XML-based Feature Modeling of IoT Applications

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Abstract

Internet of Things (IoT) aims to connect internet devices anywhere, anytime, anyplace with any other device to enhance the security, reachability and interconnection of different devices. In recent research, IoT applications are facing the management and usability problems of devices in different perspective such as in same domain but different functionality (environment). In this study we propose XML-based feature modeling approach to manage IoT applications to deal with multiple perspectives. By using feature modeling for IoT applications, reusability of devices and related applications can be well managed in different environments. We proposed XML-based Multi Software Product Line (MSPL) feature modeling framework for IoT applications to increase the reusability in different environments.

Index Terms: Internet of Things (IoT), Software Product Line (SPL), XML-based Feature Modeling.

I. INTRODUCTION

Internet of Things (IoT) related applications make the devices usable according to requirements and environment. IoT can be used anytime, anywhere and compatible with any other devices. As from last decade internet is broadly used in every field such as health, transport, mobile devices etc. and every end user device is connected with internet cloud [1]. Therefore, multiple devices are interconnected with different functionalities and these functionalities are handled by applications of IoT. Hardware of IoT remains same such as Bluetooth, sensor and Wi-Fi. However, applications of those hardware are different according to end user requirements [2]. Therefore, variability management of IoT applications is hard task because of different environments.

Software Product Line (SPL) has got high intention to manage the commonalities and variability of applications that share common resources for product development. Feature model is tree structure that is used to manage the commonalities and variability of SPL with different pre-defined notations such as mandatory, optional, alternative and OR features [3]. IoT applications are based on environmental requirements i.e. variability exist in IoT applications. However, IoT applications are based on multiple SPLs because multiple hardware applications are used in IoT system [4].

Multiple SPLs variability management is complex and hard task to ensure no constraint violations occur. In this paper we have proposed XML-based feature modeling framework

for variability management of IoT applications. XML-based feature modeling supports all cardinality and contextual constraints with efficient way by using XML-schema. Moreover, XML schema translated to XML domain feature model and extracted to XSLT for application development [2].

The remaining paper is organized as follows: section II describes the related work, section III describes the SPL feature modeling, section IV describes the XML-based IoT feature modeling and section V is conclusion and future work of this study.

II. RELATED WORK

Multiple SPLs have been used for IoT applications to exploit the domain knowledge in order to manage the commonalities and variability of IoT applications. SPL domain of IoT applications configured and identify the constraints and complex relationships among features [2].

SPL process is used to develop agents of IoT applications such as server and other mediums between IoT devices. Self-StarMAS proposed to develop the agents of IoT by using Common Variability Language (CVL) of SPL. Agents are used to well manage the IoT applications such as self-adaption, self-management and context awareness in distributed IoT system [5].

XML schema model is proposed to link and collaboration between IoT devices. XML seems good modeling tool where number of constraints and relationships exist between features. XML schema ensure the product compatibility between devices in different environments [6].

Sensor IoT model proposed that support Body Area Network (BAN) application design for health care devices. BAN applications needs to satisfy functional and nonfunctional requirements (security, energy, privacy, etc.). Feature model consists on attribute values of each feature, these attribute values can be functional and non-functional [1].

Our proposed approach covers the complete SPL process model (domain and application engineering) by using XML-based feature modeling of IoT applications. Our model is effective to manage the commonalities and variability of IoT applications to specify the environmental constraints and relationships among IoT application features.

