MOBILE FRAMEWORK FOR INTEGRATED 4S DATA

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ABSTRACT

Recently, PDA and cellular phone with color LCD have been widely used in various fields by high efficiency and micro miniaturization technology. According to maturity of these mobile environments, user request about mobile application field is increased. Mobile applications provide various information which is concerned with user's position through cable and wireless transmission.

This paper discusses the issues related to the mobile framework for integrated 4S data. The integrated 4S data mean spatial data fusion on GIS, SIIS, ITS, and GNSS. The mobile framework provides not only spatial data but also location services such as reverse geocoding, directory service, etc. It consists of client subsystem, service provider, and data provider.

KEY WORDS: mobile, OGC, GML, 4S, Web Feature Server

1. INTRODUCTION

Recently, PDA (Personal Digital Assistant) has been used widely in various fields by high efficiency and micro miniaturization technology. Also, prevalence of individual cellular phone has been increased rapidly as mobile communication technology grows. According to maturity of these mobile environments, user request about mobile application field is increased. Mobile applications provide various information which is concerned with user's position through cable and wireless transmission (Oh *et al* 2002).

4S technology integrates 4 kinds of systems that process spatial information: GIS (Geographic Information System), GNSS (Global Navigation Satellite System), ITS (Intelligent Transport System), and SIIS (Spatial Imagery Information System). Spatial information processing field is expected to get synergy effect and overcomes limit of individual development of each technology via 4S technology (Joo *et al* 2002).

This paper proposes the mobile framework for integrated 4S data. The mobile framework provides not only spatial data but also location based services such as reverse geocoding, directory service, etc. It consists of client subsystem, service provider, and data provider.

WIPI and Webpad are considered as H/W of the client subsystem. The WIPI is a national standard platform of cell-phone. The Webpad (4S-Mobile H/W) is developed for processing spatial and location data. We develop portrayal and map interaction component for them to test functions of the framework.

The service provider adopts OpenLS (Open Location Services) specifications for interoperability in mobile environment (OpenLS 2002). It provides catalog service, gazetteer service, geoparser service, and geocoder service. They may use current location of a user instead of explicit input of coordinate.

The data provider provides both geometry data and location data. For geometry data, we adopt the web feature server (WFS) specification of Open GIS Consortium (OGC) (Vretanos 2002). It is used to request to access spatial data in web environment. The location data server provides current location of user and historic information of movement.

We will briefly explain the OpenLS and web feature server specifications in the following chapter. The third chapter presents overall architecture of the mobile framework. From the fourth chapter to the sixth, we describe subsystems in detail. The seventh chapter concludes the paper and discusses about further study.

2. OGC SPECIFICATIONS

OGC is an international industry consortium of more than 220 companies, government agencies and universities participating in a consensus process to develop publicly available geoprocessing specifications (OGC 2002). In this chapter, we describe OpenGIS specifications, such as OpenLS and WFS, which are expected to empower mobile technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

2.1 OpenLS

The interface specifications of the Open Location Services (OpenLS) facilitate the use of location and other forms of spatial information in the wireless Internet environment. The purpose of OpenLS is interoperable location application services that will integrate spatial data and processing resources into telecommunications and Internet services infrastructure (OpenLS 2002). Figure 1 shows the framework of OpenLS.

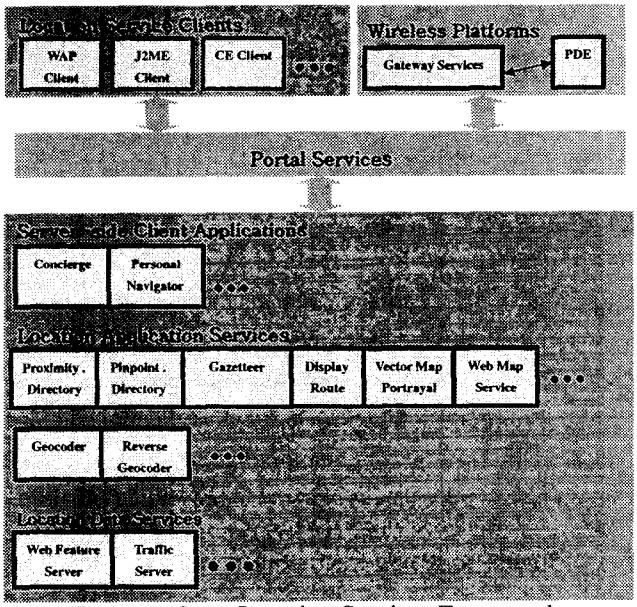

Figure 1. Open Location Services Framework

Directory services of OpenLS search yellow pages, green pages, travel guides, and so on. Route determination services support navigation. Geocode services map an address to a coordinate. Reverse geocode services find an address from a coordinate.

