

# International Case Studies of Smart Cities

Songdo, Republic of Korea

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# International Case Studies of Smart Cities

## **SONGDO** REPUBLIC OF KOREA

IDB-KRIHS Joint Research



## Abstract

This case study is one of ten international studies developed by the Korea Research Institute for Human Settlements (KRIHS), in association with the Inter-American Development Bank (IDB), for the cities of Anyang, Medellin, Namyangju, Orlando, Pango, Rio de Janeiro, Santander, Singapore, Songdo, and Tel Aviv. At the IDB, the Competitiveness and Innovation Division (CTI), the Fiscal and Municipal Management Division (FMM), and the Emerging and Sustainable Cities Initiative (ESCI) coordinated the study. This project was part of technical cooperation ME-T1254, financed by the Knowledge Partnership Korean Fund for Technology and Innovation of the Republic of Korea. At KRIHS, the National Infrastructure Research Division coordinated the project and the Global Development Partnership Center provided the funding.

Songdo, as part of Incheon Free Economic Zone, is an iconic new smart city of Korea that hosts international business events and attract IT, bio-tech, ad R&D facilities. Its smart city initiative began in 2008 and is still ongoing with an aim for completion by 2017. The project is largely divided into six sectors including transport, security, disaster, environment, and citizen interaction while other services related to home, business, education, health and car are also being developed. Specialized service in Songdo includes smart bike services, criminal vehicle tracking and monitoring unusual activities through motion detecting technology while Integrated Operation and Control Center (IOCC) readily facilitates collaboration between various agencies and citizen engagement. Songdo smart city initiative is managed by Incheon U-city Corporation, a private-public partnership in order to secure funding for system operation through effective business model.

JEL Codes: L86, L91, L96, O18, Q55, R41

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# Executive Summary

Following the establishment of Incheon International Airport, three new town developments were pursued in the city of Incheon. Songdo, as a part of Incheon Free Economic Zone, became an iconic new smart city town of Korea. Smart city project in Songdo developed and still is developing quickly; it was originally initiated by UPS (U-city Strategy Plan) in 2008, and is still ongoing with its construction to aim for completion by 2017. Currently, this new city is striving to become a leader of smart cities of the world by actively hosting international business events, and to attract IT, BT, R&D related facilities to be located in the city.

The smart city project of Songdo is largely divided into six sectors including transport, crime prevention, disaster prevention, environment and citizen interaction, to provide smart applications. Other services relating to Home, Store, Learning, Health, Money and Car are also actively being developed.

Specialized service in Songdo is utilizing RFID/USN technology to provide environmentally friendly (for example, U-bike, or U-street) services. RFID/USN technology is also used for crime prevention through the use of vehicle registration number detection camera that is able to filter out stolen vehicles, unpaid tax vehicles, and criminal vehicles. The CCTVs installed around Songdo uses advanced motion detecting technology to monitor, in real-time, for any unusual activities. Moreover, the operation center is readily connected with various disaster-related organizations to prevent for any disasters and to effectively engage with citizens. Songdo has the most advanced Integrated Operations Command Center in Korea and their integrated smart city services are provided, not only for Songdo, but for nearby cities too.

A special attention should be drawn at establishment of Incheon U-city Corporation. Incheon U-city Corporation holds private-public partnership (PPP) formation, where the city of Incheon holds 28.6% of the share and the rest are held by private firms. The ultimate purpose of such PPP was to create stable and efficient smart city construction, securing funding for system operation and management, forming an effective business model, and maximizing benefits for citizens. Incheon U-city Corporation is currently handling general system construction, maintenance business, as well as international consulting business for countries that wishes to create smart cities. It is important to emphasize that the success factor of Songdo had perhaps been this attempts to maximize public-private partnership. For sustainable development of the smart city projects, not only public initiatives are important, but it should be developed along with private companies and their business ideas, engaging with other parts of the society.





Songdo, Korea (Source: Songdo International Business District website)

# SONGDO, Korea

## 1. Introduction

### 1.1. General city overview

Songdo international city is part of the Incheon Free Economic Zone (IFEZ) along with Yeongjong and Cheongna, and it is located southwest of Incheon Metropolitan City.

The city was built on reclaimed land based on the Basic Plan of Public Waters Reclamation for Songdo area established in 1979. The Governmental office of Songdo International City was opened in November 2003 in accordance with the newly introduced law on IFEZ. KRW 45,269 billion has been invested in three districts under the IFEZ, Songdo, Yeongjong, and Cheongna (total area of 132.92km<sup>2</sup>) to build infrastructure for the new city.



Figure 1 Development plan map of IFE

The function of each district is as follows. Songdo is in charge of international business relating to IT, BT and R&D, Yeongjong focuses on aviation logistics, tourism, leisure, and Cheongna concentrates on international finance, high-tech industry, and distribution. Geographically, the IFEZ is located where 61 foreign cities with over 1 million people can be reached within 3.5 hours flying distance. Thus, making one-day business based on 2.5 billion people possible. In terms of useful infrastructure, the area consists of Incheon International Airport, which functions as the hub airport of northeast Asia. Incheon airport has been globally ranked number 1 for 10 consecutive years for airport services, and ranked number 2 for international cargo transportation. Also, Incheon Harbor which consists of cutting-edge harbor infrastructures is located at a 20-minute car distance from the IFEZ. On top of this impressive connectivity, the area lies only an hour away with Korea's metropolitan area (Seoul).

