A Smart Web Platform for Telematics Services toward Ubiquitous Environments

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***Abstract*—This paper takes care of an evolution of web architecture for Telematics services on ubiquitous environments. Telematics has become one of upcoming convergence fields where many kinds of services are now be operated or planned to be launched. However, most of Telematics services are currently operated in a closed architecture: they require hardware and software configurations exclusively. In order to achieve ubiquitous capabilities in Telematics model, this paper proposes a web service platform for Telematics based on web service architecture. With the proposed Telematics service broker, service providers can register their services, and service consumers can find what services are available and how to use them. Adopting open architecture, the platform will contribute to efficient provision of Telematics services in upcoming ubiquitous environments.**

Keywords-Telematics; ubiquitous; web service; platform; XML; UDDI; car navigation

I. INTRODUCTION

Next generation technologies have been receding into background of our lives. Ubiquitous computing, "Invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere," pursues smart environments [8]. In such a space, several devices will typically have to work together to perform a particular task without awareness of human beings. Dynamically collecting a group of smart devices to enable an interaction or to perform a perceptual task requires a shared computational substrate that allows the devices to communicate bits that represent concepts in a shared ontology [9]. These calm technologies suggest an importance of an explicit geometric and geographic model for pervasive information, a representation of physical relationships between people, things, and devices. Moreover, in order to achieve an extensible and casual access to computing, much attention should be paid on the geographic points.

With respect to geospatial features, Open Geospatial Consortium (OGC) and International Organization for Standardization (ISO) have promoted research projects and proposed recommendations and implementation specifications for interoperable distribution of spatial and traffic information based on XML Web service technologies. The OpenGIS Service Framework is concerned with the functional decomposition of the system into a set of services that interact at interfaces without regard to distribution [10]. It also defines the core concept of services, interfaces, and operations, and then describes the Publish-Find-Bind mechanism that represents the interactions among different services. Recently, Telematics has become one of upcoming convergence fields where many kinds of technologies such as Geographic Information System (GIS), mobile communication, positioning technology, and multimedia service are combined. Telematics with GIS and Web services technologies has promoted the spread of geographic and vehicular information widely and supported various kinds of driving services. However, most of currently operated Telematics services have closed architecture. They exclusively use their respective data, hardware configurations, communication environments, and client terminals. Therefore a service user who wants to change the service provider cannot use his current environment, and may change terminal, software, and all others that are necessary. Such incompatibility brings obstacles to interact between systems, things, and devices, which make people be faced with unveiled seams between disappearing technologies.

We take care of an evolution of web architecture for Telematics services on ubiquitous environments. This paper proposes an open architecture for Telematics services based on web service architecture, which enables many service providers and consumers to request and response in standardized manner. The architecture also contains a design of methods representing request and response of Telematics service by XML schema. Prior example of similar approach can be found in the case of Web Feature Service (WFS) specification [1, 2]. In order to maximize the benefit, this paper proposes a smart web platform that can manage multiple service providers, consumers, their connections, and service distribution in an open environment. Based on the web service architecture, the Telematics service platform provides XML Web services by exposing useful functionality to web users through a standard web protocol. Also, to verify the architecture of the proposed service platform, we implement a prototype route service system and apply it to the service platform as a service provider.

The rest of this paper is organized as follows. Section 2 describes the proposed service platform in detail. In Section 3, operating functionalities of the proposed platform are described. Section 4 shows an entire implementation of the web platform including Telematics route service. Finally, we conclude this paper in Section 5.

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II. SMART WEB PLATFORM FOR TELEMATICS SERVICE

A basic concept of the service environment is based on the Web Service Architecture (WSA) with Publish-Find-Bind mechanism [3]. Service providers can register their services, and service consumers can find what services are available and how to use them. The architecture can support an extensible environment with interactions of roles to perform basic operations; it identifies common elements of global web services network that are required to ensure interoperability between web services. In this section, we describe a scheme for requesting and responding services in a standardized manner adapting XML to Telematics service and an architecture that enables many servers and users to request and response using XML.

With open standards and interests in communication and collaboration among services, the service platform is expected to become a suitable framework for service integration and extension.

In actual services of telematics, there may be various types of terminals and communication environments. Therefore, a service platform should consider and manage information about heterogeneous clients. We assume that a service provider should define the possible terminal type(s) and communication method(s) that can use its service. The main design issue of the proposed Telematics service platform is a management of such information of all registered services, as well as the request/response XML schemas. The Telematics service platform consists of three modules: service manager, communication manager, and platform operating manager. Fig. 1 shows the overall architecture of the proposed Telematics service platform, and details of each module will be followed.