In this paper, we implement a core part of OpenLS specifications such as geoparser, geocoder, and gazetteer. The catalog service specification is implemented to search a server who provides requested spatial data and service.

2.2 WFS

A WFS provides access to spatial or location data and is capable of handling queries that let a client request just the data needed for a particular application. Queries can restrict the returned information based on either a desired geographic extent or based on properties of the information itself. In this way, clients can adapt requests for information based on the needs of users. For example a user can select a particular point on a map and ask for more information about a specific item on the map, or a user can ask for a listing of all the items visible on the map that match a selection criterion (Vretanos 2002). The WFS provides operations to access metadata and spatial data such as GetCapabilities, DescribeFeatureType, GetFeature, etc.

The WFS specification uses XML and defines XML schema for request and response of each operation. Especially, response of GetFeature is defined as GML (Cox *et al* 2002). Table 1 shows request of GetFeature to obtain spatial data in GML format.

Table 1. Encoding of GetFeature

Parameter	O/M	Description
REQUEST=GetFeature	M	Request to obtain spatial data
PROPERTYNAME	O	A list of properties
FEATUREVERSION	O	Feature version to fetch
MAXFEATURES	O	Maximum number of features
TYPENAME	M	A list of feature type names to query (Optional If FEATUREID is specified)
FEATUREID	O	An enumerated list of feature instances to fetch
FILTER	O	Detailed query
BBOX	O	Bounding box to fetch

3. OVERALL ARCHITECTURE

The mobile framework for integrated 4S data is a set of subsystems such as client subsystem, service provider, and data provider. Figure 2 shows the overall architecture of the mobile framework for integrated 4S data.

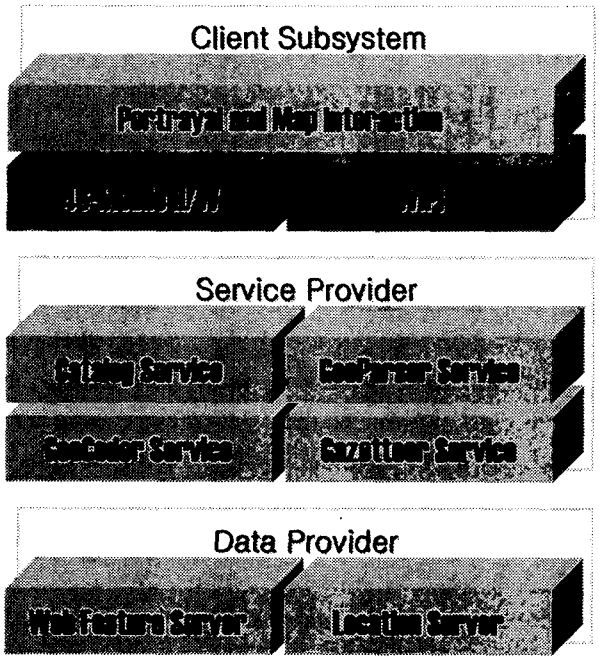

Figure 2. Overall Architecture

The client subsystem consists of H/W and S/W. The service provider supports catalog, geoparser, geocoder, and gazetteer services. The data provider supports spatial data and user's location data.

4. CLIENT SUBSYSTEM

Mobile users bring mobile terminals to process spatial data concerned about their current location. The client subsystem covers S/W and H/W for the location based service. For the S/W on mobile terminals, we develop portrayal and map interaction component. As client terminals, we develop a Webpad, called 4S-Mobile H/W, that optimized to process spatial data and use Korean cellular phone platform, named WIPI, to process mobile client.

4.1 Portrayal and map interaction

The portrayal and map interaction client S/W has user interface to display spatial data and to process user's input events. Due to huge size of spatial data, it provides progressive transmission of spatial data. Multi-threaded process is used to display and access spatial data simultaneously. The portrayal and map interaction client manages a list of feature type that contains feature list and style for representation.

