The Extended PARLAY X for an Adaptive Context-Aware Personalized Service in a Ubiquitous Computing Environment*

Sungjune Hong[1], Sunyoung Han[2,]**, and Kwanho Song[3]

[1] Department of Information and Communication, Yeojoo Institute of Technology, 454-5 Yeojoo-goon, Kyungki-do 469-800, Korea
sjhong@mail.yeojoo.ac.kr
[2] Department of Computer Science and Engineering, Konkuk University, 1, Whayang-Dong, Kwagjin-Gu, Seoul 143-701, Korea
syhan@kkucc.konkuk.ac.kr
[3] National Internet Development Agency of Korea, 3F, 1321-11 Secho-2 Dong, Secho-Gu, Seoul, 135-875, Korea
khsong@nida.or.kr

Abstract. This paper describes the extended PARLAY X for the Adaptive Context-aware Personalized Service (ACPS) in a ubiquitous computing environment. It can be expected that the context-awareness, adaptation and personalization for the Quality of Service (QoS) / Quality of Experience (QoE) in a ubiquitous computing environment will be deployed. But the existing PARLAY X is lacking when considering QoS / QoE in network. To address this issue, this paper suggests the extended PARLAY X for ACPS. The objective of this paper is to support the architecture and the Application Programming Interface (API) of the network service for the context-awareness, adaptation and personalization in a ubiquitous computing environment. ACPS provides a user with QoS / QoE in network according to the detected context such as location, speed and user's preference. The architecture of the extended PARLAY X for ACPS is comprised of a Service Creation Environment (SCE), the semantic context broker, and the overlay network. SCE uses Model Driven Architecture (MDA)-based Unified Modeling Language (UML) / Object Constraint Language (OCL) for an expression of context-awareness, adaptation, and personalization. The semantic context broker is a broker role between the SCE and PARLAY gateways. The overlay network is a broker role for QoS / QoE between PARLAY gateway and the IP network.

1 Introduction

There is increasing interest in a ubiquitous computing environment with Next Generation Network (NGN). A ubiquitous computing environment with NGN needs

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** Corresponding author.

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the provision of seamless applications in the face of changing value chains and business models, requiring the ongoing replacement and extension of service delivery platform enabled by new information technology and software tools.

New open network service delivery platform standards, such as PARLAY [1] Application Programming Interface (API), are based on the principle of service programming support with network protocol abstraction and the exploitation of state of the art information technology. In addition to PARLAY, the most innovative software development approach, the Model Driven Architecture (MDA) [2], aims to provide total freedom to application development. Consequently, it seems logical to use MDA-based PARLAY such as medini [3] for the rapid and highly automated development of network service on the PARLAY based service delivery platform.

However, the existing MDA-based PARLAY does not consider that the context-awareness [4], adaptation [5], and personalization [6] for Quality of Service (QoS) / Quality of Experience (QoE) [7] in a ubiquitous computing environment. It can be expected QoS / QoE for the customized network service in a ubiquitous computing environment will be deployed. To solve this issue, Web Architecture for Service Platforms (WASP), developed by Telematica Instituut and Ericsson, conducted a research project for context-aware middleware focused on semantic web service [8] technology, using PARLAY to 3G network. WASP focused on semantic web service technology which creates difficulties for many developers who are not adept with the semantic web service in developing a new network service. In addition, WASP lacks in considering adaptation and personalization in a ubiquitous computing environment.

Therefore, this paper suggests the extended PARLAY X for the Adaptive Context-aware Personalized Service (ACPS) for the context-awareness, the adaptation and personalization in a ubiquitous computing environment. All references to 'the extended PARLAY X for ACPS' from this point forward is abbreviated as 'ACPS'.

The objective of this paper is as follows:

- To support the context-awareness, the adaptation, and personalization for the QoS / QoE in a ubiquitous computing environment.

