Next Generation Mobile Service Environment and Evolution of Context Aware Services

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Abstract. Context aware service which provides best suitable services for a user by analyzing user's needs and situational information, will be one of the promising next generation (NG) mobile services. In this paper, we propose the NG mobile service environment based on the NG mobile service platform and evolutional phases of context aware services in the NG mobile service environment. We then introduce the Context Aware Follow-me (CAF) service developed as a prototype of promising NG context aware mobile service followed by introduction of testbed system developed to investigate feasibility of the CAF service.

Keywords: Next Generation Mobile Service, Next Generation Mobile Service platform, Context Aware Service

1 Introduction

The next generation (NG) mobile communication aims at the support of high speed data rate and the convergence of various networks such as 2G and 3G wireless, WLAN, WPAN, DAB and DVB[1,2]. Also, the vision of NG mobile telecommunications has a thread of connection to the concept of ubiquitous computing networks where anyone is able to circulate all kinds of information or contents without restrictions on time, location, device, and data rate [3,4]. Therefore, in the NG mobile communications it will be possible to make a communication community having no restriction on time and location, and thus context awareness will be realized using various sensors and devices and related technologies under such ubiquitous NG mobile communications environment. By such context awareness, context aware service which provides best suitable services for a user by analyzing user's needs and situational information will be one of the promising NG mobile services [5].

In contrast to existing mobile services provided mainly by network operators, NG mobile services are expected to be provided by many mobile service providers, called the third party service providers, other than network operators. Under such NG

mobile service environment, the mobile service platform offers various means of connecting users and service providers will play a very important role in supporting various future mobile services not only for service providers to provide services effectively but also for users to use services easily.

In this paper, we propose the architecture and functions of the NG mobile service platform and evolutional phases of context aware services in the NG mobile service environment. We classify evolutional phases based on ranges of context information and evolutional trend of telecommunication technologies and networking environment in the NG mobile communication environment. Then, we propose the Context Aware Follow-me (CAF) service as a prototype context aware service that will be provided in NG mobile communication environment. The CAF service is designed to support seamless mobility of user service by domain federation and provides optimized service based on various context information such as user's location and preference, capability of devices located around a user, and characteristics of services in use.

This paper is organized as follows. In next section, the NG mobile service environment is described with the focus on the NG service platform. In section 3, four evolutional phases of context aware services are proposed. In section 4, design concept, scenario, an overall system architecture, a prototype test-bed system and example service flow of CAF service are presented. Finally, we conclude this paper in section 5.

2 Next Generation Mobile Service Environment

In the next generation (NG) mobile service environment, the mobile service platform will play a very important role in supporting various future mobile services not only for service providers to provide services effectively but also for users to use services easily. Figure 1 describes architecture and functions of the NG mobile service platform.

In order to provide NG mobile services, a mobile service platform should have various functionalities such as service provisioning function (SPF), context processing function (CPF), service session management function (SSMF), and security function (SF). SPF is responsible for registration and management of various context aware services. In addition, based on context information provided from CPF, SPF provides the best suitable context aware service to a user through service generation procedure where candidate services for a user are found, composed and adapted to the service environment existing around the user. CPF stores crude context information collected by various context collectors in a standard format and infers useful context service information that can be directly used for service provisioning. SSMF is responsible for establishment of a session for service between a user and a service provider as well as service mobility for seamless service provisioning regardless of user's location and movement. SF is responsible for authentication and admission of services and other security related tasks during service provision period.

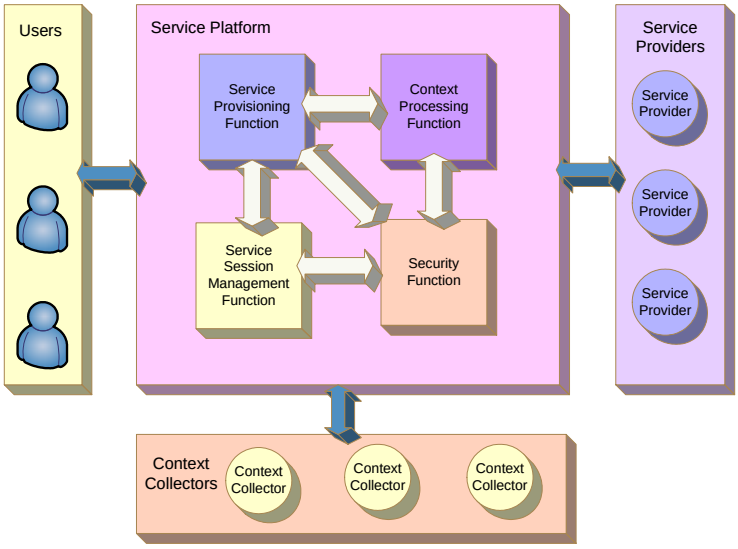

Fig. 1. A NG mobile service platform

3 Evolutional Phases of Context Aware Service

We classify the provision of context aware service (CAS) into four evolutional phases based on ranges of context information and evolutional trend of telecommunication technologies and networking environment in the next generation (NG) mobile service environment.

