

A Process-Aware IoT Application Execution Environment Design

Minjae Park*, Hyunah Kim**, Hyun Ahn**, Kwanghoon Pio Kim**

*Department of Computer Software, Daelim University, South Korea

**Department of Computer Science, Kyonggi University, South Korea

mjpark@daelim.ac.kr, {hyuna486, hahn, kwang}@kgu.ac.kr

Abstract— Process-based application-driven environments are becoming very diverse. As IoT-based application implementations are widely used, an execution environment that can run IoT devices is needed. We typically build a program-driven operating environment, but we want to run those applications or services on a process-based basis. Therefore, we design a process-based IoT application execution environment that binds such a running application.

Keywords— Process-Aware IoT Application, Workflow, BPM

I. INTRODUCTION

Through the change of the process, it is possible to easily define and apply the change such as the self change or execution method of the IoT executing device. IoT environments can be changed at any time, depending on the needs of application changes. The advantage of process management technology is that it is very easy to modify and manage a set of existing procedures.

Therefore, we propose a process-aware IoT execution environment design to cover with the change of IoT easily.

II. PROCESS-AWARE IoT EXECUTION ENVIRONMENT

Two of the largest of the process-based IoT execution environments are modeling and execution. This chapter describes modeling methods and implementation methods for IoT execution design.

A. Process-Aware IoT Environment Modeling

The IoT process model can be extended based on existing workflow models. We have extended it based on the ICN model[1, 2], and its extensions[3, 4] a well-known workflow modeling method. The components of the ICN are not lacking in representing basic workflows. It also defines processes, activities, roles, actors, applications and their relationships. Based on these ICNs, we focus on applications and the sensors and services they can run. We describe it here as IoT-ICN. The meta-model for representing the IoT-ICN configuration is shown in Figure 1. An Figure 2 shows the IoT-ICN model based on the meta-model components.

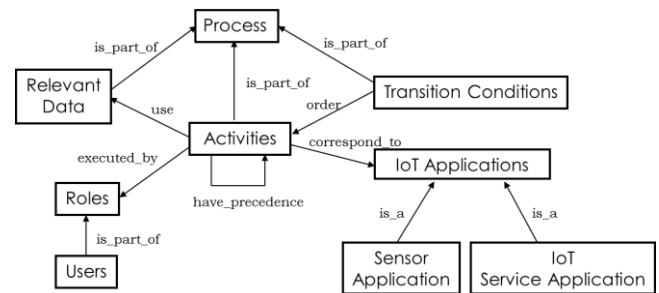


Figure 1. Meta model of IoT-ICN

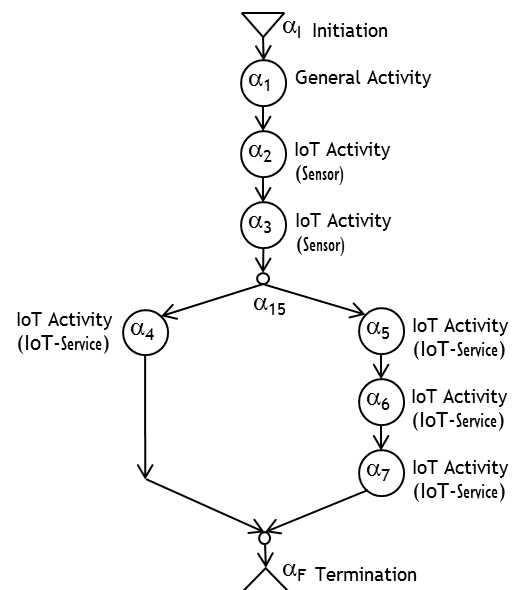


Figure 2. An IoT-ICN Model

B. Process-Aware IoT Environment Enactment

The process-aware IoT enactment service deploys the IoT process model defined by the workflow and executes it according to the defined procedure. Figure 3 describes the deployment of the IoT process model and the engine for managing it.

