

# Toward a new semantic framework for internet of things-aware business process discovery

Iman Elkodssi<sup>1\*</sup> and Hanae Sbai<sup>1</sup>

<sup>1</sup> Mathematics, computer science and application laboratory FST Mohammedia, Hassan II university of Casablanca

**Abstract.** A fundamental obstacle to the automatic detection of business processes is the lack of modeling concepts that explicitly express Internet elements as components of a business process model. In order to present a framework for discovering business process models from sensor data, we studied and compared the work associated with process modeling in an intelligent environment. In this article, we presented a semantic framework built on our Extended BPMN for IoT ontology model.

## 1 Introduction

The basic goal of a smart space is to use the raw data from environment-deployed sensors, actuators, and tag devices (RFID) to make decisions about the environment itself. These sources provide unstructured sensor logs, which cannot be used as input data when applying process mining to discover process models. In this context, several works have proposed approaches to transforming sensor logs into event logs to apply process mining techniques to automatically generate process models. The main concept is to apply process mining to the sensor log to generate an output BP element. the majority of existing works focus more on how to transform sensor logs, which are unstructured and raw data, into event logs and apply process mining, but the iot element is not identified as an output. Therefore, there is a need to model these processes associated with the IoT.

Similar to this, numerous approaches to handling the complex and diverse IoT domain have been presented in the literature, including semantics. [2] worked on a semantic model for the IoT domain in the same way. In addition, [3] propose a semantic framework connected with the definition of IoT resources to design IoT-compatible business processes in the European H2020 FIESTA-IoT3 project. Despite the various research initiatives in the field of IoT, only limited work exists on techniques for modeling and integrating IoT elements into business processes (BP). In fact, today, these IoT elements continuously participate in various BPs.

The object of this paper is to use standard semantic technologies, in particular ontologies, to give a semantic representation that allows us to describe the concepts relating to IOT and the elements of an executable business process described in BPMN. In the following section, we present the state of the art of work related to our research.

---

\* Corresponding author: [elkodssi.iman@gmail.com](mailto:elkodssi.iman@gmail.com)

## 2 A state of art

In this section, we present the state of the art of work on the management of business processes through IoT logs. Many research projects have focused on business process management, such as In the context of business process modeling, [5], [6], and [7] have introduced an extension to the BPMN element level for process management related to the Internet of Things (IoT); the goal in [5] is to propose a set of extensions for BPMN 2.0 that are effective for modeling WSN processes, and [7] develop an extended conceptual framework in the form of a referential architecture that can be a standardized reference model supporting the conceptual integration of the Internet of Things and process awareness. From another point of view, [4] presents a semantic framework for developing IoT-aware business processes. The authors of [8] and [9] proposed frameworks for discovering a process model from raw sensor data by using process mining techniques.

Table 1 represents the different approaches related to the management of business processes according to the IoT elements (i.e., the appearance of these elements in output) and the PM application (i.e., for the discovery of processes).

**Table 1.** comparative table.

	Approche	Purpose	IoT Concept						Process Mining
			Device			Content Information			
			Sensor	Actuator	Reader	Sensing task	Reading Task	Actuating Task	
<b>Process Aware IoT</b>	[4]	identification and integration of IoT resources as a new automatic resource type on the business process layer	+	+	-	+	-	-	NO
	[5]	Introduce a new approach to improve the performance of business processes using wireless sensor networks.	+	+	-	+	-	+	NO
	[2]	Introduce a new approach to improve performance metrics of business processes using ubiquitous computing.	+	-	+	+	+	-	NO
	[6]	proposes a concept of process-aware IoT services that can be supported by the conceptual	+	+	-	+	-	+	NO

		architecture and implement a process-aware IoT service running on an IoT community computing environment							
	[7]	The proposed process-aware Internet of Things framework is revised from the Internet of Things framework.	+	+	+	+	+	+	NO
<b>Business Process Model</b>	[8]	Presents a framework to discover activities and process models from event location sensor data	-	-	-	-	-	-	YES
	[9]	Provides an unsupervised method of discovery and activity tracking in an intelligent environment	-	-	-	-	-	-	YES

*Business process model based on process mining techniques:*

To simulate business processes, many frameworks and techniques have been developed. In this regard, my first paper is a comparative study of previous works on business process management in an intelligent environment from the perspective of process mining and business process approaches, where the representation of IoT elements is not taken into account in the processes discovered by process mining algorithms. [8][9].