Songdo is still under development with plans to invest KRW 21,544 billion over 53.4km<sup>2</sup> area until 2022 in order to contain 101,780 households and 259,669 people.

## 1.2. Smart city overview

### 1.2.1. Development background and history

As part of the nation's project to build a cutting-edge green city as a new growth power, Songdo is being developed into a ubiquitous city. This plays a pivotal role in the IFEZ's vision and realization strategy. The project began with the philosophy to build and provide citizens with a living environment that is convenient, pleasant, and healthy. Songdo international city's smart city project is carried out according to strict and thorough plans.

In 2008, the validity of the project was examined and a ubiquitous service platform (USP) was established, and in 2009 the working design was completed. Based on this, 5-step Intelligent Transport System (ITS) pilot project was implemented between 2009 and 2014. In 2012, Incheon U-City Corporation, which is a private and public joint corporation, was established to exclusively take care of the IFEZ's U-City business. The corporation was established by CENTIOS, a joint corporation of Incheon city, KT, and CISCO. Then in 2014, MOLIT's (Ministry of Land, Infrastructure and Transport) pilot project was carried out. With implementation of pilot project, the integrated operations center of Songdo city was established in 2014, and it has been operating in real-time until the present day

Duration	Project content
2007~2008	Examine validity & establish USP
2009	Complete working design service
2009~2014	Attract MOLIT's demonstration project & carry out project (stage 5)
2012	Establish Incheon U-City corporation
2013~2014	Close contract with agencies to develop Songdo zone1~zone4 & begin project
2014	Open City Integrated Operations Center
2016	Expect to complete project at zone1~zone4
2017	Expect to carry out project at zone5~zone7

Table 1 Songdo U-city project progress

Songdo plans to invest KRW 164.7 billion and establish U-City at zone1~zone4 by the end of 2016. Yeongjong is currently running a U-City project at Yeongjong Sky City and Midan City, whereas Cheongna has already completed establishing in 2014 and is currently in operation. Once, U-City infrastructure is completed at Songdo's zone1~zone4, the three districts (Songdo, Yeongjong, Cheongna) are planned to be connected and managed as one. The IFEZ plans to spread private-public joint service models and expand exports.

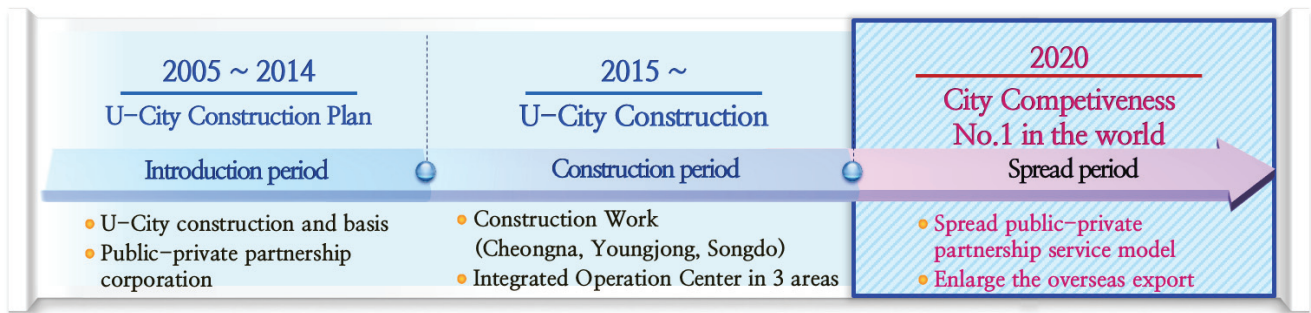


Figure 2 Target for each step of establishing Songdo U-city

### 1.2.2. Vision, current and future projects



Figure 3 Songdo U-city's vision, Goal & Core strategies

The IFEZ has set its goal to be ranked number one in the global city competitiveness by 2020. Through this the IFEZ's vision is to realize a global leading U-City. In order to achieve this goal, the IFEZ has set 5 core strategies: i) establishing and operating a public IFEZ U-City; ii) developing cooperation model with private sector services; iii) strengthening the foundation of public-private cooperation; iv) expanding overseas export of IFEZ U-City; v) building high-tech clusters and inviting international events.

i) To establish and operate a public IFEZ U-City, U-infrastructures are being constructed on-site

and are being connected to the U-City operation center through communication networks. In the future, the U-infrastructures of Yeongjong and Cheongna will be connected with Songdo's to establish an integrated operating system.

ii) U-City services are enhanced by developing cooperation models with private sector services. Also, specialized services of public-private corporations are being distributed. The goal is to acquire U-City's investment and operation costs by collaborating with global corporations when developing public-private cooperation models, as well as to establish an IFEZ U-City that can be

sustain its development and attract foreign capital. To achieve this, a public-private U-City corporation was established for the first time in 2012 in order to utilize privately owned technologies and resources.

iii) Global U-City R&D center and private cooperative corporations are established to strengthen the foundation of public-private cooperation and to activate private investments. The 'GCoE(Global Center of Excellence)', which is the U-City R&D center of CISCO, is built at Songdo to develop new technology with the objective to lead the overseas smart city market in the long term.

iv) Past development experiences are made into models and networks between countries are reinforced to expand overseas export of IFEZ U-City. The smart city projects of developing countries such as China, Philippine, and countries of the Middle East are carried out as national projects and the IFEZ is working to attract exports and to invite companies into the area.

v) The city attempts in holding various international events and making mid-long term master plans to create cutting-edge clusters and international events.