ACPS provides users with the QoS / QoE according to the changing context constraints and the user's preference. The existing PARLAY is the open Application Programming Interface (API) to converse telecommunication, Information Technology (IT), the Internet and new programming paradigm. PARLAY Group, a group of operators, vendors, and IT companies, started in 1998 with the definition of an open network Parlay API. This API is inherently based on an object-oriented technology and the idea is to allow third party application providers to make use of the network (i.e., have value added service interfaces). MDA is an approach to the full lifecycle integration and interoperability of enterprise system comprising of software, hardware, people, and business practices. It provides a systematic framework to understand, design, operate, and evolve all aspects of such enterprise systems, using engineering methods and tools. MDA uses Unified Modeling Language (UML) / Object Constraint Language (OCL) [9]. OCL is a UML extension for expression of semantics.

This paper describes the design and implementation of ACPS in a ubiquitous computing environment, and is paper is organized as follows: Section 2 illustrates the design of ACPS; section 3 describes the implementation of ACPS; Section 4 compares the features and performance of ACPS. Finally, section 5 presents the concluding remarks.

2 The Design of ACPS

2.1 The Overview of ACPS

A scenario using ACPS is depicted below. We assume that there are the contexts such as location and speed in the surroundings of a wireless device that is detected from sensors called motes [11] or Global Positioning System (GPS). Moreover, we assume that the Wireless LAN region is enough of network resource and the CDMA region is short of network resource. In the middle of an on-line game, a user in the WLAN region decides to go outside to the CDMA region while continuing to play the game on a wireless device. The wireless device is continually serviced with degraded application quality on the screen, albeit there is a shortage of network resources in CDMA region. Therefore, the user can seamlessly enjoy the game on the wireless device.

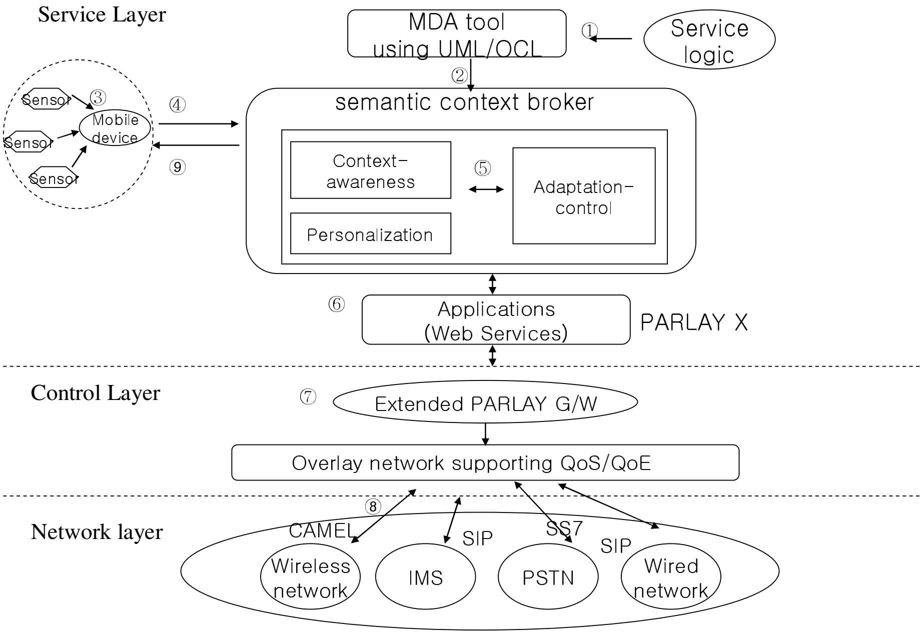

Fig. 1. The architecture of the extended PARLAY X for ACPS

We assume that semantic context broker can get the context such as location and the speed by GPS. The mobile devices including the intelligent agents can get the context such as weather, temperature from the sensors called motes. The mobile device informs the semantic context broker of the context.

