OSGi 플렛폼 기반의 상황인식 서비스지향 아키텍처에 관한 연구

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Study on Context-Aware SOA based on Open Service Gateway initiative platform

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요 약

제안된 OSGi 플렛폼(Platform) 기반의 상황인식 서비스지향 아키텍처에서 서비스공급자는 다양한 센서들로부터 상대적인 서비스들을 통합하여 각각 서비스를 SOAP 메시지로 묶어서 웹서비스를 서비스중재자의 UDDI서버에 등록하면, 서비스요청자는 UDDI서버에서 특정한 서비스를 검색하고, 서비스공급자에게 해당 SOAP메시지를 호출한다. 최근 유비쿼터스 홈네트워크 상황인식기술은 RFID/USN, 위치기반 기술을 중심으로 연구가 진행되고 있으나 이를 위한 서비스 지향 아키텍처에 대한 연구는 원만하게 진행되지 않고 있다. 따라서, 본 논문에서는 OSGi Platform 기반에서 다양한 센서들로부터 수많은 상황인식 서비스가 동적으로 움직이게 되고 사용자 요구 및 필요성에 따라 신규서비스의 제공 및 기존 서비스의 변경과 제공된 서비스간에 데이터 공유, 서비스 라이프사이클, 서비스분배의 효과적인 관리를 위하여 ATAM 으로부터 추출된 성능 유티리티 트리에서 이산 Little's Law를 적용함에 따라 546 TPS 에서 초당 상황인식트랜잭션 처리횟수를 향상시키는 OSGi Platform을 이용한 eclipse STP 기반의 상황인식 SOA를 제안하고자 한다.

ABSTRACT

In an proposed Context-Aware SOA(Service Oriented Architecture) based OSGi(Open Service Gateway initiative) platform, Service provider manages relative kinds of services in an integrative basis from various sensors, puts each service in a SOAP (Simple Object access Protocol) message, and register them to the UDDI(Universal Description Discovery and Integration) server of service registry, service requester retrivel the specified kinds of services and call them to service provider. Recently most context-aware technologies for ubiquitous home network are mainly putting emphasis on RFID/USN and location-based technology. Because of this, service-oriented architecture researches have not been made enough. Under the environment of an OSGi service platform, various context-aware services are dynamically mapping from various sensors, new services are being offered for the asking of users, and existing services are changing. Accordingly, the data sharing between services provided, management of service life cycle, and the facilitation of service distribution are needed. Taking into considering all these factors, this study has suggested an Context-Aware SOA based eclipse SOA Tools Platform using OSGi platform that can transaction throughtput of more than 546 TPS of distributional Little's Law from ATAM(Architecture Tradeoff Analysis Method) while remaining stable other condition.

키워드

OSGi, Contxt-aware SOA, distributional Little's Law, ATAM, Fuzzy

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Ⅰ. INTRODUCTION

From now on, the applications and services in the ubiquitous era are to be characterized by a context-aware system, so that the smart entities with computing and communication ability will be able to recognize dynamic environmental changes and smartly respond to them. Context-aware information includes almost all information available at the time of user's interaction [1]. The context-aware information also includes the information that the application can be aware of in the application operation environment. Therefore, it generally covers the location, identification, activities, and status of people, groups, or objects [2][3]. The context-aware information collected and recognized will go through the treatment process of adapting, filtering, and mapping so that it may be provided to the users.

Under the ubiquitous environment, a context-aware system collects context from various sensors or devices, predicts the services that the user wants, and provides the most relevant information service [4]. In a context-aware system, the low-level context collected or recognized by the sensors or devices has to go through the middleware such as the process of adapting, filtering, and mapping, so that it may become a high-level context.

However, the existing context-aware systems have some limitations on the range of information, without considering the user's taste and interest. Also, they have mainly put emphasis on RFID/USN, and location-based services, and so lacked in service-oriented architecture[5][6][7].