The Songdo Knowledge and Information Industrial Complex contains world class level RFID/USN facilities and provide high quality services based on sharing. Through this, the city is forming the basis for establishing a cluster network of the RFID/USN industry, including inviting core corporations, accumulating support facilities etc.

The U-City International Conference that has been held since 2008, provides the future direction of future cities, city regeneration

models, and shares the vision of a happy future technology city. By hosting international meeting related to U-IT and carrying out Songdo tours, the IFEZ is appraised as having established its status as a 'Global Leading U-City'. The city has also been hosting the Incheon Digital Art Festival(Indaf) every year since September 2009. This event is planned to be developed into a world-wide culture content business that integrates cutting-edge technology, cultural and artistic factors that are applied to the U-City model.

## 2. Service spectrum

### 2.1. Overview of the Smart services and high level functions

Songdo U-City can be divided into public services and private services. Public service sectors are designed to provide 24 services in 6 categories including traffic, crime prevention, facility management, disaster prevention, environment, and providing information to citizens. Private service sectors are to provide services relating to home, store, learning, money, health, and car.

Environmentally friendly services are to be provided as specialized services by utilizing U-IT such as RFID/USN. The services include U-Bike, U-Street, U-Foreigner Support Mobile Service etc.

Songdo U-City collects 24-hours real-time data from on-site equipment such as CCTV, various sensor devices, traffic detectors. Systems in Songdo are being built so that the collected data is stored at the data base through the integrated platform and analyzed by application services and big data analysis to provide citizens with useful services.



Figure 4 Service Provided by Songdo U-city

## 2.2. Transportation and urban mobility

U-IT technology based on wire-wireless communication infrastructure is applied to existing traffic components such as roads, traffic facilities, vehicles, to enhance the efficiency of traffic infrastructure, and to increase the safety and convenience of users.

### 2.2.1. Provide Public Transportation Information

In order to maximize the convenience of using public buses, bus arrival information is provided at bus stops along with subway information of

nearby stations. The information is not only provided in Korean but also in various languages for foreigners to use.

The CCTVs installed at bus stops not only monitor in real-time possible facility problems that may arise, but also check for unexpected situations that may arise nearby. If a citizen presses the alarm bell in such emergency, it is immediately connected to the operator at the center.

During the night time automatic power-saving functions operate by using movement detection sensors that turn on the system when someone approaches and turn off when no one is there.



Figure 5 Public Transportation Information Providing Service & Function

### 2.2.2. Illegal Parking Control Service

In case for illegally parked vehicle, the driver is informed through announcements or SNS and guided to other public parking where spaces are available. If the driver refuses to follow directions, then illegal parking control is enforced. During the night time surveillance cameras used for controlling illegal parking are used as crime prevention CCTVs to monitor crimes.

### 2.2.3. Cutting-Edge Traffic Signal Control System

The upgraded version of the COSMOS (Cycle Offset Split Model of Seoul) system is applied to

the Songdo traffic signal control system. During the peak hours, Time Based Control (TBC) is implemented where all signal indications are operated as regular signals. During non-peak hours, Traffic Response Control (TRC) is implemented where detectors at left turn lanes detect the flow of traffic and flexibly manages signal indications by sometimes skipping left turns when there are no cars that need to turn left. Also, if urgent situations where fire trucks or 119 emergency vehicles need to pass through occur during non-peak hours, operator intervention control is implemented by using detectors at left turn lanes to allow the continuous traffic flow of emergency vehicles.





Figure 6 The operational conception of illegal parking enforcement system

## 2.3. Safety and citizen security

To provide citizens with a safer living environment, the IFEZ collects and integrates all footage from crime prevention, disaster prevention, environment, and traffic surveillance cameras of Songdo, Yeongjong, and Cheongna, and monitors them all together at one spot. By sharing these video footage, the sources can be used for various purposes.

### 2.3.1. Vehicle Monitoring for Crime Prevention

Cameras loaded with Automatic Number Plate Recognition (ANPR) are installed in at major intersections of Songdo International City. These cameras collect license plate number information of passing vehicles in real-time. The

collected data is sorted to find wanted vehicles or vehicles of delinquent tax payers. The information is then sent to police stations, tax offices, or related organizations for swift responses.

### 2.3.2. Active Crime Prevention Monitoring

Through the image recognition function, cameras can actively monitor and detect whether the detected object(s) is in fight, has collapsed, is wandering, or is trespassing etc. If an abnormal activity is detected, it is immediately alarmed to the operator and the CCTVs near the area function together to form a net to monitor such abnormal behaviour. The location and situation are sent to police stations, 119 for immediate actions.

Surveillance monitoring



Figure 7 Vehicle Monitoring for Crime Prevention

2.3.3. Abnormal Sound Monitoring

If a citizen shouts or screams in an urgent situation, sound sensors detect this and CCTVs nearby automatically turn their angle to show

center operators images of the situation on hand. The center operator checks the situation through video footage and spreads the location and content of the emergency to related organizations for swift action.