3.1 Phase 1: User Input Based CAS

The phase 1 *user input based CAS* uses context information inputted by a user through intelligent mobile terminals or generated in mobile terminals or mobile communication system during service provisioning. Context information used in this phase is time, schedule information, user status, user information such as the phone number and address, user activities such as meeting, eating and resting, caller information, and network information.

Figure 2 shows environment and traffic flows for the phase 1 CAS provisioning. The phase 1 CAS is provided by following procedure. A user requests services based on available service list offered by wide area service platform via mobile communication network. At this moment, context information collected by the mobile terminal is transferred to the wide area service platform with the service request. Then the service platform selects a suitable service provider based on registration information of the user and the received context information, and supports service traffic delivery between a user and the selected service provider.

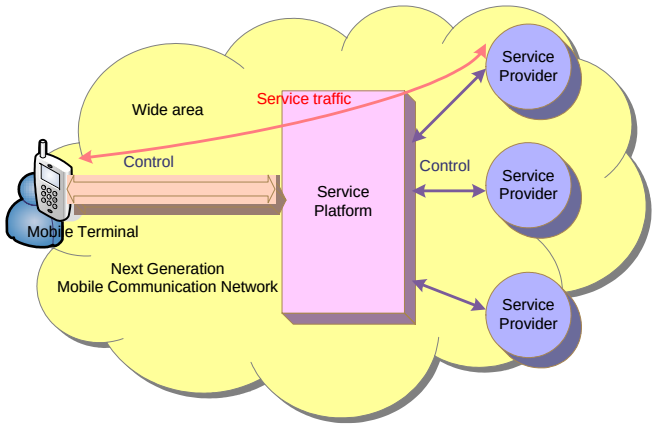

Fig. 2. The environment of the phase 1 CAS provisioning

3.2 Phase 2: User Vicinity CAS

Due to development of sensor technologies, various sensors are embedded in an intelligent mobile terminal and ambience context information such as physical, location, and environmental information around a user is collected. The phase 2 *user vicinity CAS* is provided by combining such ambient information with context information obtained for phase 1 services.

Figure 3 shows environment and traffic flows for the phase 2 CAS provisioning.

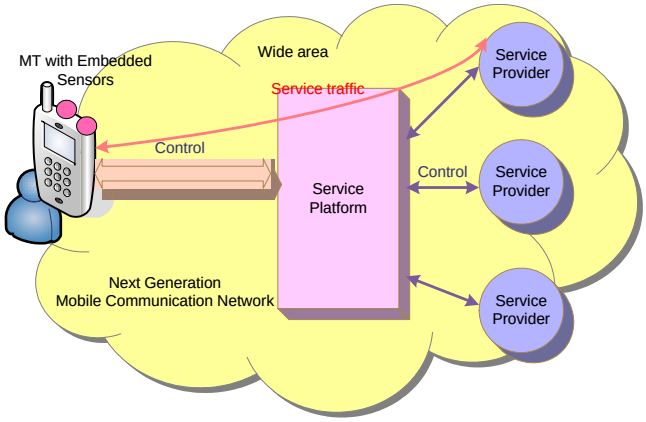

Fig. 3. The environment of the phase 2 CAS provisioning

The phase 2 CAS provisioning procedure is almost same as that of phase 1 except the fact that range of context information is expanded to measured user context information and ambient information.

3.3 Phase 3: Intra-domain CAS

In phase 3 *Intra-domain CAS*, with advent of short range communication technologies, introduction of sensor networking, and penetration of intelligent appliance devices having communication and computing ability, range of context-awareness will be expanded. And, specific services provided within a local area where a user is located will be appeared. In addition, since CAS will be provided via not only the user's mobile terminal but also other best suitable devices based on user's preference, service mobility will be accomplished.

Figure 4 shows environment and traffic flows for the phase 3 CAS provisioning.

