DEVELOPMENT OF THE SURFACE TO AIR MISSILE SIMULATOR THROUGH THE PROCESS OF COMPONENT COMPOSITION AND DYNAMIC RECONFIGURATION OF WEAPON SYSTEM

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ABSTRACT

The concerns of the technology of the reusable component are increasing for producing the software effectively and developing the products quickly on demand of customers. Technologies of composition and dynamic reconfiguration of the component are needed to develop the simulator of the weapon system in field of national defense. It is needed to develop the surface to air missile simulator as the example of the weapon system through component-based development. In order to develop the simulator, creation of components of the simulator is required and the process of reconfiguration is defined and realized. The process of reconfiguration consists of four parts: management, semantic test, composition and performance evaluation. In first part, the developer can easily create lots of component models including characteristics of the product of the weapon system and quickly manage them by using the management tool. In second part, semantic tester tests that whether the reconfiguration and import in the simulator are possible or not. In next part, the composer constructs the product models configuring surface to air simulator by composing existing component and newly created component. Then the results of construction can be entities of detecting radar, the surface to air missile, the launcher of the missile and aircrafts of the simulator of the weapon system. In last part, the existing 3D-based simulator for evaluating the performance of the component of the weapon system confirms the effects of reconfigured components by importing it. Therefore, this study provides basic framework to simulate common weapon systems through the technology of composition and the process of dynamic reconfiguration.

Keywords: surface to air missile, modeling and simulation, reusability, component

1. INTRODUCTION

Developing a simulation model will require a lot of time and money in the field of modeling and simulation. Developed model is hard to be used as other applications by its closed architecture. To overcome this hardness, we require developing a basic component model that can give flexibility, scalability, reusability in modeling and simulation. Also, we require assembling and composing component model and need a way of component based development for new simulation model. This way is to assemble developed components and create new applications. It has advantages such cost and time of development and maintenance of software. Ultimate goals of this development are maximizing reusability of components and increasing productivity of the software.

New software model of the weapon system is developed by applying the technology of software product line in the field of modeling and simulation of weapon system that has a lot of similarities for each product. Therefore, in order to effectively reuse, pre-built, core assets of the software, studies are needed for this processes; management, selection, assembly and composition of component models.

The component reconfiguration of weapon system and related works are handled in second chapter. In third chapter, the development of surface to air missile simulator and its application example are organized. In the last chapter, it ends the study with conclusion and future work.

2. COMPONENT RECONFIGURATION OF WEAPON SYSTEM

Through software product line based development, it designs the dynamic component reconfiguration framework which can reuse and compose quickly the component of weapon system. Software product line based development is the way of keeping common elements of the product and only changing the distinguishing characteristics of it for reusing components. In order to realize the framework, components will be defined and developed as the unit of reusable model. The component model consists of physical part and behavior part. It is reconfigured through considering characteristics of two parts of it and being selected and composed.

The component model can be created, modified and deleted by graphic-based management tool of the

component. Also, it can be aproved to reuse for constructing the reconfiguration framework of weapon system by semantic tester of the component after different developers created it. In order to develop the simulator of suface to air missile of weapon system, it is reconfigured as composing the reuable components. For composing existing component and newly created component by the tool, the composers of the component model are developed. They also consist of physical composer and behavior composer. Physical composer constructs physical model of the product by composing components grouped by physical characteristic of component model of weapon system like the performance of the component. Furthermore, behavior composer constructs behavior model of product by including logics and rules in product. Then we can reconfigure product model of the simulator of weapon system through use of two composers.

2.1. The Process of Component Composition

2.1.1. Software Product Line Engineering

The recent interest in the field of modeling and simulation is development of reusable and configurable simulation model. It is generalized small quantity batch production from rise of importance of personalization of the customers and issued software product line engineering for corresponding the demand of customers and environment of the market. Software product line engineering is paradigm that reusing the core asset from similar product and inevitable choice for development of new product that satisfying time and economic restriction of the development (Chen, Yu, Gannold, Gerald C., Collofello and James 20006).

The definition of software product line engineering is paradigm for developing the applications of software sing platform and mass customization (Pohl, Klaus and Bockle 2005). The objective of software product line is increasing efficiency of the development by reusing the product strategically as analysis of similarities and differences between the products of software set. So it is to choice the option of product according to the user's intention and to produce new software on one of basic platforms along the choice. The basic concepts of it are understanding the similarity among characteristics of the product and supporting the variability among the application programs by distinguishing that of the product complicity (Clements, Paul and Northrop 2002).

The structure of software product line engineering is as below Figure 1. It is classified domain engineering and application engineering. Domain engineering is process of development by setting up core assets from common function through analysis of similarity and the variability. And it specifies requirements and characteristic of components and grafts them onto the basic framework. On the other hand, application engineering classifies the variability from characteristics of components and develops the target application. These two engineering help developing target application by reconfiguring pre-modeling components as specification of the variability from the basic framework.