Figure 8 Active crime prevention monitoring



Figure 9 Abnormal sound monitoring

## 2.4. Emergency and response

Songdo collects information in real-time on emergencies such as disasters by connecting and integrating with external agencies such as Incheon Fire Department, National Emergency Management, and Incheon LNG production base. Information is also collected from the emergency rooms of public & private buildings

and from Songdo U-City's U-Crime Prevention system. Information on natural disasters such as earthquake, tsunami, typhoon etc. are collected from the Incheon Fire Department and National Emergency Management. Information collected from Incheon LNG production base consist of information on emergencies within the base, explosions or fires. The U-Disaster Prevention service system collects real-time information on the level of floods, subsidence etc.



Figure 10 Emergency response: collecting, monitoring and broadcasting

The center gathers all the information to monitor for disaster situations. At times of emergencies, the situation is broadcasted to citizens through VMSs installed on site or through web and mobile applications. At places such as parks, plazas or waterside areas, evacuation announcements are made through crime prevention speakers.

## 2.5. Environment

Environment detecting sensors are installed at Songdo's parks, shopping areas, schools, and housing areas to measure weather and atmosphere conditions. Weather sensors measure wind direction, wind velocity, temperature & humidity. Whereas environment sensors measure the level of fine dust, carbon monoxide, nitrogenous compound, sulfur oxides, and ozone amount.

Road surface detecting sensors & weather sensors are installed at main roads and Songdo

bridges 1~3, to collect information on road environments that are related to traffic safety such as frozen surfaces, fogs etc. The information collected from these sensors are then reorganized as spatial-temporal information and combined with the analysis results of big data from the past, to produce predictive information that is passed onto citizens through various information delivery channels.

## 2.6. Energy saving

IoT sensors are installed at houses and buildings to provide real-time information to users, of how much energy has been consumed and what measures can be taken to minimize utility bills, through mobile applications. Using smart applications, users are able to manually turn off electric devices just by touching their smartphones and control the temperature and lighting of their houses before they return to their home.



Figure 11 Environment & Disaster prevention monitoring

## 2.7. Citizen interaction and communication mechanisms

Through mobile devices citizens are provided with information regarding public administration, processes of civil affairs in order to increase the efficiency of operations, and to enhance citizen satisfaction.

Citizen communication services such as mobile civil affairs administration service, customized administration service for citizens, on-site administration service etc. are provided to citizens and the system is currently being expanded.

## 2.8. Integrated Facility Management

On-site facilities installed at Songdo International City have various sensors attached to them. If something goes wrong with these facilities, the center can detect conditions from afar.

If irregularity is confirmed the center and ward officials work together to send maintenance workforce on-site to solve the problem and the information is recorded at the facility history management system. Also, the situation is informed to citizens while facilities are being repaired, so that it does not cause any inconvenience.



Figure 12 concept of operating integrated facility management system

### 3. System Configuration

#### 3.1. Overview

Songdo U-City collects 24-hour real-time data from on-site equipment such as CCTV, various sensor devices, traffic detectors. The data is stored at the data base through the integrated platform and analyzed by application services and big data analysis to provide useful services to citizens. Various ubiquitous technology (BcN, USN, RFID etc.) have been adopted and applied all around the city from the city planning and development stage. The IFEZ is planning to

construct a futuristic city of new concepts and prepare an innovative milestone for creating a new growth power.

The city is connected by a single communication network and individual services in administration, traffic, crime prevention, disaster prevention, environment, underground utilities etc. are interconnected. Also, by providing cutting-edge services and controlling through integrated systems, the IFEZ is realizing a smart city that has the competencies to lead the world's U-City market.