Fig. 1 shows the overall architecture of ACPS which consists of the service layer, the control layer, and the network layer. This paper focuses on the service layer. The service layer includes Service Creation Environment (SCE) [10] and the semantic context broker. SCE is based on MDA technology and uses Unified Modeling Language (UML) / Object Constraint Language (OCL). SCE can specify the policy of

ISP or the network administrator. The semantic context broker is developed for the purpose of the extension of PARLAY X for adaptation, context-awareness, and personalization.. The adaptation function can get the context such as the policy from the ISP or the network administrator. The wireless sensor network called a mote can detect the contexts. The context-awareness function can get the context such as location, weather, and temperature from GPS or sensors. The personalization function can get the context such as the device type and the user's profile. The semantic context broker can analyze the context and decide the optimized network protocol. The semantic context broker informs the overlay network of the request of the optimized network protocol. The overlay network can support the protocol adaptation for QoS / QoE according to the request of the semantic context broker. Hence, the semantic context broker interprets the context for context-awareness and personalization according to the changing context and the user's preference and reconfigures the protocol for adaptation.

2.2 The Semantic Context Broker

The role of a MDA tool is to make a role of the SCE, which can obtain the service logic and the context constraints from the Internet Service Provider (ISP) or the network administrator. The service logic depends on a UML/OCL notation. We developed the semantic context broker for ACPS. The semantic context broker is for PARLAY X with QoS / QoE and to support context-awareness, personalization, and adaptation in the service layer as depicted in Fig. 2. The role of the semantic context broker is to obtain the context such as location and speed, to make an interpretation for context-awareness, and to re-composite each protocol for adaptation and personalization according to the context. The overlay network can support QoS / QoE according to the request of the semantic context broker in the control layer. ACPS uses MDA-based SCE with OCL and web service technology, whereas the existing PARLAY X uses XML-based web services technology. The signaling of PARLAY Gateway uses Mobile Application Part (MAP) in Wireless Network, SIP in IP Multimedia System (IMS), SS7 in Public Switched Telephone Network (PSTN), and SIP in wired network such as the Internet

In Fig.1, the operation of ACPS is as follows:

1. The MDA-based SCE defines the service logic and context-constraint.
2. The service logic and context-constraint using UML/OCL is transferred to the semantic context broker. The semantic context broker translates UML/OCL to PARLAY X.
3. Many sensors called motes inform the semantic context broker of the detected context information.
4. The mobile user's information such as user's preference and device type is transferred to the semantic context broker.
5. The semantic context broker converses the detected information into XML-based context information and reconfigures the service for adaptation according to the context.
6. The semantic context broker translates the XML-based context information into the XML-based PARLAY X.
7. PARLAY X is converted into PARLAY gateway.

8. The overlay network can support QoS / QoE according to the request of the semantic context broker.
9. Finally, ACPS provides the user with the customized network service with QoS / QoE .