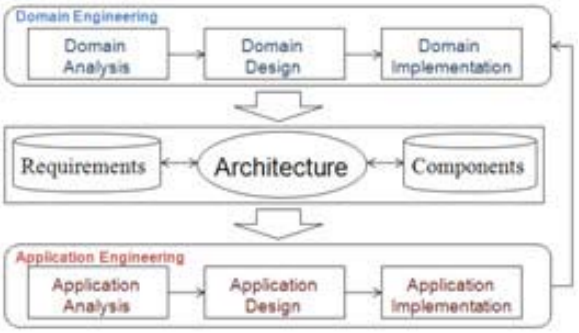

Figure 1: The Structure of Software product Line Engineering

2.1.2. Development of Basic Component Model

By applying software product line engineering, it is needed to develop basic component model of weapon system that is possible to reconfigure as unit of the component. This study develops basic component model that is possible to create various products efficiently by considering scalability of weapon system. Basic component model consists of physical part and behavior part. Physical component model contains representing physical characteristics of the weapon model. In order to develop physical component, it is needed to define criteria for description of weapon system. It is decided by requirements of the domain. This study decided criteria limits at entity level.

Next, this study considers fidelity of physical component model that represents correspondence with real entity model like the missile. High fidelity of entity model causes low reality. So it is needed to decide at optimum level. As example, the missile is composed 4 parts by analyzing its functionality and structure in figure 2.

Behavior component model also represents tactical behavior and decision. And it is developed by dividing 3 parts; basic behavior, composition behavior and judgment.

- Basic behavior: The behavior that performs alone fundamentally designed
- Composition behavior: Combined behavior except basic and original function of entity
- Judgment: It represents the state of the behavior by deciding changing behavior or not.

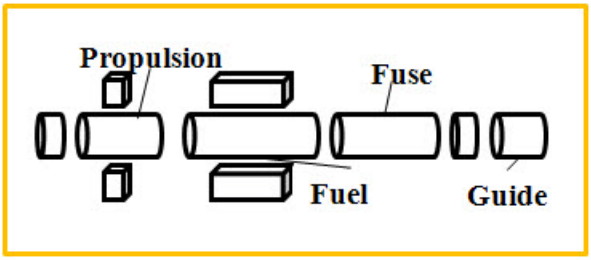

Figure 2: Structure of Missile Considering Fidelity

2.2. The Process of Dynamic Reconfiguration

For dynamic reconfiguration of component model, developed basic component models are configured onto product model that means the entity of weapon system. Next, the product models are also reconfigured to system model as application program by following the designed DCRF (Dynamic Component Reconfiguration Framework).

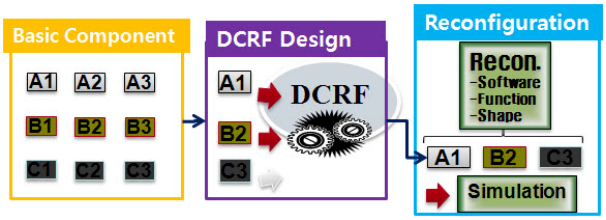

Figure 3: The Process of Dynamic Reconfiguration

2.2.1. Description of Dynamic Component Reconfiguration Framework

The framework of dynamic component reconfiguration is proposed based on requirement of customers and reusable basic components. It consists of system layer, product layer, component layer and supporting tools. At component layer, the components are reconfigured to form product models and they also are reconfigured to develop the target application system.

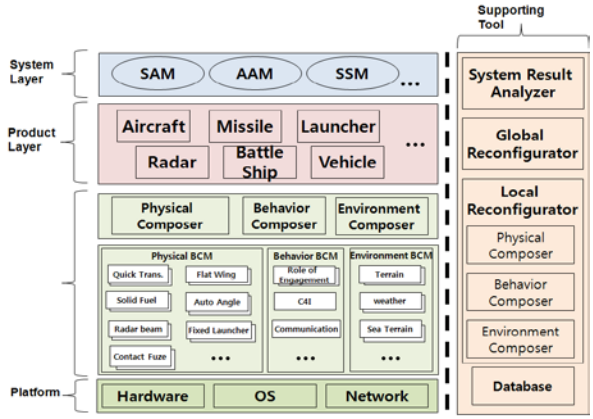

Figure 4: Dynamic Component Reconfiguration Framework

2.3. Related works

Typical national defense simulation system by reusing components and configuring is OneSAF (One Semi-Automated Forces) model. OneSAF is comprehensive model that used in ACR (Advanced Concepts and Requirements), RDA (Research, Development and Acquisition) and TEMO (training, exercise and military operation) (Giampapa JA, Sycara K, Owens S, Glinton R, Seo YW, Yu B 2004). OneSAF model has the concept of assembled software product line. This concept is based on completed system that consists of many products, and they also consist of many components. OneSAF is possible to comprise various and differenced product needed to customers as other composition of products.