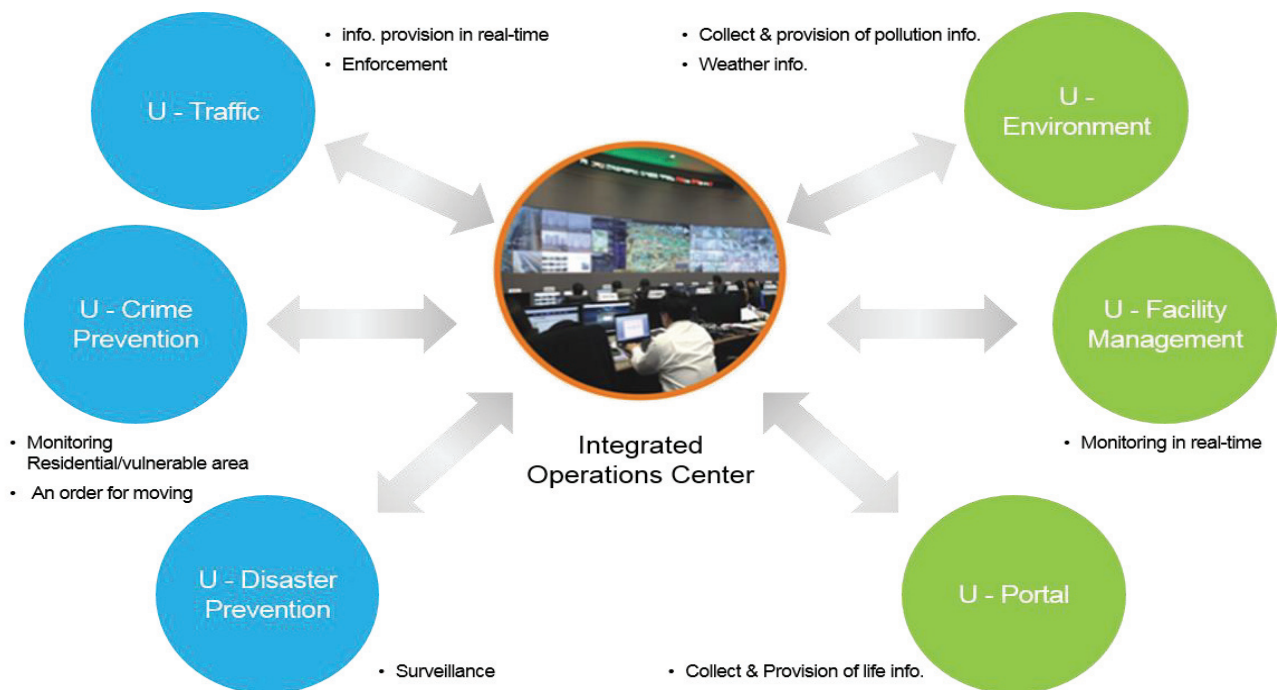


Figure 13 Songdo U-city integrated operations center

#### 3.2. Level of physical system integration and interoperability

In Korea, city management and traffic information centers are built in city units and categorized as district centers. City unit centers are vertically linked to provincial unit centers and provincial unit centers are vertically connected to the national center which is the highest level center in Korea. In terms of hierarchy, Songdo U-City integrated operation center is under the Incheon metropolitan city center. However due to the IFEZ city's

characteristics, many parts of the city will be managed independently to enhance efficiency. In other words, Songdo center directly collects information on emergencies such as disasters in real-time, by connecting and integrating with external organizations such as Incheon Fire Department, National Emergency Management, and Incheon LNG production base, without having to go through the Incheon metropolitan city center.

However, in spite of this, all the information that is linked is strictly guarded by the Korean government's designated technical information exchange standard according to type, definition, characteristic, exchange method, information provider's rank, and authorization. Information sharing and connecting is operated based on the

standard node system defined by the Korean government. Depending on the characteristic of linked information, the exchange cycle can range from second unit cycles when short to 5 minute cycles when long. Of course in an emergency situation, swift response system through immediate transmission is devised.

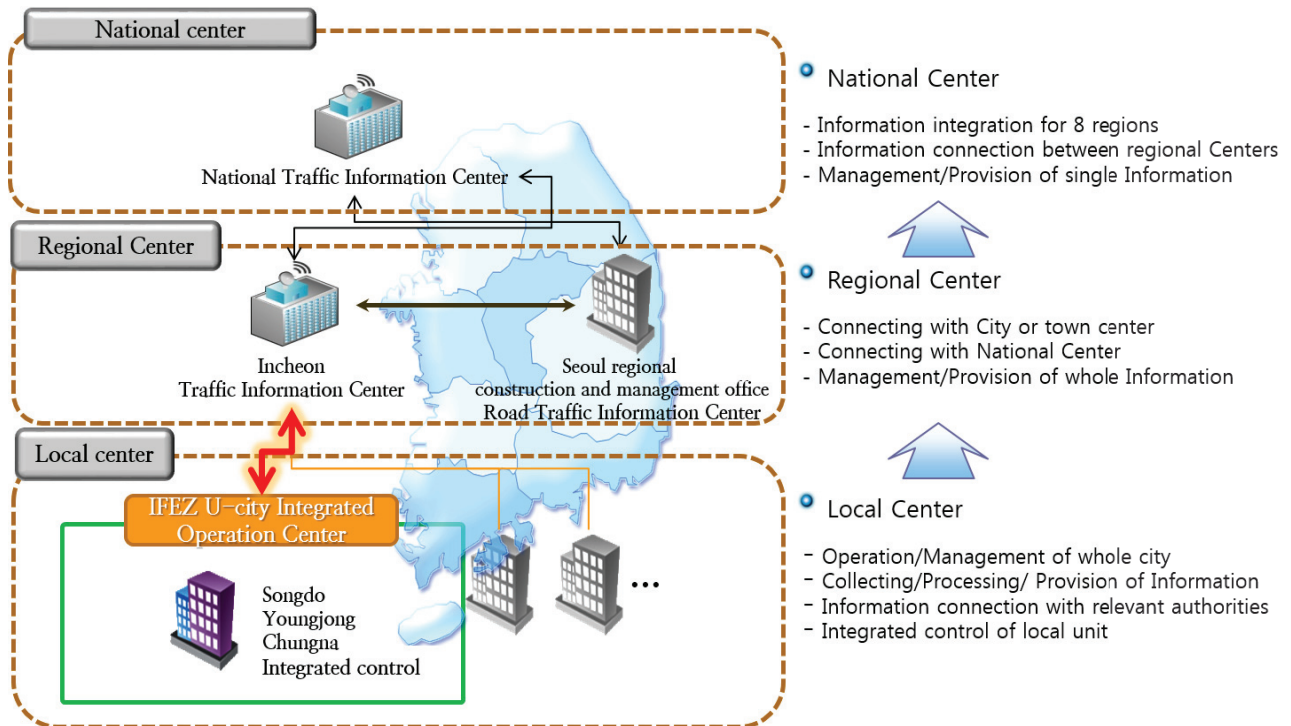


Figure 14 Hierarchy of centers of Korea

### 3.3. System architecture

#### 3.3.1. System layout

Songdo U-City system is a part of the IFEZ's integrated U-City system. The IFEZ's integrated U-City system connects and integrates the U-City systems of Songdo, Cheongna, Yeongjong/Midan, and control them as a single system. Therefore, the center system is composed of integrated platform, integrated management server, integrated web system, integrated operation storage and backup equipment. This not only reduces construction costs but also enhances control efficiency. Also, decision making is possible with only minimum working personnel, therefore significantly reducing maintenance and administration fees.