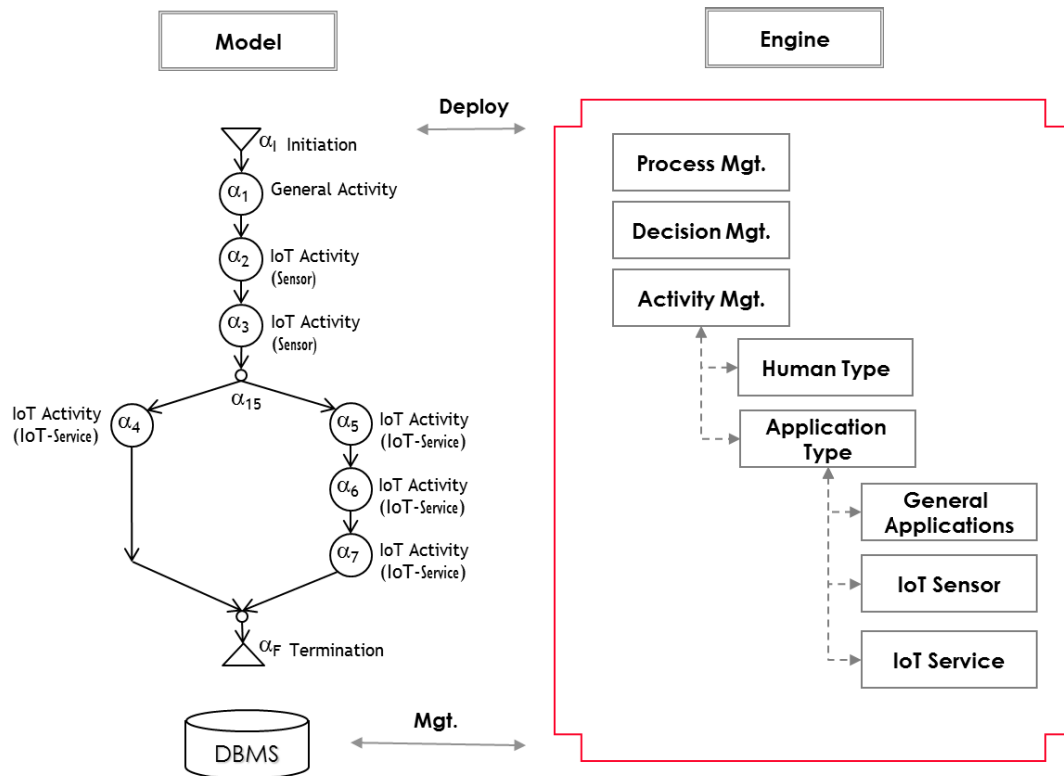
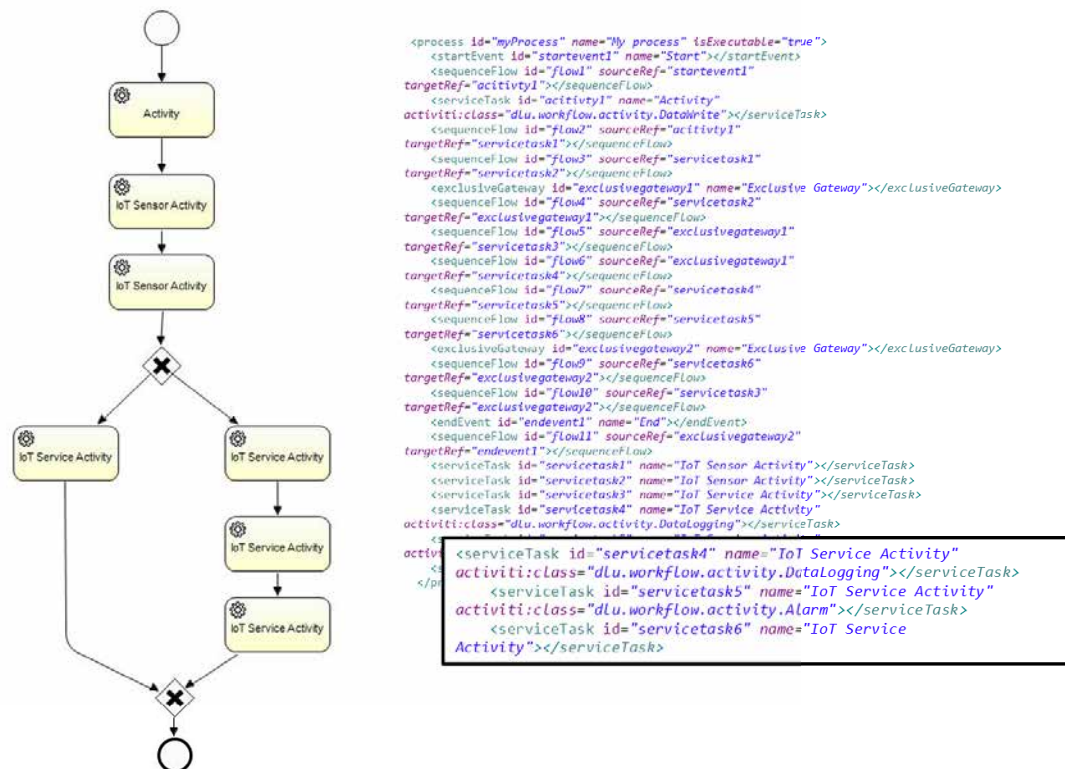