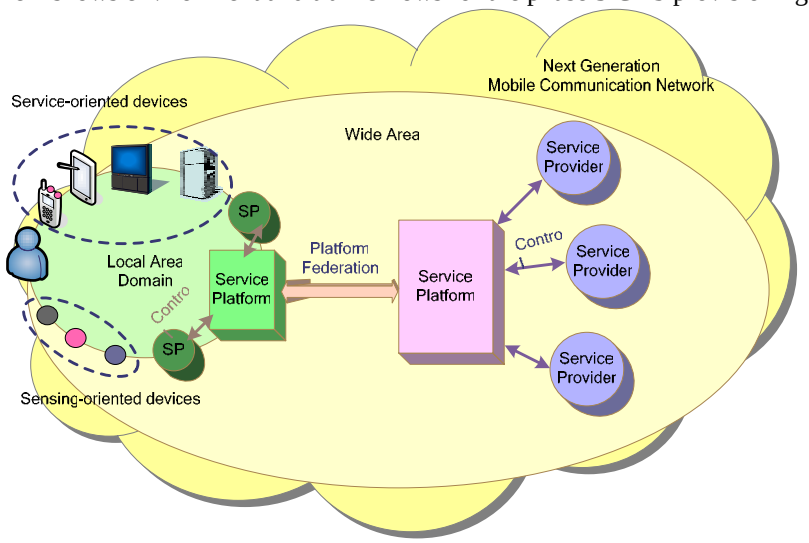

Fig. 4. The environment of the phase 3 CAS provisioning

In phase 3 CAS, it will be used that context information collected by sensing-oriented and service-oriented devices located in close proximity of the user in addition to other collected context information defined in phase 1 and 2. Sensing-oriented devices collect ambience information of a specific area, body status information of human and animals, and necessary physical characteristics for living, whereas service-oriented devices like information appliances collect device information such as device availability and device capability and other context information obtained while serving. A service platform located within a local domain, called a *local service platform (LSP)*, stores and manages context information collected from sensing and service oriented devices. The LSP also manages information about services provided within a domain. In this phase, when a user selects a CAS, one of two possible types of CASs, a local domain CAS and a wide area CAS, is provided according to user's selection of service and its coverage. If the selected service can be supported by using context information stored and managed at a LSP, a local domain CAS will be provided. Conversely, if it is required to provide a wide area CAS, related context information stored and managed at a LSP is

transferred to the *wide area service platform (WSP)* so that the WSP can provide suitable CAS by means of federation between the LSP and the WSP.

3.4 Phase 4: Global CAS

In the phase 4 *Global CAS*, the range of context-awareness will be expanded to all domains based on all IP networking environment of NG mobile communication and standardized context information transmission method between service platforms. In this paper, for the convenience, the domain where the user is located is called the *local domain*, and other domain where the user is not located but transmits various context information to the local domain is called *remote domains*.

Figure 5 shows environment and traffic flows for the phase 4 CAS provisioning.

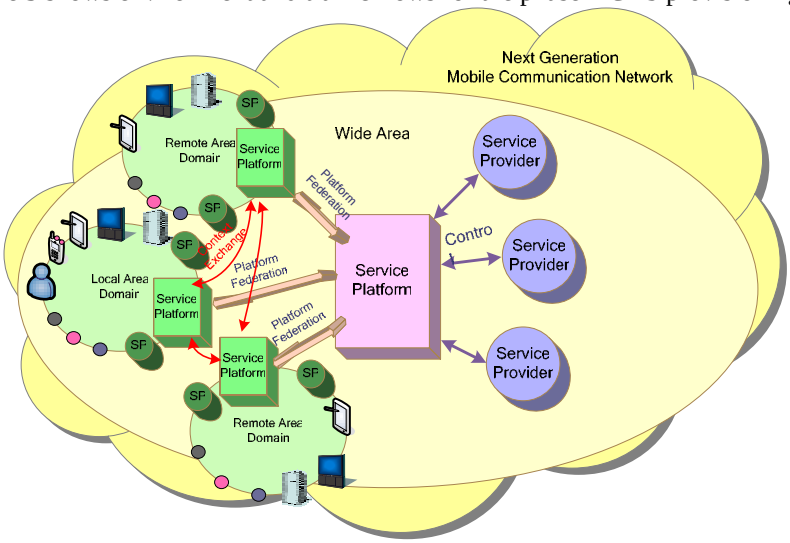

Fig. 5. The environment of the phase 4 CAS provisioning

Under such environment, a user can control a remote domain or get various information about emergency, urgency, or concerning information from remote domains. In addition, a user can get an efficient and customized CAS by means of federation with other services provided in remote domains. Context information is directly exchanged between local domains with assistant of the wide area service platform for interconnection, federation and control of such inter-domain activities. In other words, a user can search information of remote domains authorized to use and selects a remote domain among them to get service and context information from it. Then the wide area service platform gives the selected remote domain an order to send required service and context information the local domain where the user is located. Finally, the local domain gets required information from the remote domain.