Songdo U-City system forms the U-City

integrated platform for U-services in traffic, crime prevention, disaster prevention, environment, facility management etc. Through this the system provides citizens with information and converged services.

The IFEZ integrated U-City system forms an integrated platform for integrated U-services and manages the integrated image system and integrated web system. The center infrastructure is composed of center system infrastructure, ICT infrastructure and base facility. Figure 15 is a layout of the center H/W of Songdo & IFEZ U-City system. The center system consists of integrated platform domain, integrated image processing domain, integrated web domain, and other servers etc. U-traffic, U-crime prevention, security and operation sectors are in charge of controlling the center system in real-time.

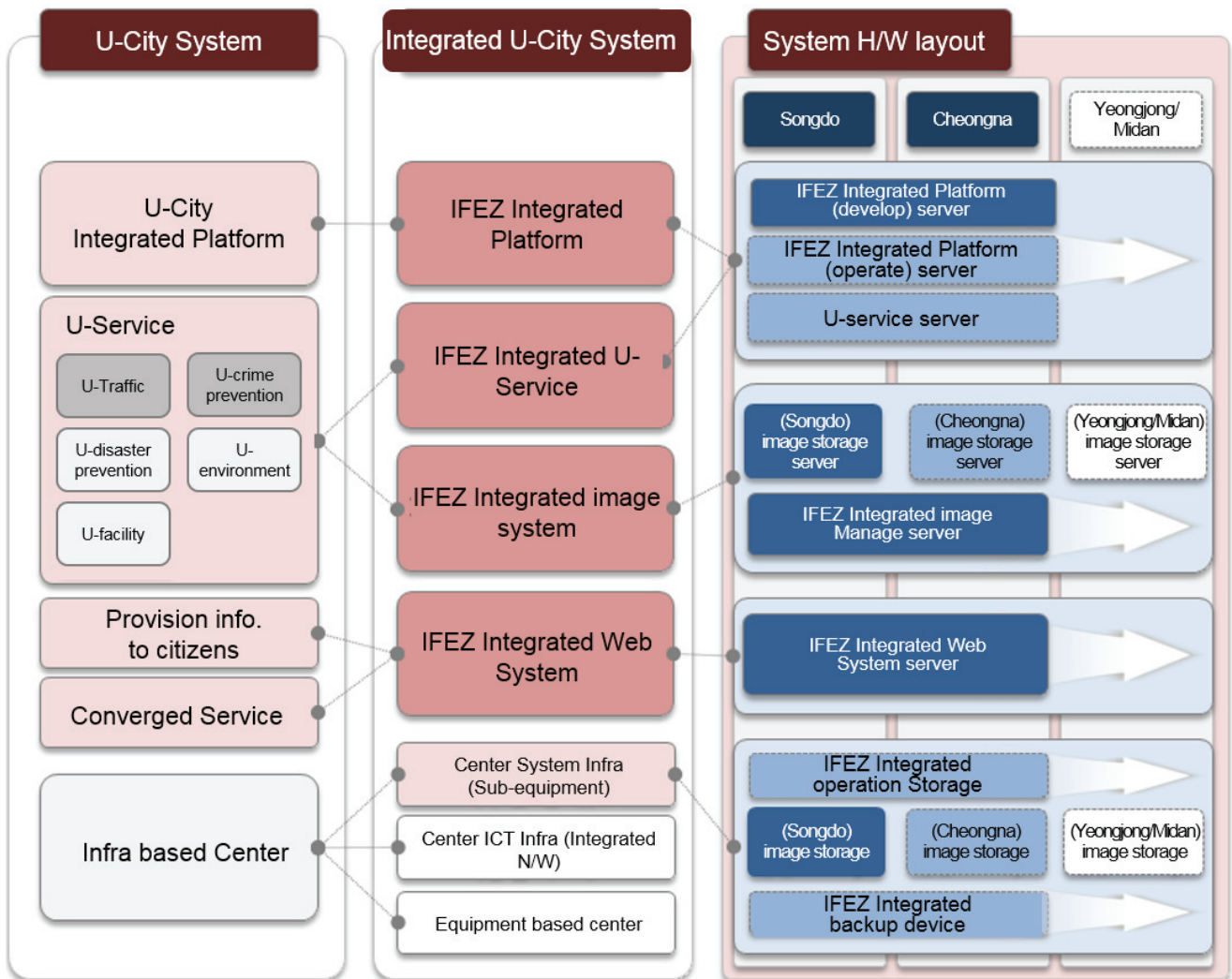


Figure 15 Songdo & IFEZ U-city system layout

### 3.3.2. Information flow

Real-time data is collected every minute by information collecting equipment installed on-site and condition detecting sensors that are attached to various facilities. Collected information is stored at the database through integrated platform. Also, the data is interconnected with information from public institutions such as the Incheon City Traffic Information Center, Institute of Health and Environment, Korea Meteorological Administration, Police Agency etc. Through this, the completeness of the information is enhanced. The manufactured information is provided to

public institutions & portal sites, and to private businesses such as advertising agencies, content offering enterprises etc.

