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GNSS COMPONENT MODELING FOR BUSINESS PROCESS-ORIENTED SYSTEM

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***Abstract*— In this paper suggests a modeling methodology to build a key business process-oriented system based on extraction of key components that is not limited to a certain domain. From this business-oriented perspective, major key components are extracted and applied to relevant application, which contributes to improved software quality such as development, maintenance, productivity, etc. To extract components, necessary functions for a system are classified functionally and hierarchically and modularized. From the process, the self-execution unit is produced for a meaningful service. It does not use the existing procedure- or object-oriented system, a process-oriented component design method, but business-based modeling methodology, and it suggests a process to extract, define, and analyze components that are commonly used in relevant application domains which is a foundation for building GPS system.**

***Keywords*— Business Process, GNSS, Component, Modeling, Framework**

1. INTRODUCTION

Global Navigation Satellite System (GNSS) refers to a constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers. The receivers then use this data to determine location. By definition, GNSS provides global coverage. Examples of GNSS include Europe's Galileo, the USA's NAVSTAR Global Positioning System (GPS), Russia's Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS) and China's BeiDou Navigation Satellite System [1-3].

On different domain, but it has common and key components. In other word, the existing applications have disadvantages in terms of separate implementation and development for each domain even though they have common components. Thus, from business-oriented viewpoint, GNSS applications extract key components, which is utilized for building related applications [4, 5]. And, their software quality has to be improved in terms of development, maintenance, and productivity. In short, the GNSS component will have to be made of the self-execution unit that hierarchically modularizes functions provided by a system. By applying the reusable property, the component is developed by distinguishing between reusable and new one, which reduces its development time and secures quality component. To extract quality one, a systematic modeling method that accurately expresses user's demands is required [6-8].

In this paper aims to extract key components that is not limited to the specific domain and suggest a modeling method that is able to build business process-oriented system.

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2. RELATED WORKS

By ensuring reusability and independence of software module, the component shows the new paradigm to solve problems of complexity and productivity of software. Various methodologies of developing UML – key methodology based on component – have been actively used in diverse fields, including development process, system engineering, and business process [9, 10].

Recent projects for GNSS component development process extracted components after requirement analysis of business components. Then, business components extracted by an interaction diagram are refined, and the components to be included in the system components that are extracted for defining architecture are found and combined [11-13]. However, the method has an advantage in that its extraction clearly separate system and business components because it clearly defines the system component that can be functionally reused in respect of system service [14-16].

In this paper, it does not use the existing procedure or object-oriented system, a process-oriented component design method, but business process-based modeling methodology, and it suggests a process to extract, define, and analyze components that are commonly used in relevant application domains which is a foundation for building GPS system to overcome these disadvantages.

3. SYSTEM REQUIREMENT ANALYSIS

Analysis of business requirements and extraction of business class models are required prior to developing an application. According to these requirements, mobile and reference stations receive signals from GPS satellite. The satellite continuously transmits information about time, its orbit, rough orbits of entire satellites, their reliability, and error correction factors that are required for other navigation system, and the receivers of mobile and reference stations continuously receive these message signals for navigation. The assignment table about requirements, actor, and use case is shown in Table I.

Table 1. Assignment Table about Requirements, Actor, and Use Case

No.	Requirements	Actor	Use case
1	The receivers of mobile and reference stations receive signals from the GPS satellite. The signal contains information about time, its own orbit, rough orbits of entire satellites, their reliability, and error correction factors that are required for other navigation system.	· Satellite · Mobile Device	· Receive GPS signal
2	The receiver of mobile station receives signals from GPS satellite and processes data. And then, using the signal, the location of mobile station is measured, orbital information relating the satellite is extracted, and rough information of orbit such as the number of satellites and the satellite number that is used is extracted. In addition, the receiver extracts the time to receive signals from the GPS satellite.	·Mobile Device	· Process GPS data · Measure mobile location · Extract orbit information · Extract receiving information

