ABSTRACT

The emergence of Software Product Line (SPL) has changed the way software products are engineered and delivered. On the other hand the distributed computing technologies such as Distributed Component Object Model (DCOM), Remote Method Invocation (RMI) and Web Services brought about reusability and dynamism to software development process. Thus there is ever increasing complexity in SPL and its configuration management. As change became indispensable due to new paradigms or dynamic business needs in the context of globalization, SPL has been given high importance. As assets in product line are inter-dependent, changes to them often have ripple effect and propagate to other products. In the context of customer-driven development, anticipation and change management are to be given paramount importance. It demands implementation of software variability that drives home changed, extended and customized configurations besides economy at scale. There is unprecedented need for avoiding reinventing the wheel in the wake of pressure to deliver software in time. Moreover, quality and time-to-market requirements force organizations to be customer-centric. To satisfy ever changing customer needs, there is need for a comprehensive framework for SPL configuration management and new product derivation. Many approaches came into existence towards improving configuration of product line. The existing approaches addressed different aspects of configuration management. However, a comprehensive approach could not be found.

Design and implementation of such framework is highly desired. It is the motivation behind this research which aims at improving SPL configuration management and product derivation by proposing a framework with underlying algorithms, variability-aware design patterns and ontology. Critical path analysis, weight computation and feedback are salient features in the proposed algorithms for high quality product derivation. The proposed framework is extensible and generic in nature. The research is based on three hypotheses conceived from literature insights. First, a framework for SPL configuration management can improve quality of configuration management of SPL and derivation of quality product. Second, variability – aware design patterns can exploit feature model of SPL thus leveraging configuration management and product derivation. Third, the use of ontology in SPL
can effectively represent feature model besides promoting dynamic reconfiguration and quality product derivation.

Modularization of artifacts and reusability of them is realized by using design patterns. Using design patterns in SPL is relatively new research area. Composite design patterns that are variability-aware led to the realization of high quality SPL. The use of roles and mapping them to variability model, then mapping design pattern roles to artifacts led to realization of variability with industry best practices. In addition to this, ontology is used to have formal representation of feature models. Feature model is an important constituent of SPL. A feature model represents similarities and variabilities of software besides supporting quality product derivation. However, this model has drawbacks in usage for dynamic reconfiguration. Therefore it is essential to represent features using a different model for monitoring, retrieving and modifying automatically. Ontology is one such proven model that is used to formally represent feature model in terms of concepts and their relationships in machine processable fashion.

The framework that includes algorithms, variability-aware design patterns and ontology is realized through a prototype application. The hypotheses were tested for proof of concept. Different case study SPLs such as Automated Academic Regulations (AAR), Dr. School, Library Management System (LMS) and Reservation System were subjected to experiments with the proposed framework. The empirical evaluation made by select human experts revealed that the proposed framework improved performance with respect to configuration management of SPL and product derivation. The usage of ontology in the framework further resulted in significant performance improvement in dynamic reconfiguration. The framework can be used by any software firm that in involved in product line development. The problem identified in this research that is lack of a comprehensive framework is fulfilled. The results of such framework can inspire further research in industry and academia. When a comprehensive framework is used for product line configuration management and product derivation, its impact is huge on the software industry. The impact is in the form of many benefits such as taking reusability to next level of sophistication, reducing time taken to derive new products, improving customer
satisfaction, adapting it for agility of scale, reducing budget and effort in product line systems. There are many future possibilities such as exploring cloud based product lines, mobile cloud based product lines, product lines with agile process models in the context of product line configuration management and product derivation.

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