# Software Platform Architecture for Ubiquitous City Management

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***Abstract*— U-City (Ubiquitous City), which is a city or a region with ubiquitous information technology, has recently emerged as an important government initiative for urban management in Republic of Korea. There are various kind of information related to the u-city and these information can be gathered through technologies such as wireless networking, RFID (Radio Frequency Identification) tags, CCTV (closed-circuit television) and sensors. In addition, information from existing legacy systems (e.g. Intelligent Transport System, Urban Facility Management System) can be related to the previously mentioned information. In the concept of U-City, U-services (Ubiquitous urban services) like U-Facility, U-Transport, U-Security and U-Environment are defined as services which process a large number of multiple events occurred in urban areas by using these information. In the past years, Events or information from U-services has been separately managed causing an increase in system complexity, overlapping investment costs and so on. Also, due to the lack of suitable urban management system, there has been difficulty in integrating with other urban management solutions. In terms of urban management, there must be a system that can store and process the massive amount of data collected from U-services. This paper discusses the flexible and extensible software platform architecture to manage these ubiquitous information more effectively.**

***Keywords-Ubiquitous City; Ubiquitous Urban Services; Software Platform; Flexible and Extensible Architecture; Ubiquitous Information***

## I. INTRODUCTION

In the past, there have been problems like the regional unbalance, environmental pollution and so on among cities [3]. As the search has been on for alternative city management to these problems, paradigm for city management has shifted from the conventional urban management system to the new intelligent management system based on the ubiquitous technologies [5]. With the rapid growth of ubiquitous computing systems, it is possible to provide citizen with the information services for urban situation at any time and monitor situation around cities in real time [4]. In the Republic of Korea, the word "U-City (Ubiquitous City)" refers to a city or region with ubiquitous information technologies, as shown in Figure 1. All information systems are linked, and virtually everything is linked to an information system through technologies such as wireless network, RFID (Radio Frequency Identification) tags or readers, CCTV (closed-circuit television) cameras. Using these information and technologies, it is also possible to develop cities and the quality of life among citizen. Thus, adoption of the new software platform architecture for urban management system is necessary to manage various kind of information from U-city effectively.

The following sections of this paper discuss the U-City infrastructure in South Korea and its components. This paper then introduces the flexible and extensible software platform architecture.


Figure 1. The concept of ubiquitous city

This paper is organized as follows: Section Ⅱ describes the U-City Infrastructure in South Korea. Then in Section Ⅲ, the design principles of software platform architecture is presented. In Section Ⅳ, we suggest the software platform architecture for urban management system. Finally Section Ⅴ concludes the paper and discusses future work.

## II. U-CITY INFRASTRUCTURE

Figure 2 shows the U-City IT framework which consists of the followings:

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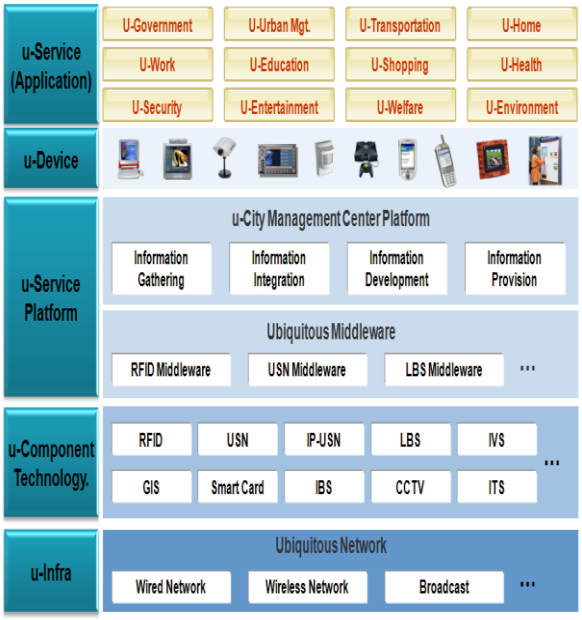