3	The mobile station transmits processed data to the control station, including its location, satellite number, the number of satellites, time to receive signal from the satellite, location of other satellites, and speed that is calculated with speedometer in the mobile station. It also transmits its own unique ID, information and its condition to the control station.	·Mobile Device ·Control Station	· Transfer GPS data · Transfer mobile station information · Transfer Processed data
4	The reference station calculates error based on the signal from GPS satellite. The calculated results are exported to RTCM format.	·Control Station ·Base Device	· Compute correction data · Set RTCM format
5	The reference station transmits the correction value of each satellite in RTCM format.	· Control Station ·Base Device	· Transfer correction data
6	The location of mobile station is calculated by using the correction value in RTCM format obtained from the reference station and information about location and satellite obtained from the mobile station.	·System Manager	· Compute mobile location
7	The control station manages databases when addition, modifying, or deleting them, analyzes the log and results of mobile station, and then extract their statistics.	·System Manager	· Manage mobile station · Manage database · Extract analysis and statistics
8	A system administer manages information about users, and the user is authorized to access the system by making ID and password.	·System Manager	· Manage control user · Manage authentication · Manage user information
9	When a user requests information about the mobile station, the control station provides information about location, speed, and time of the mobile station, then marks or analyzes its trace.	· User	· Request information ·Provide information

The extraction rule of major use cases is as follows. Major use cases only related to success of a scenario. If an exception occurred while processing the use case scenario and the use cases that do not concerns flows, the use cases are not regarded as a successful use case. From the relevant business process perspective, scenario are as follows.

▪ The receivers of mobile and reference stations continuously receive the navigation message signals, which is information about time, its own orbit, rough orbits of entire satellites, their reliability, and error correction factors that are required for other navigation system.

Extensions : If the receiver does not receive a signal, it will be an error. It prepares to receive signals by back into the situation that can receive the signal.

▪ Using the signal from GPS satellite, the location of mobile station is measured, orbital information relating the satellite is extracted, and rough information of orbit such as the number of satellites and the satellite number that is used is extracted. In addition, the receiver extracts the time to receive signals from the GPS satellite.

Extensions : If the receiver does not process the data, it receives the signal from the satellite again and processes the data.

▪ The mobile station transmits processed data to the control station, including its location, satellite number, the number of satellites, time to receive signal from the satellite, location of other satellites, and speed that is calculated with speedometer in the mobile station. It also transmits its own unique ID, information and its condition to the control station.

Extensions : If transmission is failed, it transmits data again.

4. EXTRACTION OF SYSTEM INTERFACE

In most cases, the common server logic can be figured out during refinement of use cases which is one of analysis steps, but in some case, it can be figured out during design steps, including interface layout or interface navigation design procedure. In this case, as with the method for common use cases, the object of the component can have properties of application component or business component.

The mapping relationship between the extracted use cases and system interface is shown in Figure 1.