Based on the OSGi platform, the home network industry standard, this paper has aimed to propose Context-Aware Service Oriented Architecture based eclipse SOA Tools Platform(from www.eclipse.org/stp) using OSGi platform that various context-aware services are dynamically mapping from various sensors, and offering new services along with the change of existing services according to the user's request. Accordingly, the data sharing between services provided, management of service life cycle, and the facilitation of service distribution are needed. Taking into considering all these factors, this study has suggested an Context-Aware SOA that can respond at the ratio of more than from 546 to 26,190 TPS of distributional Little's Law while remaining stable other condition.

Ⅱ. Background

2.1. OSGi Architecture

An OSGi platform has an architecture that is mutually applicable (or compatible) among the service provider, network management company, system developer, and IT-related item manufacturers.

The OSGi specifications are so widely applicable because it is a small layer that allows multiple, Java based, components to efficiently cooperate in a single Java Virtual Machine.

The presence of OSGi based middleware in many different industries is creating a large software market for OSGi software components. The rigid definition of the OSGi Service Platform enables components that can run on a variety of devices, from very small to very big. The OSGi Alliance has defined a number of services that map an external protocol to an OSGi service. Accordingly, it has several characteristics as follows: First, the services are provided in the bundle, which is a type of self-installable components. Secondly, the services are dynamic in accordance with its life cycle, while having frequent interactions. Thirdly, as the system resources for home gateway are not enough, the service bundle authentication mechanism is needed [8].

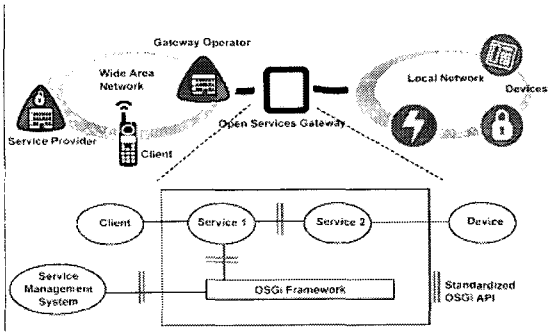

Fig. 1. Architecture of OSGi
그림 1. SOGi의 구조

2.2. OSGi Bundle

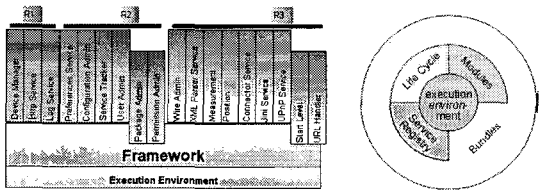

Fig. 2. Architecture of OSGi Bundle
그림 2. OSGi 번들의 구조

By using the platform independence and dynamic code-loading ability of Java programming language, OSGi service platform can easily develop an application program suitable to the small memory devices, and deploy it dynamically. In addition, management of life cycle is possible, so that an application program can be divided into the bundle, which is a type of self-installable component, thus making it possible to add a new service or renew the existing one without affecting the whole system [8].

2.3. Context and Context-Aware

2.3.1 Context

The information playing a key role in the system discussed in this study is context, i.e. the situation surrounding a user. Anind K. Dey et al. has divided this context into three categories: the dynamically changing computing environments (including processor, input-output unit, network capacity, connectivity, and calculation cost), user's environments (such as place, neighboring people, and social environment), and physical environments (light and noise). Also, he has defined the context as "any information that can be used to characterize the situation of an entity." In here, the entity means a person, place, or object that is considered relevant to the interaction between a user and an application." If an application scenario is set up based on this definition, it is easy to judge which information belongs to the context [9].

2.3.2 Context-Aware

Anind K. Dey et al. has confined "context - aware"as the recognition of context to provide relevant information and/or services to user, where relevancy depends on the user's task. In here, the context-aware feature is defined as the presentation of services to a user according to current context, automatic execution of a service in a certain context, and tagging context to information for later retrieval [9].