*Process-aware IoT model:*

Existing work related to business process modeling for IoT is mainly dedicated to discussing IoT modeling frameworks. [4] [5][2][6][7]. Each approach was thoroughly described, emphasizing its contributions to business process modeling for the IoT. Overall, they identified IoT modeling elements. The proposed solutions are independent of process mining algorithms, and regarding the presence of IoT elements in the representation of this model, we find that this criterion is partially supported in the BPMN domain.

### 3 Problem

In general, we find that the application of PM is associated with process modeling, which does not include IoT elements, namely IoT information and IoT devices. The work that represents aware IoT processes, on the other hand, has focused on manually extending IoT elements. In summary, despite the various research initiatives in the field of IoT, only limited work exists on techniques to model and integrate IoT resources into business processes. In this sense, Galoul attempted to model semantically the IoT devices cited in Table 1. but there is still a limitation associated with content information (tasks). We also point out that absolutely no contribution has considered automatically modeling the process and enriching it.

### 4 Completed actions: Semantic Model for IoT Management in business processes

In order to semantically enrich the resulting processes via the PM, we propose a framework based This framework based on two components:

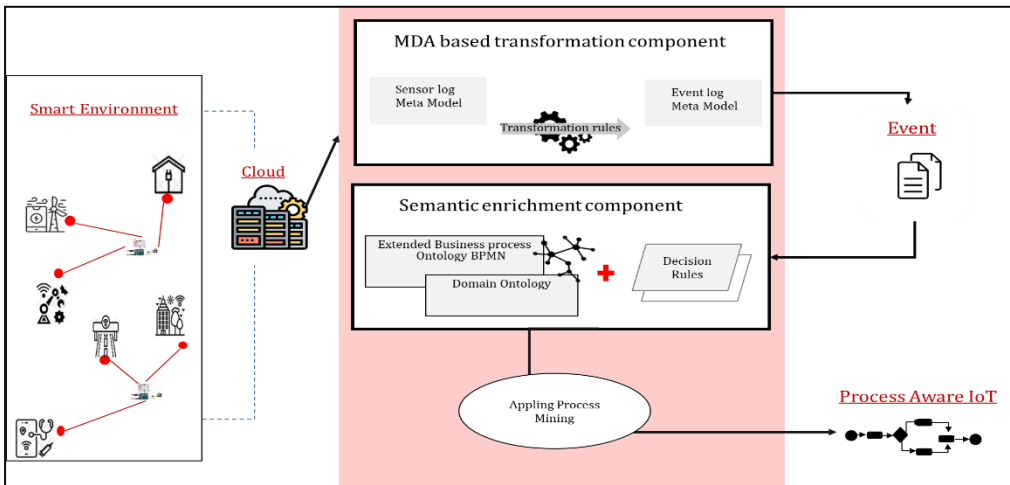
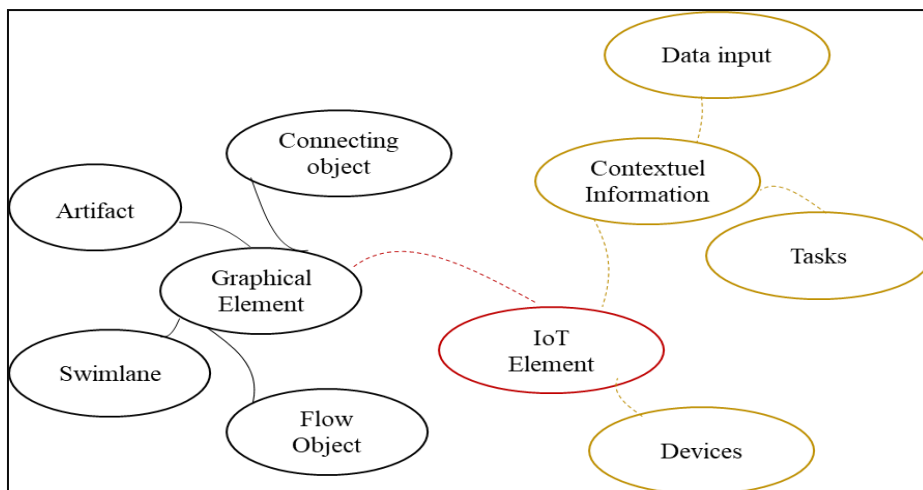


Fig. 1. An overview of our framework.