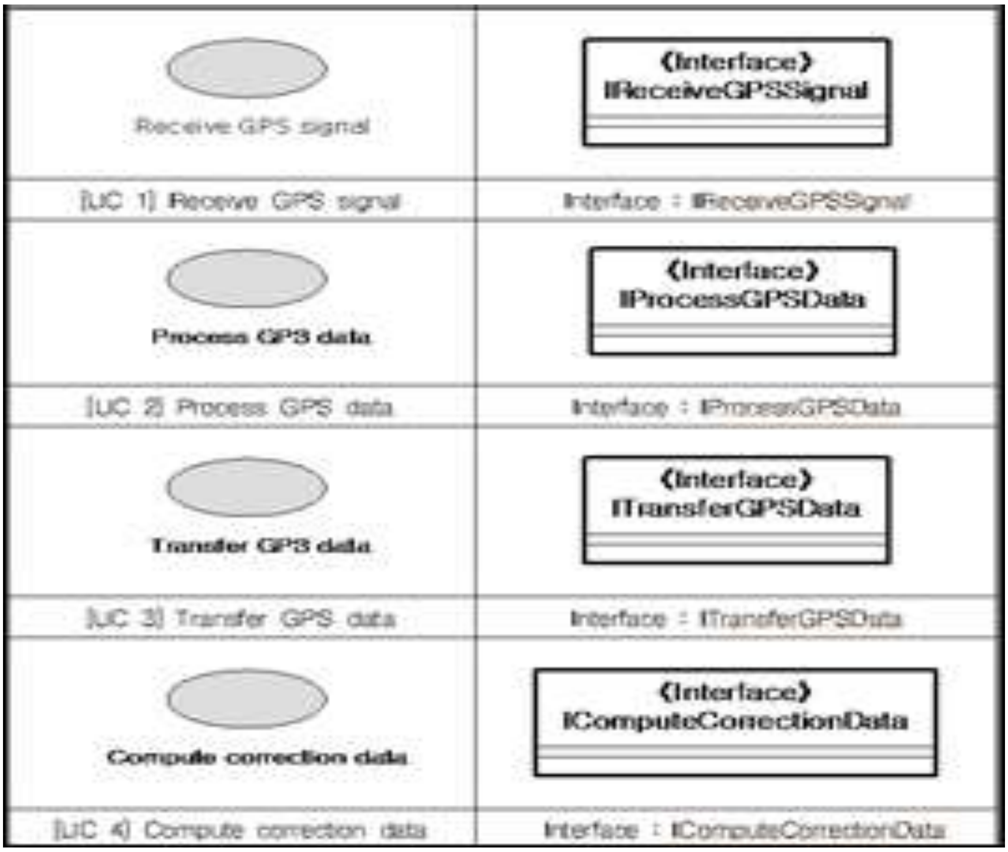

Fig. 1 Mapping Relationship between the Extracted Use Cases and System Interface

To extract system components, it does consider not only the use cases that has sematic correlation, but the common class that is included in each use case. The process to precisely extract system components should be included.

At first, the range of the business class model is determined. As shown in Figure 2, delete the class that has no relation and decide the range of the model.