Figure 2. **U-City IT** framework

- U-Service is the application set which provide citizen with a variety of urban-related services. U-Safety enables IP based broadband integrated surveillance, automatic object recognition and tracking using pattern recognition technology. U-Health is a medical data sharing system between organizations and clients integrating separated information hospital projects. U-Facility is a real-time urban monitoring and remote controlling system based on 2D or 3D GIS map. U-Transportation is tailored/real time services for customers establishing national integrated transportation information center. U-Government, which is paperless government, civil affair services, is integrated government services focused to citizens. U-Education is personalized/tailored learning services enabling decreasing expenses on private education. Learning everywhere is possible by providing mobile devices and network infra. U-Education is increasing confidence of public education with intelligent and systemic education.
- U-Device refers to a device which presents information and data collected from U-Services by providing user interface or a device which creates information and data like CCTV cameras, sensors. Wired/wireless U-Device is combined with each other to make ubiquitous computing available for the citizen
- U-Service platform makes each U-Service to interact with U-devices easily hiding the details of a particular set of functionality.
- The most widely used technologies like RFID (Radio Frequency Identification), USN (Ubiquitous Sensor Network), GIS (Geographic Information System), GPS (Global Positioning System) are grouped into U-Component Technology including 3rd party solutions.

## III. DESIGN PRINCIPLES OF SOFTWARE PLATFORM ARCHITECTURE

As mentioned above, the massive amount of data can be collected from U-Services or many kinds of ubiquitous devices. Therefore, a suitable urban management system based on layered architecture is necessary to process those data. For the effectiveness of urban management, adoption of flexible and extensible software platform architecture in urban management systems is emerging as a major issue lately.

The flexible and extensible software platform architecture is required to meet the following requirements:

- standard interface to various kinds of U-services,
- standard interface to heterogeneous ubiquitous devices using multiple protocol,
- creating and processing business events through collected data,
- interface to other relevant external systems,
- interface support for compatibility with third party solutions,
- user interface for monitoring data collected from U-services and devices,
- guaranteeing extensibility for processing large amount of data,
- standard security policy for complex interface,

We focus on two key aspects of design principles when adopting architecture for urban management system.

### *A. Distributed and loosely-coupled System*

By adopting distributed and loosely-coupled system, it is possible to distribute data and traffic load [1]. Each component can easily be altered to accommodate changes in system capability and system requirements [1][6]. When the some aspect of the system is scaled to a larger size, it can operate correctly.

### *B. Service Oriented Architecture*

SOA (Service Oriented Architecture) is a flexible set of design principles used during the phase of systems development and integration in computing. A system based on SOA architecture will provide a loosely-coupled suite of services that can be used within multiple separate systems from several business domains. SOA advocates an approach in which a software component provides its functionality as a service that can be leveraged by other software components. SOA allows the integration of existing systems, applications and users into a flexible architecture that can easily accommodate changing needs It can also provide various kinds of applications and other different platform with standard interface. There are lots of advantages including the ability to monitor and track the transaction among systems in

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terms of service oriented architecture based on ESB (Enterprise service Bus).

An ESB is an architectural pattern and a key enabler in implementing the infrastructure for a service oriented architecture. The increasing adoption of SOA and the proliferation of Web services have revealed an ever growing need to provide a managed layer between services and their consumers.

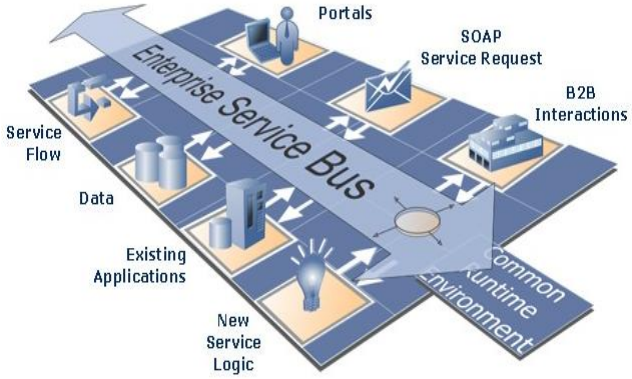


Figure 3. The Enterprise Service Bus (Mahesh H. Dodani, "From Objects to Services: A Journey in Search of Component Reuse Nirvana", IBM Software)

## IV. SOFTWARE PLATFORM ARCHITECTURE FOR URBAN MANAGEMENT SYSTEM

### A. *Layer Design of Software Platform Architecture*

A multi-layer system is using different layers for allocating the responsibilities of an application. It helps to structure applications that can be decomposed into groups of subtasks in which each group of subtasks is at a particular level of abstraction. It has several benefits than other existing system implementing its layers as a monolithic block. In multi-layer systems, each layer can be reused if it has well-defined interface. And also, changes in each layer affect only one layer. Thus, developers can adapt affected layers without altering the remaining layers.