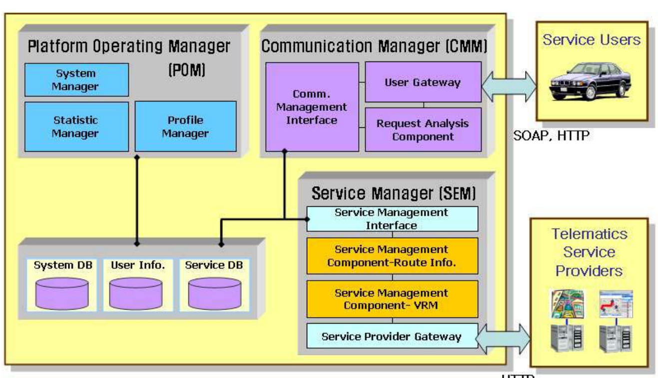

Figure 1. A smart web platform for Telematics services consisting of service manager, communication manager, and platform operating manager

A. *Service Manager*

Service manager provides a management scheme where each Telematics service is processed on aggregated service categorization as well as a communication connection between the service platform and service providers. It has three submodules: service management interface, service provider gateway, and service management component for each category of service. Service management interface connects service manager with platform databases and other modules. Service provider gateway provides communication channels between the service platform and server systems of service providers'. For the interoperability, HTTP protocol is used with XML-formatted data, and we are going to support an enhancement of TCP/IP protocol that is widely operated in industrial fields because of its outstanding performance. Service management component provides a common service schema, which is a kind of template schema for each category of service. In the case of route service, because request/response data of many route services are very similar, the service platform provides a generic request/response schema with common data included. Then each route service provider may design its own schema by inheriting the common schema and adding its own feature. To provide such a common service schema, we should list and categorize possible Telematics servics including future items, and design template XML schema for request and response of each category. In our research, services are categorized into route-guidance, safety/security, entertainment, and Vehicle Relationship Management (VRM) currently, which can be extended when new category of service is necessary. For each category we build service management component correspondingly as well as a common service schema.

In service manager, a structure of information about registered services is included. With the international standard of Universal Description, Discovery, and Integration (UDDI) [6], the structure model basically contains business entity, service entity, binding entity, and tModel. With the advanced functionality of the service platform, which even provides services to users directly, the structure model is modified into the best-fitted one for Telematics services. Fig. 2 shows a data structure model that includes information of a service provider and service itself. Service management component should be newly supplemented when new service category is added.

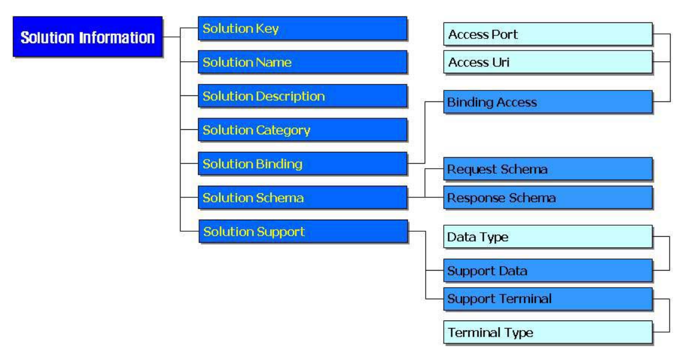

Figure 2. Data structure model when registring a Telematics service

B. *Communication Manager*

Communication manager plays a role of communication channel between the service platform and user terminals, which receives and analyzes user request, connects inner modules, and provides Telematics services to users through a user-requested communication protocol. It has three submodules: user gateway, request analysis component, and communication management interface. User gateway supports an XML Web service that takes advantage of Simple Object Access Protocol (SOAP) and Web Service Description Language (WSDL) of

W3C [4, 5]. The open web interface enables heterogeneous terminals of users to have an access to the service platform and get valuable information with less effort. For backward compatibility, it can also allow users to send requests through general HTTP protocol. Request analysis component handles users' queries. With the possibilities of heterogeneous types of user terminals, it analyzes what users want to do and recognizes what environments users are on, which makes possible user-specific Telematics services. Communication management interface connects workflows on communication manager with other modules such as databases and service manager. It is going to include protocol recognition procedure for supporting multiple protocol communication such as SOAP, HTTP, and TCP/IP.

C. Platform Operating Manager

Platform operating manager wholly controls system values on the service platform and manages information on platform databases: managing profiles of users, service providers, and system administrators, and monitoring the whole system. It has three submodules: system manager, profile manager, and statistics manager. System manager monitors operating performance of the platform server; it checks CPU utilization, memory usage, status of databases, and so on. Profile manager administers accounts and associated information concerning service users, service providers, and service itself. Statistic manager gathers numerical data on service provision and system performance. Statistical values per user, service provider, and service category can be recorded for service charge. Though details about charge are beyond the scope of this paper, platform operating manager provides a summarized form of statistical history that can be directly connected to a commercial billing system. Statistical values on system performance are recorded for stable operation of a physical server.