Figure 3. Process-Aware IoT Enactment Service



A good way to enactment an process-aware IoT

Figure 4. An Executable Workflow Description XML based on Standard

environment is to use a workflow engine. We expanded the node to take advantage of the existing open source workflow engine Activiti[5].

The nodes that the engine can execute are described in the form of xml for execution and can be described as shown in Figure 4.

III. CASE STUDY: A SMART COMPANION TOILET

We have tried to define and execute these IoT processes as workflows as an example. To implement smart toilets for companion animals, we simply attach sensors and introduce process management technology. In order to check the animal's bowel activity, the data was received based on the bowel-related sensor and the alarm service was provided based on the data.

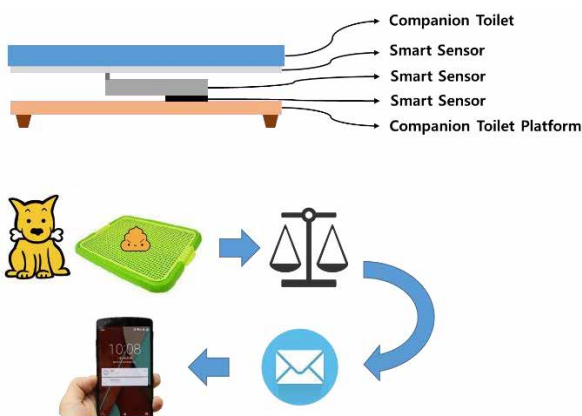


Figure 5. A Smart Companion Toilet Concept

The environment is defined as a process, and the environment based on the defined process will be executed automatically through the workflow engine.