III. Context-Aware SOA

3.1. Design of Context-Aware SOA

A Enterprise Service-Oriented Architecture (SOA) is a software architecture that is based on the key concepts of an application front-end, service registry, and Enterprise service bus. A service consists of a contract, one or more interfaces, and an Application. An Application consist of a Business logic and Data [10].

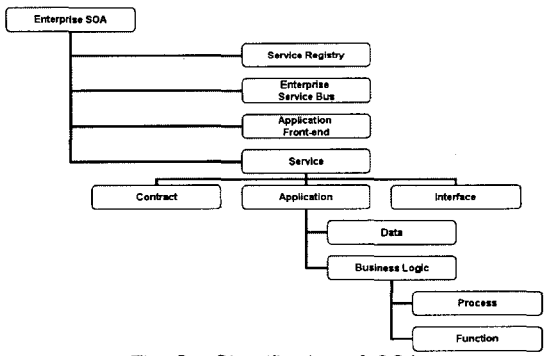

Fig. 3. Classification of SOA
그림 3. SOA의 분류

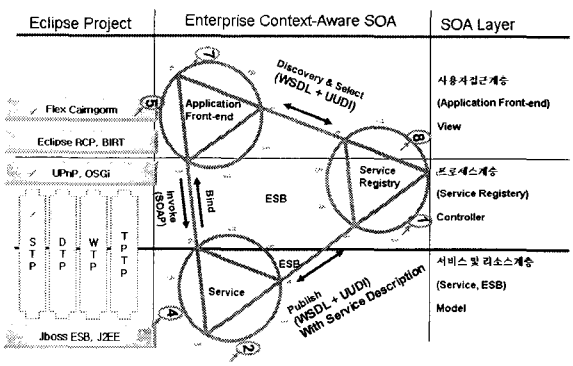

Fig. 4. Context-Aware SOA
그림 4. 상황인식 SOA

Table 1. Service Mode and Quality Attribute of Context-Aware SOA
표 1. 상황인식 SOA의 서비스모드, 품질속성

Ennead	MVC Mode	Quality Attribute
	Service Mode	Eclipse plug-in project
7→1	View→Controller	Performance
	Discovery & Select	prosyst UPnP
1→4	Controller→Model	Performance
	Publish	eclipse STP
4→5	Model→View	Availability
	Bind	prosyst OSGi
5→4	View→Model	Agility(Modifiability, Interoperability)
	Invoke	Flex Cairngorm

3.2. Feature of Context-Aware SOA

As illustrated in the <figure 3> and <table 1>, the Context-Aware SOA is composed of the MVC (model-view-controller) Architecture and Event Driven Architecture in the center, 8core eclipse project in the left [11].

As illustrated in the <table 2,3> and <figure 4,5>, this framework satisfies OSGi3.0/4.0 specification, and consists of UPNP bundle, JBoss ESB, eclipse STP project, the WTP bundle supporting spring framework, the DTP bundle supporting Hibernate framework for OR Mapping, and Adobe Flex of X-internet language based on Eclipse, so as to raise the user's experience matter, and so on.

Table 2. Context Algorithm of Context-Aware SOA
표 2. 상황인식 SOA의 컨텍스트 알고리즘

Ennead	Service Mode	Context Algorithm
6	-	Service Manager : 사용자의 컨텍스트 변화에 대하여 센싱대기
7→1	User Input	사용자는 시스템으로 컨텍스트 자동입력
9	-	Context Manager : 사용자 인증과 컨텍스트 충돌을 사전 감지하여 모델변경준비
1→4	Modify Model	시스템은 컨텍스트 감지하여 모델변경
3	-	Context Intepreter : Who, What, Where, When의 컨텍스트 해석
4→2	Notify Changes	컨텍스트 모델 해석
2→8	Notify Changes	켄텍스트 모델 변경하여 백업데이타 생성
9	-	Context Manager : 변경된 컨텍스트에 대한 사용자 인증 후 통보
8→5	Notify Changes	변경된 컨텍스트 사용자 리스너에게 통보
6	-	Service Manager : 사용자의 의도인 Why를 파악하고 검증한다.
5→7	Notify Changes	사용자는 의도된 서비스인지 검증한다.
5→8	Read Model	사용자 인증을 받는다.
8→2	Read Model	사용자는 요청한 서비스를 조회한다.
2→4	Read Model	사용자는 요청한 서비스를 승인한다.