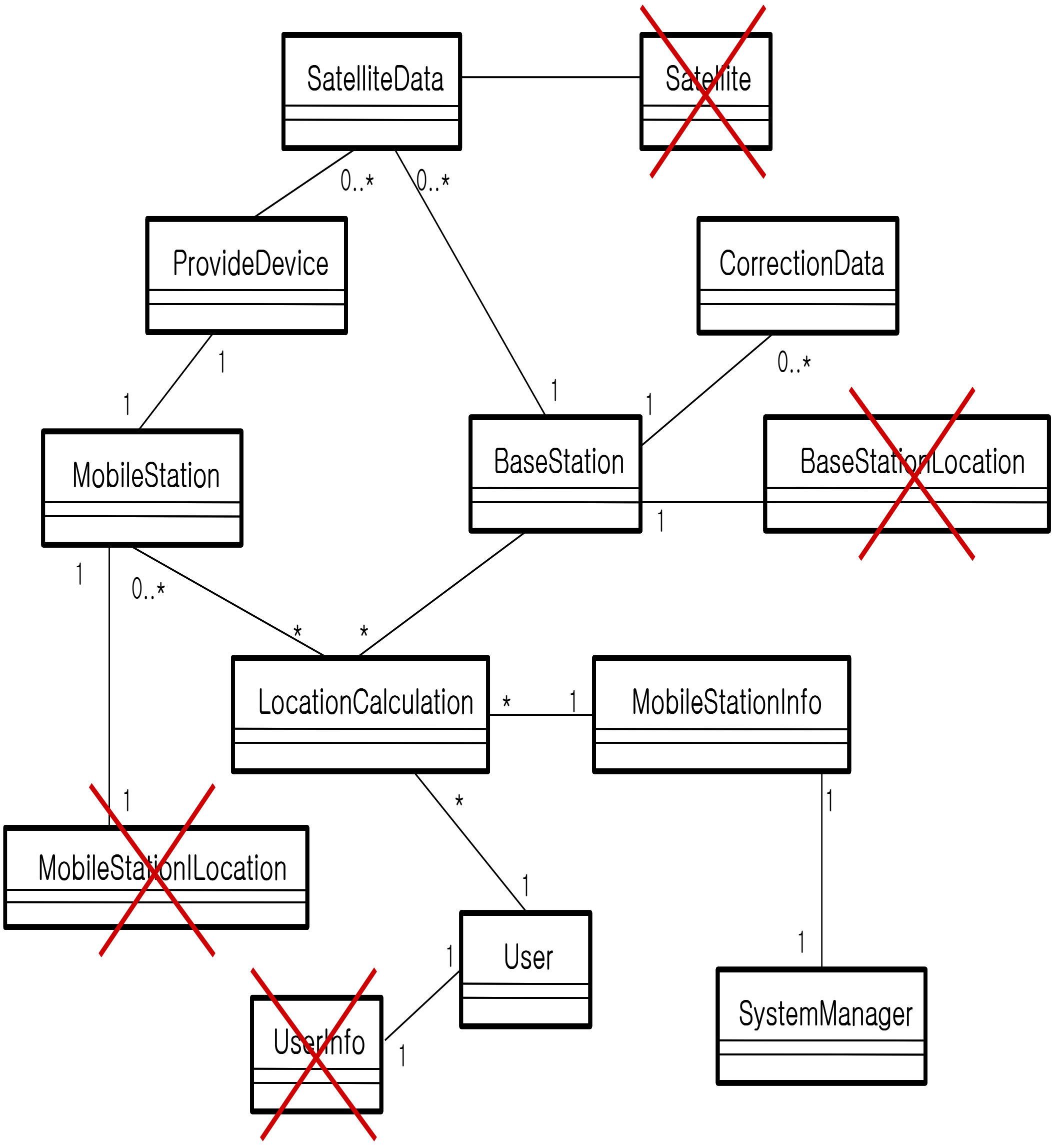

Fig. 2 Determine Business Class Model Scope

The diagram that represents relationship between extracted key classes and corresponding interface is shown in Figure 3.