Real-time information is manufactured according to various intelligent algorithms to provide various application services. During this process, real-time information is interconnected with results of big data analysis. Manufactured data is displayed on the operator's screen and provided to citizens through integrated controls.



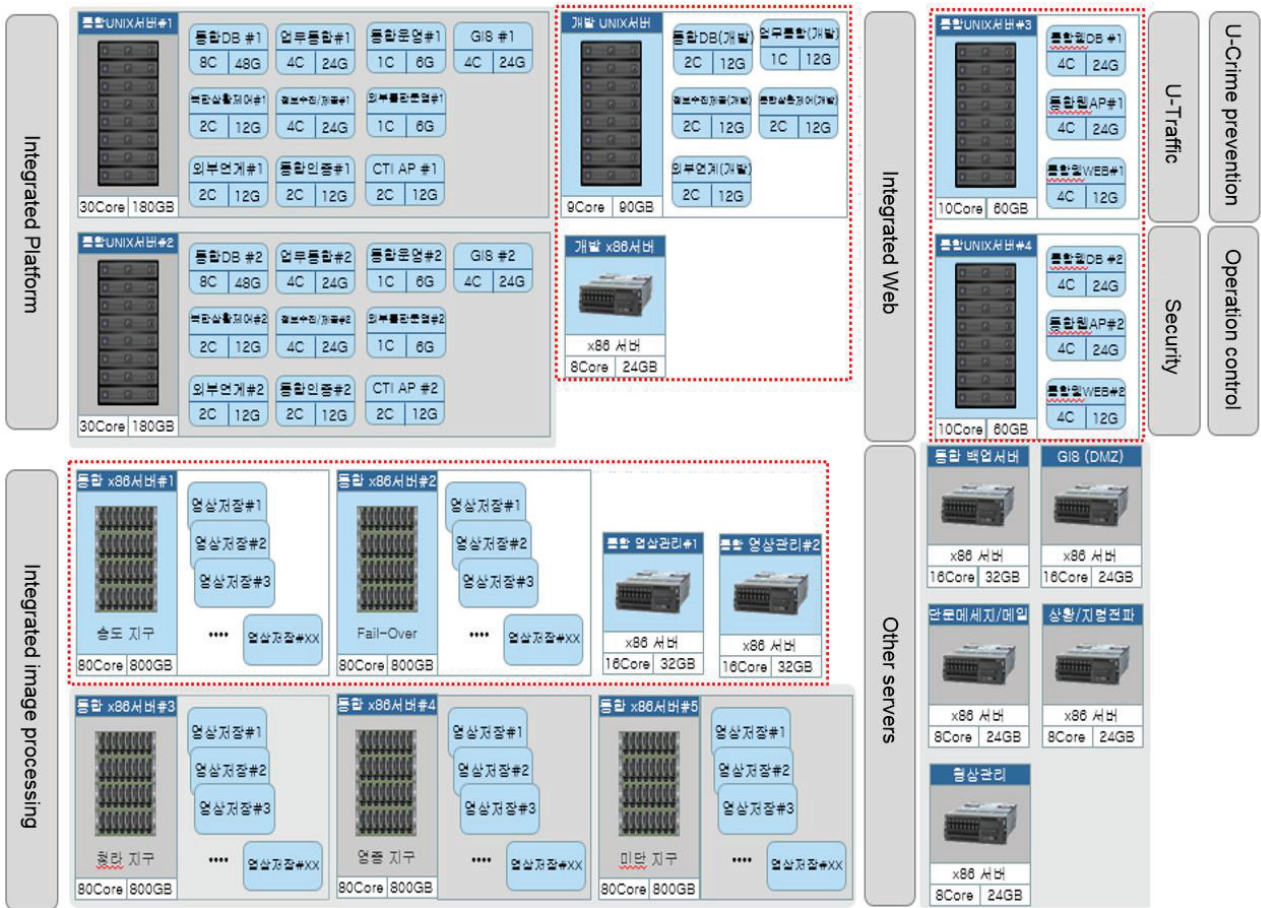


Figure 16 Songdo & IFEZ U-city system H/W layout

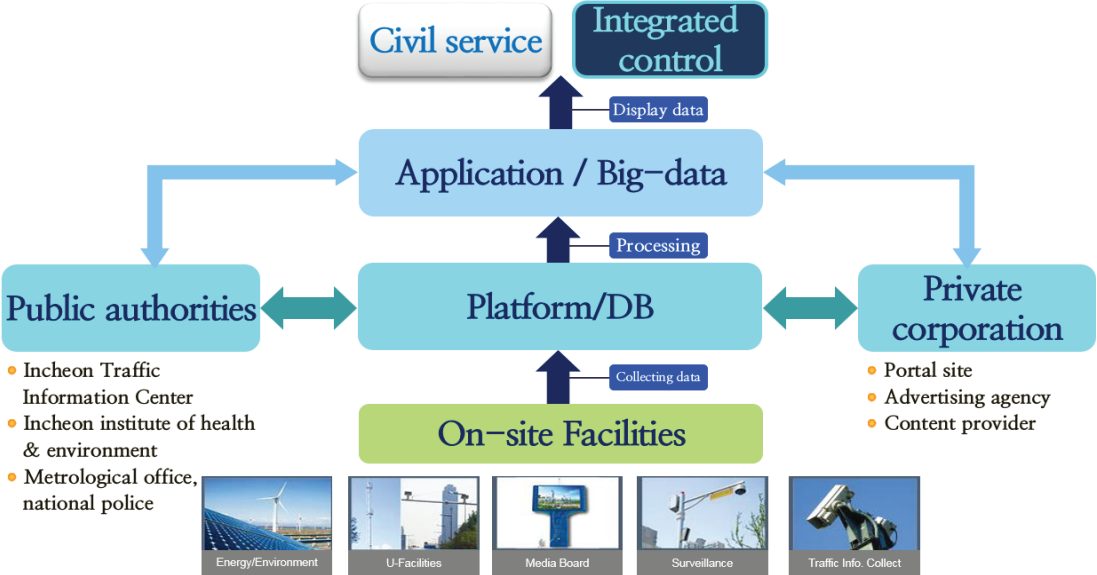


Figure 17 Information flow

### 3.4. Integrated Center System

As we have seen in the system layout, the Songdo U-City system is a part of the IFEZ's

integrated operation center. The IFEZ's integrated operation center connects and integrates the U-City systems of Songdo, Cheongna, Yeongjong/Midan, and control them in real-time.



Figure 18 View of IFEZ(Songdo U-city) Integrated operation center

The IFEZ integrated operation center is located on the 3rd and 4th floor of G-Tower at 175 Art center-daero, Yeonsu-gu, Incheon city. The center is composed of mainly integrated control room, observatory, equipment room and conference room, over a total area of 1,169.5m<sup>2</sup>. The center situation board consists of 85 cubes (5 rows and 17 columns) and a 250mm x

8,000mm size 3 colored LED electronic display is installed on top of the cubes to display emergency messages. The integrated control room has 22 operator seats and 24 seats for visitors to use to watch.

Main equipment & S/W that are built within the IFEZ U-City integrated operation center for Songdo U-City services are as follows.

Item Name	Function	Quantity
Integrated Development Server	· Integrated DB, Server for integrating operations and developing services	1
Integrated Web Service Server	· Server for integrated web services	2
Integrated Platform Development Server	· Server for developing integrated platform	1
Integrated Image Storage Server	· Server for storing/distributing camera images	5
Integrated Image Storage Fail-over Server	· Server to back up when integrated image storage fails-over	5
Integrated Image Management Server	· Manages cameras/ Manages image storage server	2
Integrated Image Saving Storage	· Storage for saving images	1
SAN Switch for Integrated Image Saving Storage	· Connect to image saving storage	2
Virtualization Solution	· Image saving server virtualization solution	1
DB Access Control S/W	· Real-time monitoring of DB access& DB information · Analysis of access trend	1
Internal Information Leak Prevention System	· Prevent internal information leakage through policies · Function for examining protocol	1
Big data Security System	· Analysis of real-time conversational packet · Network, application filtering	1
APT Response System	· Detect for malignant codes · Analyze infected host's traffic	1