4 The Context Aware Follow-me Service

4.1 Concepts and Scenario

In this paper, we propose the Context Aware Follow-me (CAF) service developed as a prototype next generation (NG) context aware mobile service. CAF service is designed for providing optimal services using best suitable devices based on user's location and preference, capability of available devices and characteristics of services in use. CAF service provides service features such as context awareness, service mobility, service personalization, service adaptation.

A possible service scenario of the CAF service is given below.

- Tom is driving a car on the way home. He takes French lesson using the mobile foreign language lesson service. Since he is driving, he takes lesson only in audio sound mode. After arriving home, Tom gets out of the car, but the lesson is continued via his mobile terminal with giving audio and video mode services simultaneously. As soon as he enters living room the lesson service is shifted to a TV. After finishing French lesson, Tom begins taking a bath. When he is in bath room, Jain calls him, and the call is forwarded to a smart mirror equipped in bath room only with voice mode. When the bath is over, the call is shifted to his mobile terminal with giving voice and video mode simultaneously.

4.2 System Architecture

The system for the CAF service is divided into the indoor domains and the outdoor service area.

Each domain is consisting of several elements such as a service platform, a location server, location management systems, a media adaptation server and smart devices.

Functions of each system element are as follows.

- A service platform manages service information within its domain area, identifies and authorizes a user, collects context information about users and service devices, and provides optimized services via best suitable devices by controlling session and mobility.
- A location management system detects the user's current location.
- A location server identifies user's current location.
- A media adaptation server trans-codes media to be suitable to the selected intelligent device and, vise versa.
- A smart device has communication capability with system elements in domain and multimedia service support capability.
- A mobile terminal can support multi radio access technologies such as CDMA, WLAN and WPAN.

4.3 The Test-bed System for CAF service

In order to investigate feasibility of the CAF service, we developed a test-bed system. As shown in Figure 6, the test-bed system consists of two domains such as a car domain, and a home domain, and outdoor area in addition to a mobile terminal that can roam those domains. In each domain, location systems are based on RFID.

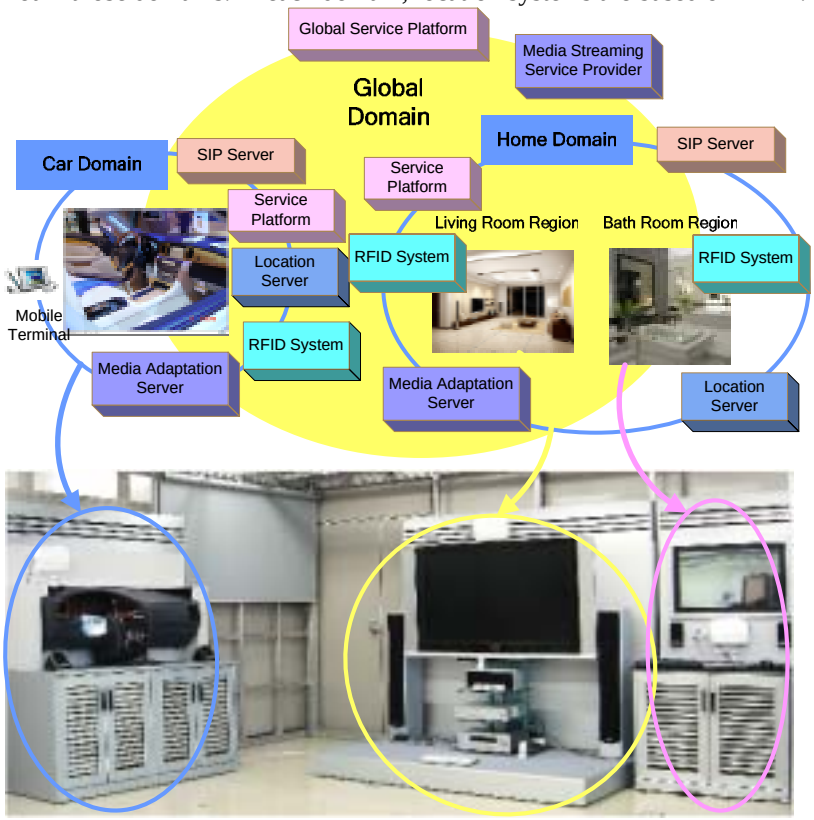

Fig. 6. Test-bed system for the CAF service

4.4 Service Flow in Test-bed System

Figure 7 presents a sample CAF service flow for a specific situation when a user enters home from outdoors domain while using the VOD service via his mobile terminal and show how the CAF service is provided in this situation. We describe message flows among service elements such as the mobile terminal (MT), the outdoor service platform, the home domain service platform, the location server (LS), the media adaptation server (MAS), the smart home theater system (SHTS), the smart mirror (SM) and the VOD service provider.