Considering the advantage of a multi-layer system mentioned above, adopting multi-layer system is necessary to improve system performance and reduce system complexity because the urban management system has to process large amount of data gathered all around the city. Platform-independent technologies can be provided through this layered architecture and also loosely-coupled system is needed to meet the requirements of many applications.

As shown in Figure 4, in this section, we introduce layer design of software platform architecture. The architecture consists of 3-level layer based on distributed system and each layer interacts with other layer by standard interface like web services. Each layer consists of stand-alone components which have similar responsibility resulting in developing each layer easily and load balancing.

*1) U-Infra Abstraction Layer:* This layer collects data through interaction with sensing collection server like RFID middleware, USN (Ubiquitous Sensor Network) middleware, media board and CCTV server. It provides standard APIs (Application Programming Interface) to control U-devices (ubiquitous devices). For example, it receives response from sensors after sending request for controlling sensors.

*2) Platform Service Layer:* This layer stores and processes data collected after sending commands to U-Infra Abstraction Layer. On the request from U-Service Integration Layer, it processes data and events to U-Service Integration Layer.

*3) U-Service Integration Layer:* U-Services interacts with other layers through U-Service Integration Layer. This layer proposes internal/external interface standard.

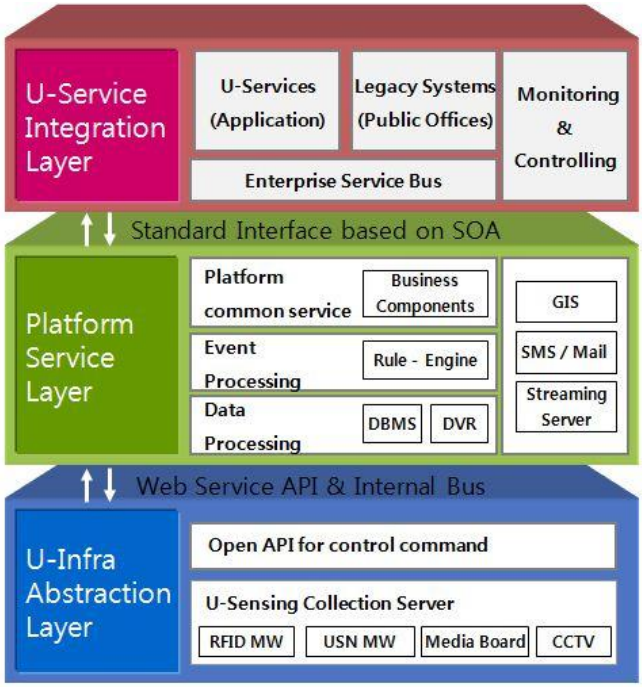


Figure 4. Layer design of software platform architecture

Each layer can be installed independently or integrated into a single machine depending on the capacity of the system. The software components belonging to one layer communicate with the other layers in a way of pre-defined interfaces. For example, a component of Platform Service Layer can call Web Service APIs of the U-Infra Abstraction Layer, which displays alert text message of the possibility of flooding through the media board (also known as digital signage) around the street. In the same manner, USN Middleware of U-Infra Abstraction Layer can send the water level information to the subscribers (U-Service application or Monitoring System) using the Internal Bus that can be implemented with Message Oriented Middleware.

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## V. CONCLUSION AND FUTURE WORK

In Korea, most of urban development project recently established is being promoted by national U-City strategy. With increasing number of U-City construction projects, it is expected that the total number of population residing in U-Cities in 2015 will reach at about 2.3 million. The U-City act proposed by the Korean Ministry of Land, Transport and Maritime Affairs was enacted through discussion with related departments and public hearing. As the demand for U-City rises, the demand for the robust software system which is capable of managing information and the devices city-wide will become a greater priority.

In this paper, we proposed software architecture for U-City information system but more work is needed. We need to find and develop new service models for U-City residents. Standardization of the software platform would be an issue for government to prevent overlapped investment. More than all, the work should be for the convenient, safe, and pleasant life of citizens.

## ACKNOWLEDGMENT

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