As most users don't try to pay a fee for using a context-aware service, the commercialization of this service is not easy. Therefore, in order to increase the practicality and utilization rate of the context-aware services, it is necessary to provide a higher value to all the players related to it. The context-aware service based on the suggested Context-Aware SOA needs both the facility operator who gives access to an IT device and the service manager who helps to select an optimal service suitable to the user's situation.

Table 3. eclipse Project table
표 3. 계층별 이클립스프로젝트 구성표

Layer	Eclipse Project	Homepage URL
View	Flex Cairngorm	labs.adobe.com/wiki/index.php/cairngorm
	eclipse RCP, BIRT	eclipse.org/rcp, eclipse.org/birt
Controller	UPnP	upnp.org, prosyst.com
	OSGi	osgi.org, prosyst.com, eclipse.org/equinox
Model	TPTP	eclispe.org/tptp
	WTP	eclispe.org/webtools, springframework.org
	DTP	eclispe.org/datatools, hibernate.org
	STP	eclispe.org/stp
	JBoss ESB	labs.jboss.com/portal/jbossesb
	J2EE	java.sun.com/javaee

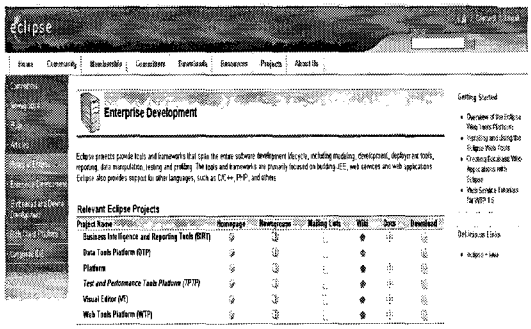

Fig. 5. Screenshot of eclipse enterprise SOA
그림 5. 이클립스 엔터프라이즈 프로젝트 스크린샷

Service provider manages relative kinds of services in an integrative basis from various sensors, puts each service in a SOAP message, and register them to the UDDI server of service registry, service requester retrivel the specified kinds of services and call them to service provider.

Even if there is no definite demand from a user, the context from various sensor and service should be well mapped to provide an optimal service. Various contexts have to be analyzed in advance, and then when a concrete context happens, the necessary service is to be retrieved immediately and realized.

3.3. Evaluation Criteria of distributional Little's Law from ATAM

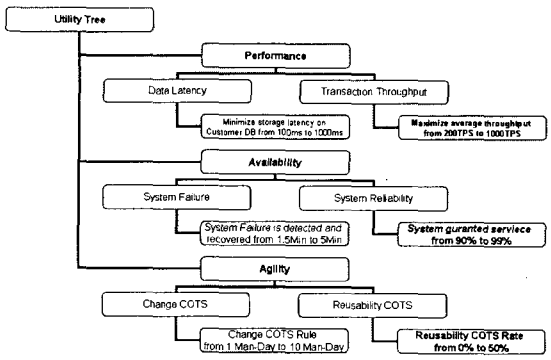

Fig. 6. Proposed Utility tree of ATAM
그림 6. ATAM의 제안된 Utility Tree

In case of the context-aware service, the response speed per second in handling the context-aware events is very important, and so at least 500 context-aware services should be handled in a second, and Average Response Time is 3 second, and the utilization rate of CPU at the 500 TPS(from 100TPS to 1000 TPS) should be remained within 15% for practicality. Let's see the throughput curve according to distributional Little's law in queueing theory from ATAM(Architecture Tradeoff Analysis Method) of S/W architecture perspective. It changes into response time's (or activeuser's) law where users are in a real time transmission status from various sensors. Suppose that the graph of an average response time in the ActiveUser (Virtual User, ThinkTime=0) is as below [12][13].