- The extended BPMNO model, ontology domain.
- The second component is the rules of enrichment of this model obtained by semantic ontology to obtain a model annotated by IOT.

#### 4.1 Extend BPMNO by IoT element :

In this section, we present a draft that is based on a semantic model that formalizes IoT elements in the context of BPMN.



**Fig 2.** Extend BPMNO by IoT element

#### 4.2 Context reference rules :

In order to extract valuable information from context, reference rules are frequently required. context reference rules, such as decision rules; the disjunction of activities and data rules;

should be consistent with general facts or business standards in order to guarantee the accuracy of context abstraction (i.e., data constraints for activity occurrence). To put it another way, context interpretation must follow business logic. Additionally, using context reasoning requires the context reference engine.

### 5 Conclusion

IoT is used as a smart environment. In this way, IoT data is used, but in an unstructured way. Many researchers have focused much more on transforming sensor logs into event logs, applying PM, and producing business process models. However, during a comparative study, it was found that this model does not include IoT elements. In this paper, we have proposed a semantic framework based on the extended PBMN for the IoT model. By connecting IoT concepts to business process concepts, we can semantically improve and enrich the business processes discovered via PM. As a part of our current work, we'll: develop the Extended BPMN for IoT ontology; fine-tune semantic rules by deciding on an ontology specific to the chosen field; and implement the framework. Our idea is to propose a hybrid approach that aims to semantically enrich business process models via extended BPMNO. We proposed a framework for "Extend BPMNO by IoT Element," which includes key elements that capitalize on IoT-enhanced business process modeling. We are currently working on a case study for the validation of the proposed framework.

## References

1. O. Thomas et M. Fellmann M.A., « Semantic Process Modeling – Design and Implementation of an Ontology-based Representation of Business Processes », *Bus. Inf. Syst. Eng.*, vol. 1, no 6, p. 438, nov. 2009, doi: 10.1007/s12599-009-0078-8.
2. A. Yousfi, A. Freitas, A. Dey, et R. Saidi, « The Use of Ubiquitous Computing for Business Process Improvement », *IEEE Transactions on Services Computing*, vol. PP, févr. 2015, doi: 10.1109/TSC.2015.2406694.
3. M. Bermudez-Edo, T. Elsaleh, P. Barnaghi, et K. Taylor, « IoT-Lite: a lightweight semantic model for the internet of things and its use with dynamic semantics », *Pers Ubiquit Comput*, vol. 21, no 3, p. 475-487, juin 2017, doi: 10.1007/s00779-017-1010-8.
4. K. Suri, W. Gaaloul, A. Cuccuru, et S. Gerard, « Semantic Framework for Internet of Things-Aware Business Process Development », in *2017 IEEE 26th International Conference on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE)*, juin 2017, p. 214-219. doi: 10.1109/WETICE.2017.54.
5. C. T. Sungur, P. Spiess, N. Oertel, et O. Kopp, « Extending BPMN for Wireless Sensor Networks », in *2013 IEEE 15th Conference on Business Informatics, Vienna, Austria*, juill. 2013, p. 109-116. doi: 10.1109/CBI.2013.24.
6. M Kim, H Ahn, KP Kim.« Process-Aware Internet of Things: A Conceptual Extension of the Internet of Things Framework and Architecture », *KSII TIIS*, vol. 10, no 8, août 2016, doi: 10.3837/tiis.2016.08.032.
7. M. Kim, K. Kim, K. Seo, J. Lee, K. Park, et K. Kim, « Modeling process-aware Internet of Things services over an ARDUINO community computing environment », in *2017 19th International Conference on Advanced Communication Technology (ICACT)*, févr. 2017, p. 163-166. doi: 10.23919/ICACT.2017.7890077.
8. A. Koschmider, D. Janssen, et F. Mannhardt, « Framework for Process Discovery from Sensor Data », in *2020 EMISA Workshop*, p. 7.
9. P. Rashidi, D. J. Cook, L. B. Holder, et M. Schmitter-Edgecombe, « Discovering Activities to Recognize and Track in a Smart Environment », *IEEE Transactions on Knowledge and Data Engineering*, vol. 23, no 4, p. 527-539, avr. 2011, doi: 10.1109/TKDE.2010.148.