III. Service Registration and Usage

A. Service Registration

Within the framework of the Telematics service platform, each Telematics service provider first should define its own XML schema, may be inherited from a common service schema, and prepare a conversion function that can convert its own data format into the XML. Then the service provider registers its service by uploading request/response XML schema together with general information such as service name, provider's contact point, and connection link (URL). In addition, when registering a service, the service provider should designate service category, response data type(s), and supportable terminal type(s). These three kinds of data are used for categorization and management of service, and enable users to retrieve available services by data type and terminal type. Fig. 3 shows an example of a service registration on a web browser.

B. Service Usage

With many services registered and provided via the Telematics service platform, a user can freely use any service whose request/response is defined and registered by XML schema, without needs to know details of the server-specific data format or environments. The service user can find available services through any terminal (a web browser in this paper) by (1) connect to the service platform; (2) designate terminal type and environment; (3) search a service list that can be provided by the service platform; (4) select a service from the list; and (5) get request/response XML schema associated to the selected service. When searching a service, the list of available services is filtered according to the type of user terminal type. Then the service user gets information to bind a target service and uses it by (1) prepare a request XML document conforming to the XML schema; (2) send the XML document to the service provider via the Telematics service platform; (3) get a response XML document from the service provider via the Telematics service platform; and (4) analyze the XML document to display or use the response data.

Figure 3. Service registration including information of service category, data type(s), and terminal type(s) on a web browser

In this environment, the service platform plays a role of a service broker that exposes a list of available services to users. It also does a role of a front interface of service provider that supports Bind procedure by (1) receive a raw format of a service data from a service provider; (2) transform the raw data into a common XML format; and (3) provide the resulted service data to users directly.

IV. Implementation of Telematics Route Service

In this section, we present a prototype of a Telematics service and its connection to the proposed Telematics service platform. Among Telematics services, most widely used one is a route guidance service (also known as a car navigation), which is spotlighted as a leading service in the field of Telematics. Therefore we develop a prototype of route service and apply it to the proposed Telematics service platform.

In order to provide the route service via the proposed Telematics service platform, a standardized interface or XML schema is required. Because there are many servers and consumers for route services with different interfaces and assumptions, there needs to generalize common cases to provide route information: vector-typed route with digital map;

image-typed route without digital map; text-typed route with no graphic display. To integrate diverse Telematics services in a single platform, we consider such cases when designing the request/response schema and management policy about services. The Telematics service platform allows service providers to register the terminal type and supportable data type in addition to request/response schema.

The service platform categorizes and manages the services considering such information, and provides the information about services when the users retrieve available services. For example, a user may ask a query like: "I want to get route information on my PDA with graphic display capability but no digital map. What is the available route service(s) I can use?" To handle the query, the service platform should integrate various types of route service and provide multi-type route service, without any change of environment of both service providers and users. We have investigated several existing commercial route servers, from which we define parameters for request options and response data as common template XML schema for route service. Of course, the route server should also support a conversion function between XML and its own data format as well as original route-finding function. In a demonstration example, the supportable types of this route server are vector, image, text, and photograph, and the XML schema is designed to express them. Vector-typed and image-typed route are requested with three coordinates designated as start, intermediate, and end points. There are additionally options including search method and coordinate system of underlying map. Although not shown in this paper, the XML schema for response data is also defined for each type of route. Fig. 4 shows a web browser that interprets and displays the XML-encoded route information provided by a service provider via the service platform.

Figure 4. Route service executed on a web browser: containing vector, image, photograph-typed route information

V. CONCLUSION

This paper proposed a smart web platform for Telematics services in an open environment. The platform consisted of three core modules (service manager, communication manager, and platform operating manager) to manage service providers, consumers, their connections, and service distribution on the Web service architecture with Publish-Find-Bind mechanism. With this platform, service providers exposed their service by defining request/response interface expressed as XML schema, and the service users could find what services are available and how to use them. This paper also developed a prototype of route service and applied it to the proposed Telematics service system to show the entire service procedure. Because the proposed architecture adopted open interfaces to give an extensible and casual access to ubiquitous computing, users could use any service registered in this platform in identical manner without knowing or satisfying server-specific conditions or requirements. In addition, the Telematics service platform supported common service schemas for each category of service and a verified data structure of registering information, which could shows an interoperable model toward open environments.

We have currently tested the service platform by connecting a route service; however, it can be generally and easily extended to other kinds of service. Because there are many kinds of services in the field of Telematics, designing the efficient method for categorization of service and defining corresponding common XML schema will be researched as the future works. With the open architecture and interoperability adopted, the proposed Telematics service platform is expected to contribute to spread Telematics data and activate related industries.

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