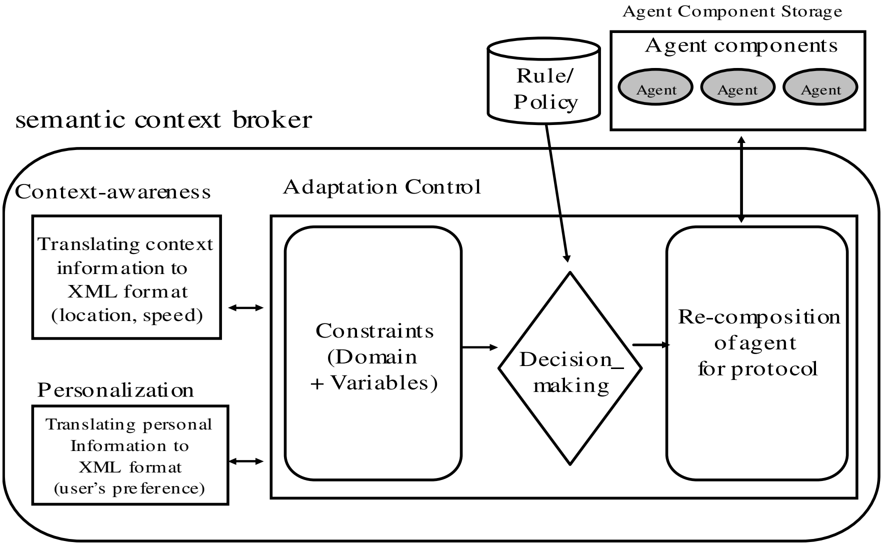

Fig. 2. Mechanism of the semantic context broker

Fig. 2 shows the mechanism of semantic context broker. The semantic context broker consists of *Context-awareness*, *Personalization*, and *Adaptation control*. *Context-awareness* has a role to interpret contexts that comes from mote or GPS. *Context-awareness* is to get the context information such as location and speed, translating the context information to XML format. *Personalization* has a role to process the user's personal information such as user's preference and the device type. *Personalization* is to get the personal information, translating the information to XML format. *Adaptation Control* is to reconfigure the protocol for adaptation according to the context. *Adaptation Control* is to re-composite the agent for protocol that can call network protocol module according the ISP's rule and policy.

2.3 The Definition of Context, Profile, and Policy for ACPS

Fig. 3 shows the context, profile, and policy for ACPS. *Context* consists of *location, speed, weather*, *temperature*, *time of day*, *presence, device type, and user's preference*. *Profile* consists of device type and user's preference for personalization. The policy from the ISP or the network administrator is expressed by OCL. The example of the policy is as follows*: if (current_location = 'WLAN region') then call RTP protocol else if (current_location = 'CDMA region') then call WAP protocol* means to call a function for RTP protocol in the case that the current location is in a Wireless LAN region where resources of a network in the surroundings are enough, and to call a function for WAP protocol in the case that the current location is in a CDMA region where the resources of network are scarce.