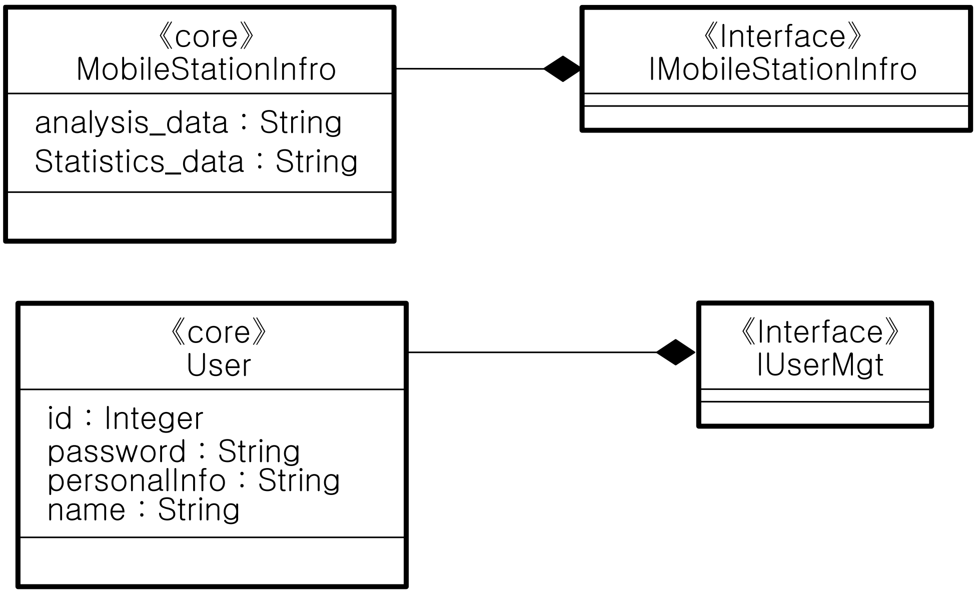

Fig. 3 Business Class Model Representing the Extracted Core Classes

As shown in the figure, the system interfaces, including IReceveGPSSignal, IProcessGPSData, and ITransferGPSData, for use cases related to the system of mobile station are specified as one component after considering the range of entire systems with systems of mobile, reference, and control stations. These interfaces can suggest one component specification because they have complex interaction and need to be processed for their interaction. Also, ICompute CorrectionData and ITransferCorrectionData that are the system interfaces of use cases relating to the system of the reference station would be one component. As they also have complex interaction between interfaces, and the data should be processed for the interaction, one component specification can be suggested.

The Figure 4 shows the component diagram that considers dependency between components drawn through such processes.

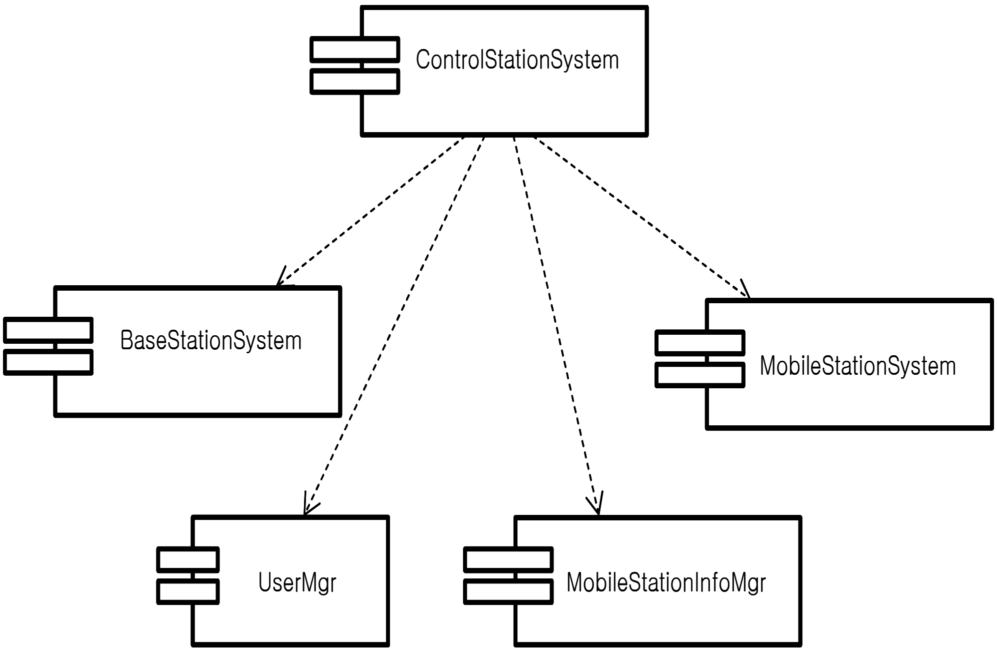

Fig. 4 Component Diagram

5. CONCLUSIONS

To develop GPS system from the business perspective, this paper suggests a modeling methodology to build a key business process-oriented system based on extraction of key components that is not limited to a certain domain. Although there are disadvantages of the existing development methods of application in that there are common modules between domains, it makes up for in disadvantages, which is implementing and developing functions in the separate domain due to ease of development. From this business-oriented perspective, major key components are extracted and applied to relevant application, which contributes to improved software quality such as development, maintenance, productivity, etc. To extract components, necessary functions for a system are classified functionally and hierarchically and modularized. From the process, the self-execution unit is produced for a meaningful service. This study suggests a modeling method, which is that the component is developed by distinguishing between reusable and new one by applying the reusable property, which reduces its development time and secures quality component. It does not use the existing procedure- or object-oriented system, a process-oriented component design method, but business-based modeling methodology, and it suggests a process to extract, define, and analyze components that are commonly used in relevant application domains which is a foundation for building GPS system.

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