Greece
Gregoris Mentzas, Information Management Unit (IMU), Institute of Communication and Computer Systems (ICCS), National Technical University of Athens (NTUA), Athens, Greece

ABSTRACT

The evolution of Internet of Things (IoT) has significantly contributed to the development of the sensing enterprise concept and to the use of appropriate information systems for real-time processing of sensor data that are able to provide meaningful insights about potential problems in a proactive way. In the current article, the authors outline a conceptual architecture and describe the system design requirements for deciding and acting ahead of time with the aim to address the Decide and the Act phases of the “Detect-Predict-Decide-Act” proactive principle, which are still underexplored areas. The associated developed information system is capable of being integrated with systems addressing the Detect and the Predict phases in an Event Driven Architecture (EDA).

KEYWORDS


INTRODUCTION

The evolution of the Internet of Things (IoT) has significantly contributed to the development of the sensing enterprise concept, which deals with the use of multi-dimensional data captured through physical and virtual sensors generating events and providing added value information. This huge amount of real-time data leads to the need for sensor-based, real-time data-driven information systems incorporating efficient processing technologies and mechanisms in order to provide meaningful insights about potential problems (Bousdekis et al., 2015). Event monitoring and big data processing
are of outmost importance because they enable not only observing current problems, but also identifying that the problem may appear, leading to the possibility to decide and act ahead of time, in a proactive way (Engel et al., 2012; Bousdekis et al., 2015). In this sense, proactive decision making (Engel et al., 2012) can be further developed and validated in the frame of a proactive Event Driven Architecture (EDA) integrating real-time data from various sources (e.g. sensors), facilitating large-scale and real-time processing of these data and combining historical data and domain knowledge with current data streams in order to provide recommendations about which actions to implement and when. Recommendations are provided on the basis of predictions with the aim to optimize the business utility function. Predictions are triggered when an unusual situation is detected based on the sensor-based real-time observations.

Despite the increasing amount of research regarding detection and prediction methodologies, algorithms and information systems, automation of decisions ahead of time is still an unexplored area. In this paper, the authors describe the design requirements for the implementation of a system for context-aware proactive decision making in sensing enterprises. More specifically, they describe how the information is processed so that decision making ahead of time is facilitated. In this sense, this paper does not focus on the algorithms implemented, but on information processing among the constituting blocks of the system architecture in order to generate recommendations ahead of time in an IoT-based environment. The current paper constitutes a significantly extended version of (Bousdekis et al., 2017a). The rest of the paper is organized as follows. First, there is a review of background and works related to proactive event-driven computing. Then, it outlines the conceptual architecture for continuously improved context-aware proactive event-driven decision making in an IoT-based environment. The system design requirements for deciding and acting ahead of time are also presented, while a system walkthrough is provided. Finally, the system evaluation results are highlighted, and the conclusions are discussed.

Background and Related Work

In the context of the sensing enterprise, physical and virtual sensing devices such as sensors, actuators and controllers are able to observe changes in the condition of systems and to generate data in the form of events, which are then further processed (Bousdekis et al., 2015). In addition, internet communication technologies integrate sensors into a multi-layered real-time big data architecture. Event Driven Architecture (EDA), which provides the capability to react to changes by handling events (Luckham, 2002; Dunkel et al., 2011), complements Service-Oriented Architecture (SOA), which supports interconnectivity at an object level, because services are enacted by triggers from events received (Engel, and Etzion, 2011; Fournier et al., 2015).

EDA and conceptual models that support it have evolved in the last several years, departing from the traditional computing architectures which employ synchronous, request-response interactions between client and servers. This is a paradigm shift in two senses (Engel et al., 2012): first, event driven architectures support applications that are reactive in nature, in which processing is triggered in response to events, contrary to traditional responsive applications, in which processing is done in response to an explicit request. Second, event driven architecture adheres to the decoupling principle, in which there are event producers, event consumers and event processing agents that are mutually independent.

The development of models and tools to express and execute reactive systems in an easy way has turned event-driven applications pervasive and part of the main-stream computing (Engel et al., 2012). A similar evolution is necessary in order to enable pervasive use of proactive computing. Building on EDA, proactive event-driven computing is a new, evolving paradigm where a decision is
Related Content

Tracking Systems for Multiple Smart Home Residents

A Conceptual Framework for Rock Data Integration in Reservoir Models Based on Ontologies
Other Typical BID Improvements

A Client-Focused Methodology for Gaze Control Assessment, Implementation and Evaluation