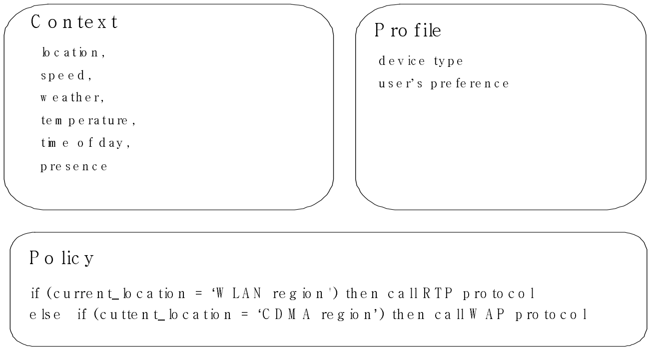

Fig. 3. Context, Profile, and Policy for ACPS

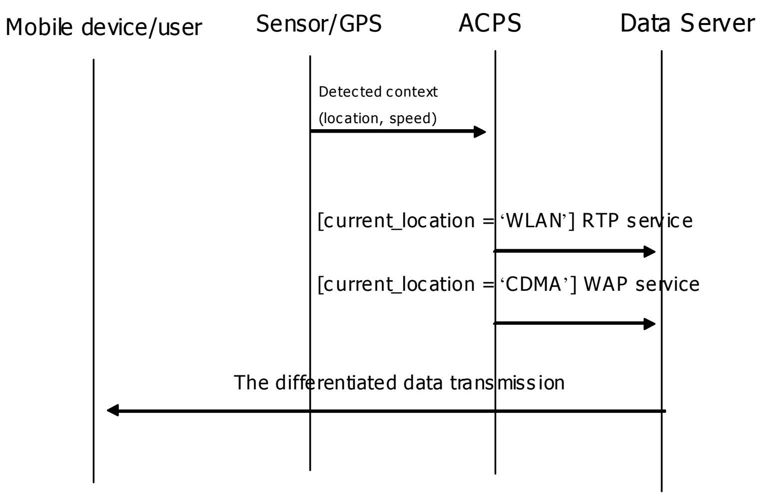

Fig. 4. Sequence diagram for ACPS

Fig. 4 shows the sequence diagram for ACPS. The sensor or GPS detects context information such as the location and speed and it informs context information of ACPS. ACPS can adaptively choose the optimized protocol, analyzing the context information and policy of the ISP. For instance, if the current location of a mobile device is in the WLAN region, users can get the high quality of service through Real Time Protocol (RTP), whereas if the current location of a mobile device is in the CDMA region, users can get the low quality of service through Wireless Application Protocol (WAP). Finally, the mobile user can get the differentiated network service.

3 Implementation of ACPS

The implementation of ACPS is based on Windows 2000 server, the PARLAY X SDK named GBox[12] of Appium company. The UML/OCL is conversed into the XML-based web service because ACPS uses XML-based web services. We have three steps in the execution of ACPS. First, the policy using UML/OCL notation is defined by the ISP or the network administrator. In Fig.4, the example of policy is the expression using OCL. Second, the semantic context broker can get the context such as location, speed, weather, and temperature from the GPS or sensor, can get the context such as device type and user's preference from the mobile device, can translate UML/OCL into XML, can analyze the XML-based information, and can find the optimized network protocol. Third, the overlay network provides users with the network service with QoS / QoE according to the request of the semantic context broker. We use UML/OCL tool, PARLAY X SDK. ACPS includes the new defined PARLAY X API such as getContextAwareness(), getPersonalization, and adaptiveProtocolType(). We assume that there are WLAN region and CDMA region according to the horizontal (x) and vertical (y) axes of PARLAY simulator. ACPS can provide RTP protocol or WAP protocol according to the context information such as location.

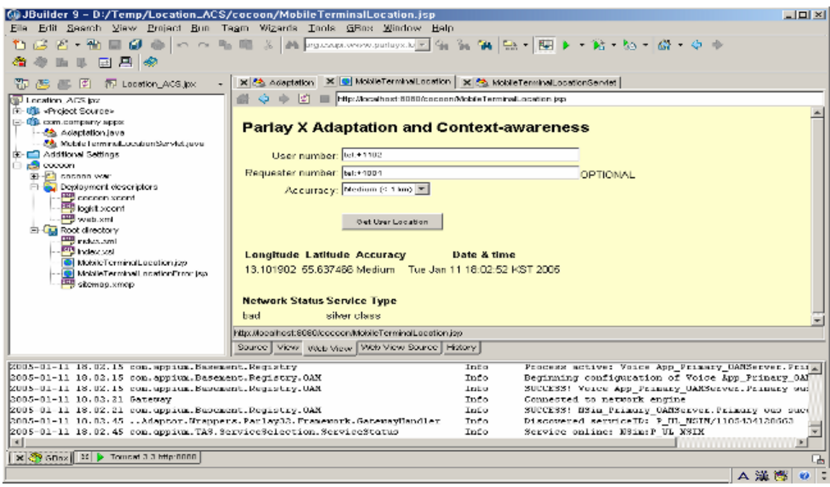

Fig. 5. The prototype for ACPS using GBox

Fig. 5 shows the prototype of the PARLAY X extension for ACPS using PARLAY X simulator called GBox. This prototype for ACPS can get the context such as the location. ACPS can decide to service the RTP protocol or the WAP protocol by the analysis of user's location For instance, if the current location of wireless device is in the WLAN region, the ACPS provides the high quality service through RTP. If the current location of wireless device is in the CDMA region, the ACPS provides the low quality service through WAP.