III. XML-BASED FEATURE MODELING

Feature model is efficient and simple method to understand the scope of product line engineering. Software product line is used to develop the families of products that share common and variable features. Common features are mandatory part of every product. However, variable features can be part of product on demand and environmental requirements [7]. Cellular mobile is most effective example of SPL where attend call and receive call are mandatory features but camera, Wi-Fi, Bluetooth, etc. are variable features that can be part of product according to end user requirements. XML based feature modeling is appropriate to apply the constraints and conditions of software product line as shown in figure 1 product line.
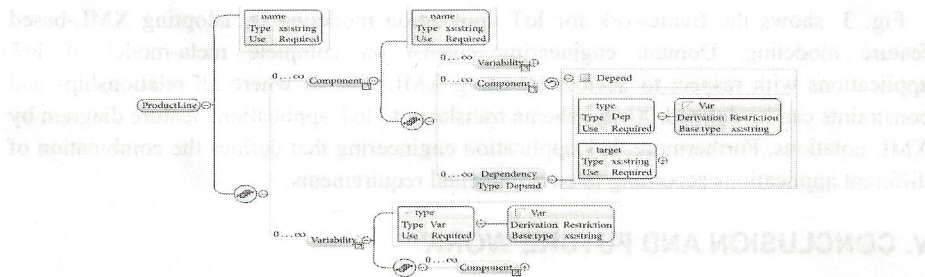
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Fig. 1. XML schema feature Model [8].

IV. XML-BASED IOT FEATURE MODELING

IoT devices use different applications according to environment such as indoor and outdoor heat sensors. Sensor hardware is same in order to change the environment however, applications that manage the heat for indoor and outdoor are different according to atmosphere. Data processing of sensor output also needs different functionalities such as big data processing, memory requirement, processing speed. XML-based modeling supports all cardinalities and contextual constraints between features of IoT applications. Fig. 1. shows the IoT feature model with multiple devices and each device consists on different feature model i.e. multiple SPLs. Communication variability feature model shown in fig. 2.
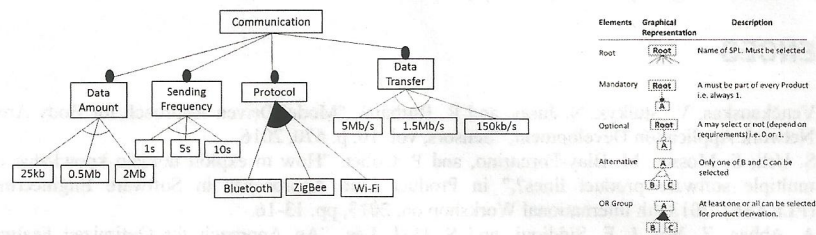

Fig. 2. IOT Communication feature model representation.

Variability management in different multiple SPLs can be managed by XML-based feature modeling as every kind of cardinality and contextual constraints can be efficiently handled by XML schema.
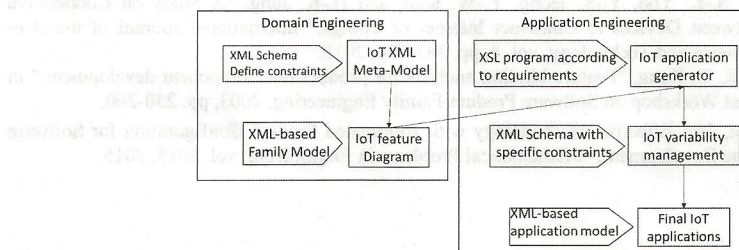

Fig. 3. XML-based Product Development of IoT Applications.

Fig. 3. shows the framework for IoT application modeling by adopting XML-based feature modeling. Domain engineering consist on complete meta-model of IoT applications with respect to devices by using XML-schema where all relationships and constraints can be defined. XML-schema translated to IoT applications feature diagram by XML notations. Furthermore, IoT application engineering that defines the combination of different applications according to environmental requirements.

V. CONCLUSION AND FUTURE WORK

Modeling of distributed IoT applications is ongoing research trend. Environmental selection of IoT applications where complex relationships and constraints exist between them is hard task. In this paper we have proposed XML-based feature modeling of IoT applications. Proposed framework is effective on complete process of IoT domain modeling to application modeling with specific environmental constraints and relationships.

Our Future work is to extend this work by applying proposed framework on different real time IoT applications and will show the proper IoT application modeling from domain engineering to application engineering.

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