3. DEVELOMENT OF THE SURFACE TO AIR MISSILE SIMULATOR

By applying designed the framework, the surface to air missile simulator is developed as one of software application. By using this simulator, reusability of developed component model is confirmed and performance evaluation of it is also possible. The user develops surface to air missile simulator by importing composed physical part and behavior part of the product model in existing 3D-based performance evaluation simulator of the weapon system. In addition, the user reconfigures various products and evaluates performace of it through the use of management tool and semantic tester.

3.1. Framework of Surface to Air Missile Simulator

As application from reconfiguration framework, SAM simulator is one of systems in system layer. Basically, it needs 4 product models such as missile, radar, launcher, and aircraft. With these as the center, there exist various components in these. For completing the product, core assets are existed and distinguishing components are composed with relative function independently.

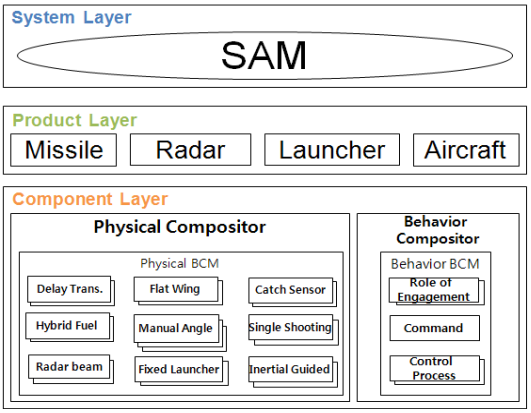

Figure 5: Framework of SAM Simulator

3.2. Application example

In this study, it develops SAM simulator that comprised of 4 product models based on the framework. Objective of this simulator is to bring down aircraft of enemy that has the mission of destroying our core facilities by shooting our missiles. The roles of each product model are as below in SAM simulator.

1. Radar: Detect aircraft and delivery information and order.
2. Launcher: Receive information and order of aircraft and fire the missile.
3. Missile: Hit the aircraft of enemy.
4. Aircraft: Move and destroy the core facilities.

After the execution of simulation, the simulator provides accuracy rate and information of product models in real time.

Also the process of reconfiguration as application is realized the developments of management tool, semantic, physical composer and behavior composer.

- Management tool: It manages so many various the basic components that have distinguishing performance models such that add, delete and modify them.
- Semantic Tester: It tests whether newly added or modified component model is possible to be used at simulator of weapon system.
- Physical Composer and Behavior Composer: By composing the basic component models, both composer creates new product models that having characteristics that are choiced by user

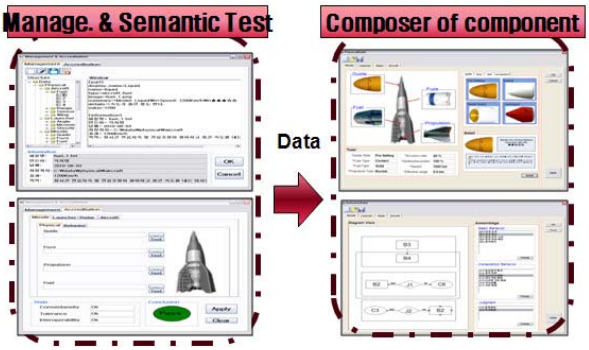

Figure 6: Application of Reconfiguration

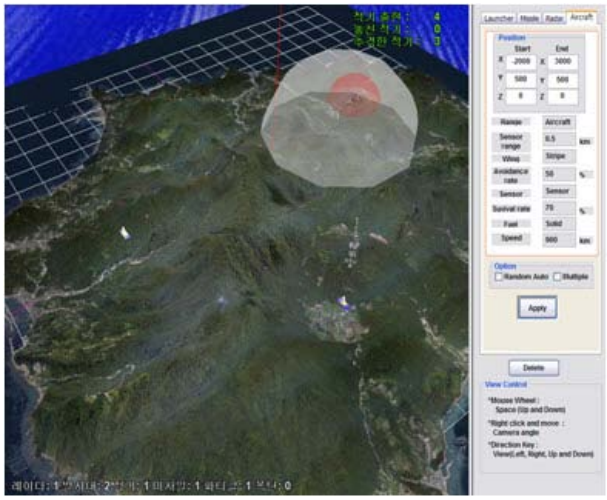
Figure 7: Surface to Air Missile Simulator

4. CONCLUSION

In this study, dynamic component reconfiguration framework is designed and realized through software product line-based development to produce the simulator easy and fast. Developed components of modeling and simulation of the weapon system increase productivity of simulation model and reduce the development cost and time. It is possible to reconfigure products as the user intended by composing reusable components that developed by the management tool and semantic tester of the component. Product models are entities of missiles, detecting radar, launchers and aircrafts for constructing surface to air missile simulator through the use of the composers. The entities include not only the physical model, but also include the behavior model to express developer's logical and specific intentions. It is possible to evaluate the characteristics of the component of the system quickly and easily through realization of the surface to air simulator. In addition, more studies are needed to store and manage the components

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