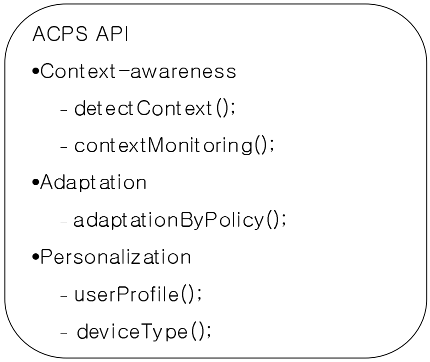

Fig. 6. The defined PARLAY X API extension for ACPS

Figure 6 shows the defined PARLAY X API extension for ACPS including context-awareness, adaptation, and personalization. The defined API for context-awareness is named as *detectContext()* that can detect the context and *contextMonitoring()* that can monitor the context. The defined API for adaptation is named as *adaptationByPolicy()* that can support an adaptation by the ISP's policy. The defined API for personalization is named as *userProfile()* which can support user's preference and *deviceType()* which can detect the device type.

4 Comparison of the Features of the Existing PARLAY and ACPS

4.1 Comparison of Main Features

Table 1 shows the comparison of main features of the existing PARLAY X, WASP and ACPS. ACPS has more features, such as supporting the context-awareness, adaptation and personalization than the existing PARLAY X. ACPS considers MDA-based SCE using UML/OCL as the language for context-awareness, adaptation and personalization, whereas, the PARLAY X and WASP do not consider MDA-based SCE albeit they support the ad-hoc context-aware language. ACPS and WASP can support the context-awareness for location, speed, temperature, and weather, using the web service technology. ACPS can consider adaptation and personalization in the network. Conversely, PARLAY X and WASP do not consider the adaptation and personalization in the network.

Table 1. Comparison of main features

	PARLAY X	WASP	ACPS
Context-awareness	-	X	X
Adaptation	-	-	X
Personalization	-	-	X

4.2 Comparison of Performance

We evaluate performance using ns-2 simulator. There are four nodes for the performance evaluation in ns-2 like Fig. 4. The node 0 is for the mobile device. The node 1 is for GPS. The node 2 is for ACPS. The node 3 is for the data information server. The node 1 informs the node 2, which is ACPS, of the location of user, detecting it from the sensor or GPS. The node 2 is to re-composite the network protocol according to the network resource. We evaluate the packet size of data that is sent to the user. We define the ChangingContext() method using C++ programming language in ns-2 for evaluation in case that the context is changed.

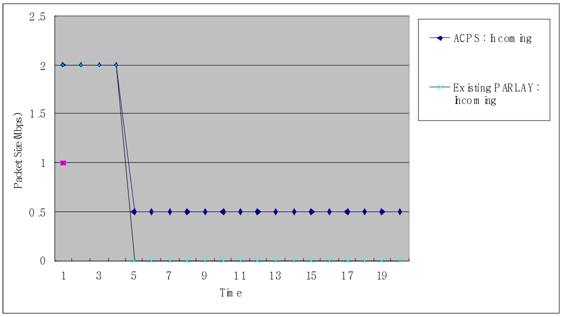

Fig. 7. Comparison of performance

Fig. 7 shows the comparison of performance on the feature of adaptation and personalization between the existing PARLAY X and ACPS. The existing PARLAY is stopped in case that the current location in WLAN is changed in CDMA region. Conversely, ACPS can keep the service because the RTP protocol service is changed to the WAP protocol service in case that the current location in WLAN is changed in CDMA region. This is attributed to the fact that ACPS supports adaptation and personalization, the existing PARLAY does not have adaptation and personalization functionality.

5 Conclusion and Future Works

This paper suggests the extended PARLAY X and the open API extension to support context-awareness, adaptation and personalization for QoS / QoE. We believe that ACPS addresses new service mechanism on delivery network platform to support more QoS / QoE on the network than the existing PARLAY X. We expect ACPS to comply with the industry standard such as PARLAY. Our future work will involve more studies applying open API extension on the standard on the reconfigurable Software Defined Radio (SDR) equipment of Wireless World Research Forum (WWRF) [13] for 4G.

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