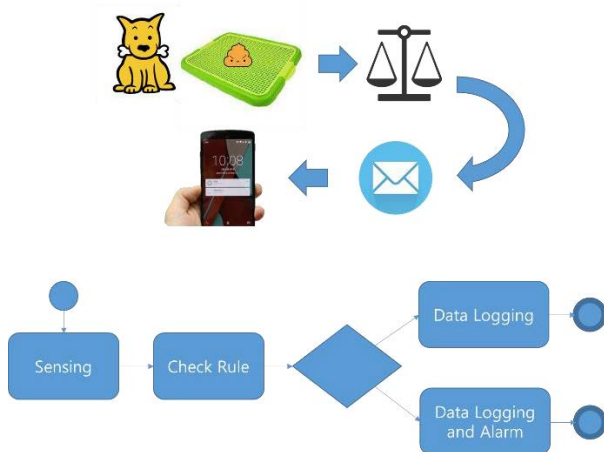


Figure 6. Process Definition of Smart Companion Toilet

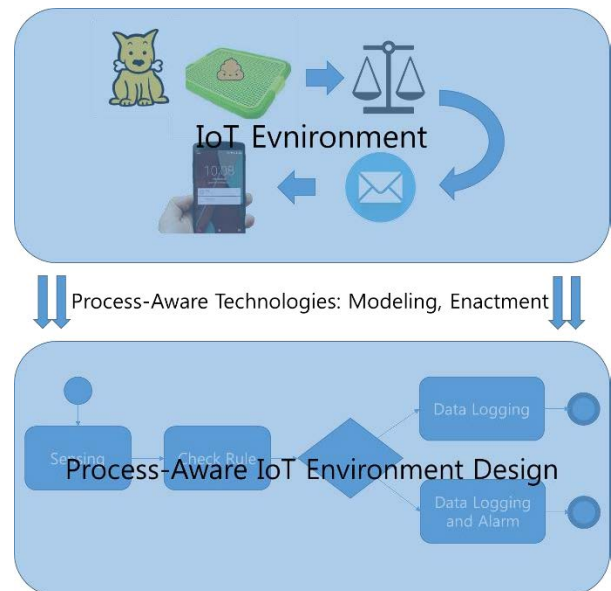


Figure 7. Process-Aware IoT Environment Design for Smart Companion Toilet

IV. CONCLUSIONS

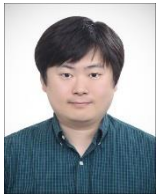
In this paper, we propose a process-aware IoT execution environment design. As a core technology, we proposed a modeling and execution technology for the IoT execution environment. Moreover, we had a study case the possible case, a smart companion toilet, based on the technology. This research is expected to be useful for the fusion technology of IoT technology and process management technology.

ACKNOWLEDGMENT

This research was supported by the contents convergence software research center at Kyonggi University funded by the GRR program (Grant No. 2017-0194) of Gyeonggi Province, South Korea.

REFERENCES

- [1] Ellis, Clarence A., and Gary J. Nutt. "Modeling and enactment of workflow systems." International Conference on Application and Theory of Petri Nets. Springer, Berlin, Heidelberg, 1993.
- [2] Kim, Kwanghoon, and Clarence A. Ellis. "ICN-based Workflow Model and its Advances." Handbook of Research on Business Process Modeling (2009): 34-54.
- [3] Ahn, Hyun, Minjae Park, and Kwanghoon P. Kim. "scien: Scientific information control nets." Advanced Communication Technology (ICACT), 2014 16th International Conference on. IEEE, 2014.
- [4] Park, Minjae, et al. "A scientific workflow model designer based on scientific information control nets." Advanced Communication Technology (ICACT), 2015 17th International Conference on. IEEE, 2015.
- [5] Rademakers, Tijs. Activiti in Action: Executable business processes in BPMN 2.0. Manning Publications Co., 2012.



Minjae Park is an assistant professor of computer software at Daelim University, South Korea. He received B.S., M.S., and Ph.D. degrees in computer science from Kyonggi University in 2004, 2006, and 2009, respectively. His research interests include groupware, workflow systems, BPM, CSCW, collaboration theory, process warehousing and mining, workflow-supported social networks discovery and analysis, process-aware information systems, data

intensive workflows, and process-driven Internet of Things and process-aware factory automation systems.



Hyunah Kim is an adjunctive professor and a faculty member of the collaboration technology research laboratory in the department of computer science at Kyonggi University, South Korea. She received her B.S. degree in computer science from Korea Nazarene University in 2001. Also, she received her M.S. and Ph.D. degrees in computer science from Kyonggi University in 2003 and 2009, respectively. Her research interests include workflow systems, SCORM-based e-Learning

process models, BPM, BPI, ACM, workflow-supported social networks discovery and analysis, and process-aware Internet of Things.



Hyun Ahn is a research professor of computer science department at Kyonggi University, South Korea. He received B.S., M.S., and Ph.D. degrees in computer science from Kyonggi University in 2011, 2013, and 2017, respectively. His research interests include workflow systems, BPM, business process intelligence, process mining.



Kwanghoon Piao Kim is a full professor of computer science department and the founder and supervisor of the collaboration technology research laboratory at Kyonggi University, South Korea. He received B.S. degree in computer science from Kyonggi University in 1984. And he received M.S. degree in computer science from Chungang University in 1986. He also received his M.S. and Ph.D. degrees from the computer science department at University of Colorado Boulder, in 1994 and 1998,

respectively. He had worked as researcher and developer at Aztek Engineering, American Educational Products Inc., and IBM in USA, as well as at Electronics and Telecommunications Research Institute (ETRI) in South Korea. In present, he is a vice-chair of the BPM Korea Forum. He has been in charge of a country-chair (Korea) and ERC vice-chair of the Workflow Management Coalition. He has also been on the editorial board of the journal of KSII, and the committee member of the several conferences and workshops. His research interests include groupware, workflow systems, BPM, CSCW, collaboration theory, Grid/P2P distributed systems, process warehousing and mining, workflow-supported social networks discovery and analysis, process-aware information systems, data intensive workflows, and process-driven Internet of Things.