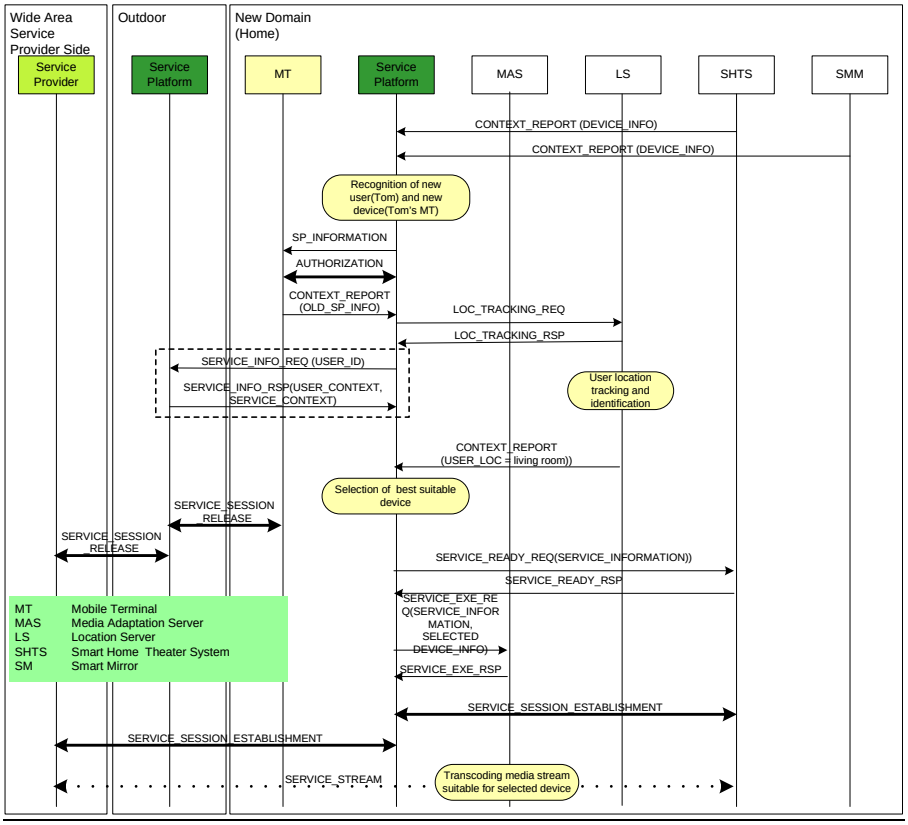

Fig. 7. The CAF service flow in test-bed system

The home domain service platform collects device related context information such as the device location, the device capability and the availability from service devices exist in the home domain. When Tom and his MT are recognized, the home domain service platform transfers service platform information to the MT with executing authorization procedure for Tom. If the authorization is succeeded, the MT reports the context information such as information of the latest connected service platform (outdoor service platform). The home domain service platform requests context information of the identified user stored in the outdoor service platform. Upon receiving such request from the home domain service platform, the outdoor service platform delivers context information such as services in use, user profile and preferences, and other context information and controls service session release between the MT and the VOD service provider. At the same time, the home domain service platform requests location tracking information of Tom to the LS. Since the LS detects that Tom enters living room, it informs the current location and location tracking information of Tom to the home domain service platform. Then, based on collected context information such as user's current location, user's profile and preference, device information and service information, the home domain service platform selects the SHTS as the best suitable service device. Then, the home domain service platform delivers service information to the SHTS to make it ready for

service. At the same time, the home domain service platform delivers information about service and selected device as well as requests for streaming media code transformation to the MAS to give the SHTS optimal service environment. Then, the home domain service platform controls service session establishment between the selected device and the VOD service provider via SIP signaling. Finally, SHTS begins to serve the identified user.

5 Conclusion

In this paper, we proposed the next generation (NG) mobile service environment based on the NG mobile service platform. And, with a view that context aware service (CAS) will be one of the promising NG mobile services, we proposed four evolutional phases of CAS, User input based, User vicinity, Intra-domain and Global context aware services, based on ranges of context information and evolutional trend of telecommunication technologies and networking environment in NG mobile service environment. Finally, we presented the Context Aware Follow-me (CAF) service as an example NG context aware service.

Currently we are researching more specific functions of mobile service platform for providing abundant CAS to user.

We hope that our research results on NG mobile services presented in this paper will play an important role in developing core technologies of NG mobile communication systems.

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