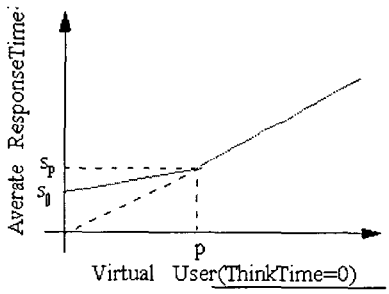

Fig 7. Throughput Curve of Little's law
그림 7. Little's Law의 성능곡선

The graph of an average response time according to ActiveUser x (x is a natural number) is expressed in the following function (f: N R). Throughput function g(x)(g:N-->R) about ActiveUser x is illustrated in the (1).

$$g(x) = \frac{x}{\frac{(s_p - s_0)}{p}x + s_0} = \frac{px}{(s_p - s_0)x + s_0 p}(0 \le x \le p) \quad (1)$$

$$g(x) = \frac{x}{\frac{s_p}{p}x} = \frac{p}{s_p}(p < x)$$

Therefore, Critical Performance Utilization of Performance Matrix and Stress Test equation is illustrated in the (2).

$$\sum \lambda i / Ti \leq \rho(1.0+\epsilon)(\epsilon > 0), \quad (\rho\, is \qquad (2)$$

Ⅳ. Experiment and Simulation

4.1. Experiment Environment

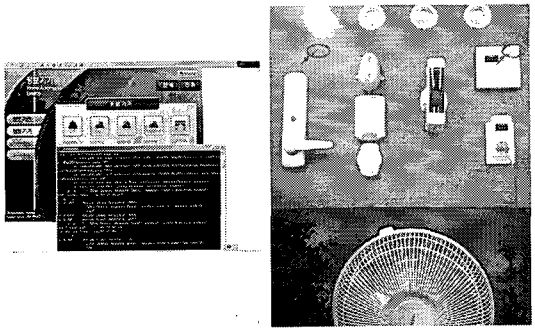

Fig 8. Home Automation Device Set
그림 8. 홈오토메이션 장비세트

As illustrated in the <Fig. 8>, the hardware of the experiment environment in this paper is composed of the Prosyst Home Automation Device Set, IBM PC Memory 1G, and 2 units of Pentium 1CPU 1GHz. The software of this experiment environment is on the basis of Java-based OSGi 3.0/4.0 specification and Prosyst PTK Home Automation Package 1.0, the network environment has been supported by PLC, and Ethernet communication.

By using Context-Aware SOA, the following packet data structure by sensor device has been defined: PLC control information (gas, Lighting, GAS, Home appliance, infrared rays). The evaluation on computing has been performed from the service viewpoint.

4.2. Simulation

(1) There is considered noise in case Simulation[12]

Table 4. Performance Matrix
표4. 성능 매트릭스

OSGi Bundle	Arrival Rate (req/sec: λ)	Arrival Ratio (pi)	Max TPS(Ti)	λi /Ti
b1	λ1 = 0.5 λ	λ1 /λ=ρ1 = 0.5	T1 = 28,000	λ1 / T1
b2	λ2 = 0.2 λ	λ2 /λ=ρ2 = 0.2	T2 = 140	λ2 / T2
b3	λ3 = 0.1 λ	λ3 /λ=ρ3 = 0.1	T3 = 5,700	λ3 / T3
bn	λn = 0	λn /λ=ρ4 = 0	Tn = 0	λn / Tn
other	λother = 0.2 λ	1-ρ= 0.2	N/A	N/A
Sum	Σ λi + λother = λ	Σρi + 0.2 = 1.0	N/A	Σ λn / Tn