4.2 The 4S-Mobile H/W (Webpad)

We design 4S-Mobile H/W that is suitable for location based services in mobile environment. It has wide touch screen display LCD (800x600) for spatial data manipulation in outdoors. It has long-lasting battery large amount of built-in memory (64M), and GPS for acquiring current location. For outdoor communication, it supports LAN, wireless LAN, and built-in CDMA (95C). Operation system of the web pad is MS-Windows CE 4.0. Figure 3 shows an example of the portrayal component using Internet Explorer on the 4S-Mobile H/W.

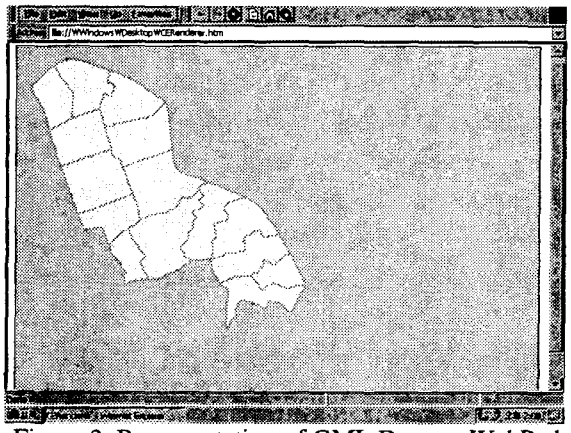

Figure 3. Representation of GML Data on WebPad

4.3 WIPI

Though result of location determination is not quite accurate, carrier companies support gateway services that provide user's position with simple location determination technique nowadays. Generally, cellular phone is more widely used than PDA at the moment. We develop the portrayal and map interaction client on WIPI, which is a Korean standard platform on cellular phone.

Figure 4 shows examples of the portrayal client that displays spatial data in vector format on WIPI phone. The example is executed under an emulator of the WIPI

platform.

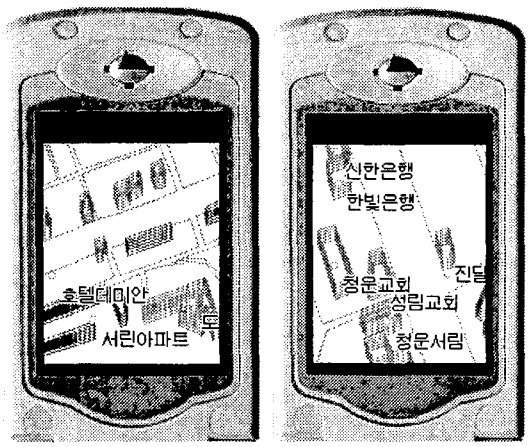

Figure 4. Spatial Data Display on WIPI Emulator

5. SERVICE PROVIDER

In general, client has less functionality to process user's request by itself. The client is likely to want to know and use providers who can serve spatial data and services. The service provider consists of catalog service, which finds providers for requested data or service, and application service, which can efficiently process spatial data instead of client terminal.

5.1 Catalog and Registry Service

The ability to locate, access, and use arbitrary resources is one of the most challenging and practically relevant objectives in the design of open, distributed systems. And in dynamic, heterogeneous environments it is advantageous to allow late binding between service requesters and service providers; that is, a client will generally not know in advance where a desired service is located (Martell 2002).

We develop a catalog and registry service to support the runtime discovery and evaluation of resources such as application services and spatial datasets. The catalog service interfaces (Enloe *et al* 1999), that allow discovery, access, and management of spatial data and services, are implemented. A registry service implementation should be construed as a web services profile of the OpenGIS Catalog Interface Implementation Specification (Martell 2002).

Discovery of catalog service are those services which allow a client to locate metadata that describe data Access Services provide the client with methods to request services on the data. Management Services define methods for a client to change the metadata held by a catalog. The Access and Management Services are optional for an OGC compliant catalog.

Providers advertise the availability of their resources in a registry, and users can then query a registry to discover resources of interest and determine how to access them as shown in figure 5.

