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A Study on Reuse Technique of Software for SaaS Using Process Algebra

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Abstract

SaaS provides software hosted on the cloud computing in a form of service. Thus, it enables the extension of service functions by combining or reusing the existing software. As an analysis technique, this paper suggests a method of verifying the reusability of a process by analyzing it with the process algebra. The suggested method can confirm the reusability of existing software, ensure the consistency of modifications by tenants or requests, and provide probabilities of combining processes.

Keywords: *cloud computing, SaaS(Software As A Service), reusability, process algorithm CCS(Calculus of Communicating Systems), ontology.*

1. Introduction

Cloud computing is a method that enables users to use resources such as hardware, memory space, and software through the Internet even if they do not know the internal operations. This method can provide efficiency in respect of cost, management, and operation for users.

Among these, SaaS(Software As A Service) provides software as a service and supports users to use software through the Internet without purchasing it. The data generated from it can be saved in the web as well. From the user's point of view, SaaS enables processing and storing data required for company operation without considering purchase, management, or security matters [1]. Also, on developer's side, the development of one software can provide customized services to various users by using this method. At this point, each user is called 'tenant' and operating the software personalized to multiple users properly is called 'multi-tenant'.

In particular, SaaS applications which supports multi-tenancy requires functions different from Business Process (BP). These applications should be provided with functions for specific service lists, tenant management, and verification. The workflow can be processes by standard XML such as Business Process

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Execution Language (BPEL) or Web Service Definition Language (WSDL) [2]. BP combines these services and is formed by the methods like provisioning, orchestration, and choreography, and at this point, it is required to verify the possible problems from it [4].

To solve this problem, formal methods are being utilized. The process algebra is one of easy techniques which can formally express message exchanges or processes between services [3]. These techniques include both BPEL in a web service or expressions of software structures, and the examples of these are Calculus of Communicating Systems (CCS), Communicating Sequential Processes (CSP), and LOTOS. These techniques are possible to be verified by tools of CWB-NC [5].

On the basis of it, this research has adopted CSS among the formal methods to understand the software structures and processing procedures registered in SaaS, and suggests methods for reusing software modules or processes based on ontology. This paper describes CSS techniques for reusing processes in chapter 2, the expression of CSS-based processes and development procedures in chapter 3, and conclusion in chapter 4.

2. CSS for Reuse of Process

Among algebra techniques for analyzing processes, CSS can be converted to BPEL, which expresses web services or processes. The processes converted to CSS can be verified by CWB-NC (Concurrency Workbrench of New Century). The verification of processes can be reused as a whole or in parts by division or combination of processes [5].

The period of developing the service can be reduced by designing codes for a service to be developed and reusing the existing service if the similar CSS is found or developing a new service if not found.

Users search for registered services to use the service. However, if the right service does not exist, it can be supported by updating a portion of the service so that the users can use it. This can be expressed in CSS as below.

A process is an agent which is a set of actions. The actions can be divided into the explicit actions and the implied actions. The explicit action is described as a, b and the implicit action is an internal action which means it can perform any actions. This implicit action is described as T. If an input action a occurs, the followed output action is 'a. If an input action occurs as 'a, the output action is "a. This "a is same as a. 0 is expressed as NIL which means the terminate of process. The below table is the summary of CSS operation based on the above contents.

Table 1. Main parameters

Description	Notation	
Sequence	.	a.b
Choice operator	+	P+Q
Parallel composition	|	P|Q
Restriction Set	¥	P ¥A
Recursion	=	K $\overset{def}{=}$ P

′.’ represents a sequence, which means action b is performed after action a, corresponding to a sequential process. ‘+’ is a choice operation, which chooses a process action between two processes (P, Q). This is relevant to a select structure. ‘=’ is a recursion operation, meaning that K is repeated by performing action def designated in P. This belongs to a recursive structure. ‘|’ is a parallel composition which means process (P, Q) can be performed concurrently. ‘\’ is a restriction set, meaning that action A cannot be performed in P.

These expressions are the methods that can describe and verify all processes.

3. Expression of CSS-based Process and Development of Process

As an application case of CSS in the chapter 2, the role that the Sanitary Agent performs is shown as figure 1. It explains that this agent can take 'Acceptance, 'refusal, 'askInf, 'paymentPublicFee, and 'req as

output actions and request, provInf, and done as input actions. In other words, the name of actions followed by ' are output actions and others are input actions.