Here, b_1=Lighting bundle, b_2=Gas bundle, b_3=PLC bundle

$$\sum \lambda n / T1 \leq \rho(1.0+\varepsilon)(\varepsilon \geq 0) \qquad (3)$$

1) $(0.5/28{,}000+0.2/140+0.1/5{,}700)\,\lambda \leq \rho(1.0+\varepsilon) \approx 0.8$
2) $\lambda \leq 0.8/\{0.5/28{,}000+0.2/140+0.1/5{,}700\} = 546$ (req/sec)

(2) There is considered no noise in case Simulation

1) Let's suppose that the JVM 1.3, method invocation of 2,200%, and the response time of 0.0042 sec per thread, it becomes 1/0.0042 =238.095 thread.
2) In case of JVM 1.4, 238.095 x 22 = 5238 thread. In case of the socket response rate of 500 each per second, 60% for reserve, 10-20% for system, and occupancy rate of 10% (i.e. 50 each per second), 5,238 x 50 = 261,904 thread.
3) 1kb per 1 bundle means 5 thread per 1 bundle, and in case of 0.5 kb per 1 packet, 10 thread handling produces one service. In theory, 261,904/10 = 26,190 services per second(req/sec). This response speed exceeds 500 service per second(req/sec).

(3) As illustrated in the <figure 9> , In case of the Fuzzy rule of utility tree, if Transaction Throughput is 546 TPS and Reusability COTS is 35% and System Reliability is 98%, then Service Requester Satisfaction is 76%/89.5%.

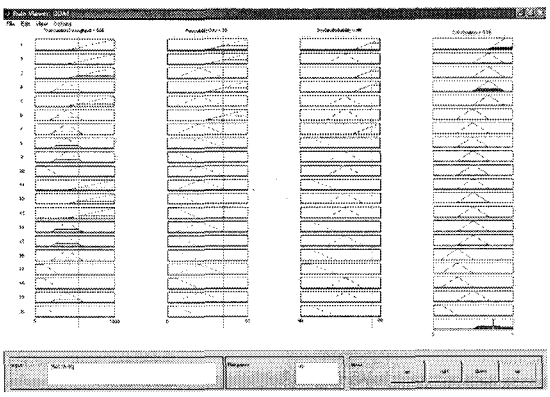

Fig. 9. Fuzzy Rule of Utility Tree
그림 9. 유틸리티 트리의 퍼지룰

V. Conclusion

The home network industry standard OSGi service platform developed by this paper aims to efficiently provide and produce various content-aware services from diverse sensors, offering new services and changing the existing services for the asking of users. In addition, data sharing between services, and the managementof service life cycle and service distribution are provided, so that this OSGi-based framework can respond at the rate of 546 TPS(req/sec) , Service Requester Satisfaction is 76%/89.5% from ATAM(Architecture Tradeoff Analysis Method) of S/W architecture perspective while remaining stable other condition.

Much more researches need to be made for the commercialization of context-aware service by means of the establishment of a business model and system as well as the improved mapping of context and service. Also, the results of user's satisfaction test should be automatically reflected in the mapping, and in case that the result of mapping comes plural, the solution for that needs to be provided. Under the environment of an OSGi service platform, various context-aware services are dynamically being mapped from various sensors; new services are being offered for the asking of users; existing services are changing; and bundled services are available.

In addition, the improvement of OWL, security, authentication system for personal information protection is also an important task for better and speedy service.

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※관심분야 : Fuzzy, RTE, SOA, Context-aware, EDA, Homenetwork Monitoring System

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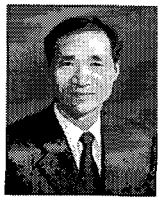
※관심분야 : Web Database, Multimedia Database and XML etc.



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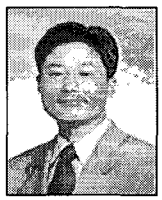
※관심분야 : Agent, RTE, SOA, EDA,



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※관심분야 : data warehousing, knowledge management, e-commerce, IS evaluation, healthcare information systems.

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