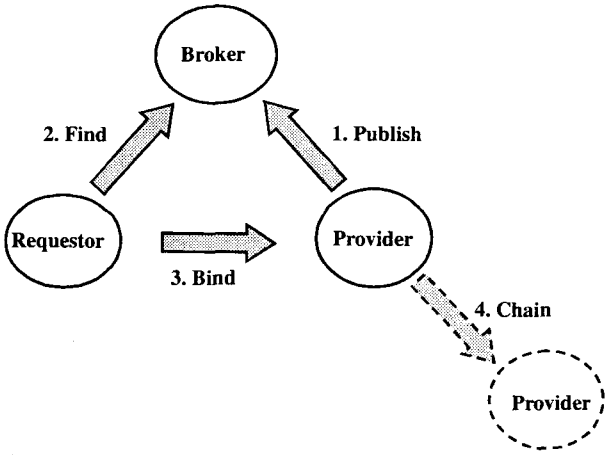

Figure 5. Registry Service

5.2 GeoParser

A Geoparser Service is a network-accessible service that focuses on the geoparsing and marking of free text messages using a vocabulary, such as place names for Korea, which is possibly specified by the user (Lansing 2002).

We develop a geoparser service provider using the gazetteer service. The geoparser service finds instances of interesting words and phrases, that is a place name in a text resource, and to return an indication of where those instances occur in the resource. Output from a geoparser service is a collection of features that identifies words and phrases in the original text resource. The returned collection of features is suitable for subsequent processing, such as user-controlled geocoding. It can be applicable to news, e-mail text, and so on.

5.3 GeoCoder

A geocoder service is a network-accessible service

that transforms a description of a spatial location, such as a place name, street address or postal code, into a normalized description of the location, which includes a coordinate geometry (Margoulies 2002).

We develop a geocoder service provider using the web feature server implemented in the data provider. It returns spatial data expressed in GML with geometries and other properties. These are the spatial data that were specified through the request filter. As well as the geocoder, we also develop a reverse geocoder service provider, which map a coordinate to a text string. It can be very useful when a user is in trouble and have to tell his/her location to others with voice communication with mobile terminal.

5.4 Gazetteer

A gazetteer service is a network-accessible service that retrieves the known geometries for one or more features, given their associated well-known feature identifiers (text strings), which are specified at run-time through a query request (Atkinson 2002).

We develop a gazetteer service provider based on the web feature server. The WFS is extended to support gazetteer service. Point of interest (POI) data and/or directory information, such as restaurants and shop, is required for searching feature identifier. The identifiers are any words or terms that describe the features, which are well known to the gazetteer service, such as a set of place names and/or landmarks.

6. DATA PROVIDER

The data provider manages and transmit spatial and location data that are used by clients and service providers. The data provider consists of web feature server and location server.

6.1 Web feature server

For geometry data, we adopt the web feature server (WFS) specification of OGC. It is used to request to access spatial data in web environment. We extend it to support progressive transmission and main-memory management for rapid response.

The goal of progressive transmission is to reduce latency time by representing only received spatial data. The remainder can be continuously received during representation with multi-threaded process. Once, the client draw already transmitted geometry data, the client should merge remainder part of geometry to the previous data and redraw periodically. More time goes, more detailed spatial data can be displayed.

Spatial data to be accessed by the client and service provider reside in main-memory and disk. Main-memory management is required to monitor where a feature is located. Spatial indexes always reside in main-memory for performance. They can be configured for efficiency by selecting spatial index structure such as R*-tree, grid, etc.

6.2 Location server

Location-based services require accurate position of moving users. User actions on a mobile terminal will lead to the invocation of location application services, and in turn, their supporting services such as accessing a location content server. The location service will be invoked from a client that operates on a 4S-Mobile H/W and WIPI with wireless communication.

In mobile environment, location services are known as gateway services. In this paper, the location server provides not only current data but also past location data. It exploits main-memory to store current location data for frequent update. Historic information about past moving is periodically stored to disk for future analysis.

7. CONCLUSION

In this paper, we have presented a framework that supports spatial data and services in location based mobile environment. The mobile framework for integrated 4S data is expected to provide interoperability by implementing interfaces in compliance with OGC specifications. Due to lack of functionality of mobile terminal, service provider and data provider have to support various applications and well-arranged data. To integrate with other parts of 4S, such as 4S-Van and satellite image management, development of sensor collection service and web coverage service of OGC can be further work

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