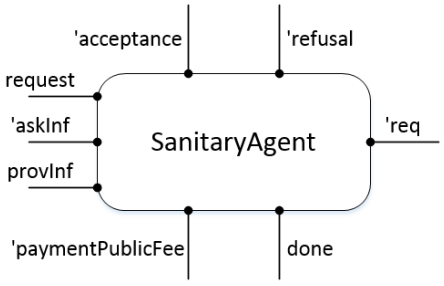

Figure 1. Actions of Sanitary Agent

This agent can be described as below by CCS syntax.

```
proc SanitaryAgency =
        request.'askInf.provInf.
                ( 'refusal.SanitaryAgency
                        + ('acceptance.'req.'paymentPublicFee.
                                done.SanitaryAgency ))
```

The task procedure is started by a request and goes through the procedures of 'askInf and provInf, and selects one procedure between 'refusal and 'acceptance. If 'refusal is selected, then the task is terminated. When 'acceptance is selected, the procedure of 'req.'paymentPublicFee.done is processed in order.

For reusability the verified process is applied as follows. Reusability includes sub-character such as applicability, adaptability and scalability.

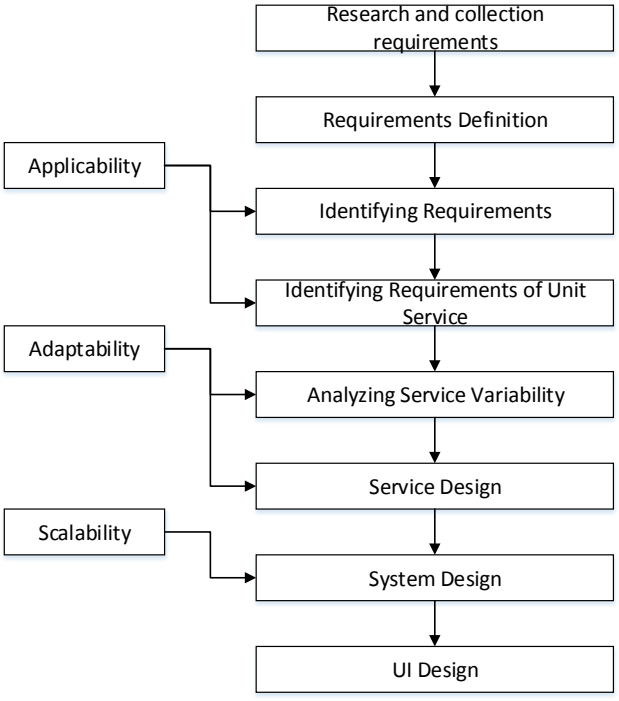

Figure 2. Relation Between Service Development Step and Reusability

The processes written in XML and CSS is possible to inspect grammar and type errors and verify the possibility of deadlock or similarity in actions with existing processes.

The process automation for this can produce processes by interaction between process developers and tenancy mediators, and can be customized to users based on existing processes and its modification by each tenant. Figure 2 shows the development framework for it.

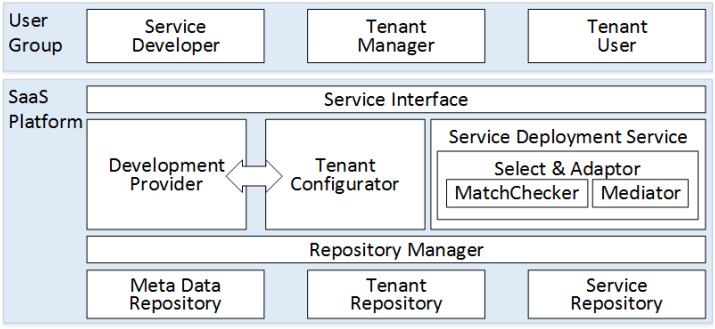

Figure 3. Framework for the Process Development

The reuse process for SaaS consists of user groups - Service Developer, Tenant Manager, and Tenant User. Every user can access to SaaS platform through the service interface and can use service development, tenant management, and services. A service developer and tenant mediator are linked together and the service deployment service performs match tests and mediations for users to use it. In addition, a repository manager is allowed to access to necessary services, tenant information, and information of meta data.

4. Conclusions

This paper has demonstrated the method of the process algebra using CSS to reuse software on the SaaS platform. With the suggested method, software can be expressed with CSS and therefore can verify the performed method and similarity to other software. This means verifying the reusability and possibility of combination of software. Later, this paper needs to suggest the reuse techniques with the definition and verification for methods of automation.

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