CCTV SSL VPN	· Certify based on authentication certificate	1
CCTV Water Marking System	· Manage for carrying out personal image information outside	1
Network Integration System	· Send data based on policies, communications relay function	1
Web Shell Detection Solution	· Real-time detection of web shell within server	1

Table 2 Main Equipment & S/W of Songdo U-integrated operation center

At first the IFEZ planned to build and operate separate centers at Songdo, Yeongjong, and Cheongna. However, plans were changed to integrate the U-City center systems of the 3 districts into a single IFEZ U-City integrated operation center.

Integration process occurred by integrating data processing room, system integration through integration platform, and equipment integration through virtualization. By integrating the 3 systems into a single center, establishment costs were reduced to KRW 14.6 billion from KRW 20.6 billion.

### 3.5. Field system

Roads, parks and main structures of Songdo are installed with information collecting equipment such as CCTC, sensors, and information providing equipment such as VMS, media boards. Also, wire-wireless communication equipment are installed to connect the above equipment to the center. Figure 19 shows the location of U-City facilities that are being constructed at Songdo zone1~4. RFID tags are installed at on-

site facilities that require concentrated management to check and monitor conditions in real-time. RFID tags are installed at 338 traffic facilities, 117 crime prevention facilities, and 3 disaster prevention facilities

### 3.6. Communication system

Songdo is constructing a wire-wireless communication network to use as the integrated U-City network. When taking a look at current construction status, 71,085m of ABC-72C type fiber-optic cable, 67,865m of ABC-48C type fiber-optic cable, and 56,567m of ABC-4C type fiber-optic cable are installed. Also, 75,380m of DI 12/10 7way type micro duct, 25,300m of LSZH 12/10 7way type micro duct, and 10,598m of DB 12/10 2way type micro duct are installed. Transmission equipment is composed of 14 COT carrier Ethernet, 486 RT carrier Ethernet, 1 EMS carrier Ethernet and 2 optical fiber monitoring systems.



Figure 19 Songdo U-city Facility Overview



Figure 20 Fibre optic cable layout of Songdo U-city

Along with wire fiber optic cable network, wireless MESH network is densely established. Broadband based networks are installed at 284 sites. What's significant is that citizens can have free access to Wi-Fi by using the AP of

broadband based networks that are installed near major parks such as central park and bus stops. This makes managing facilities and providing services to citizens happen at the same time.

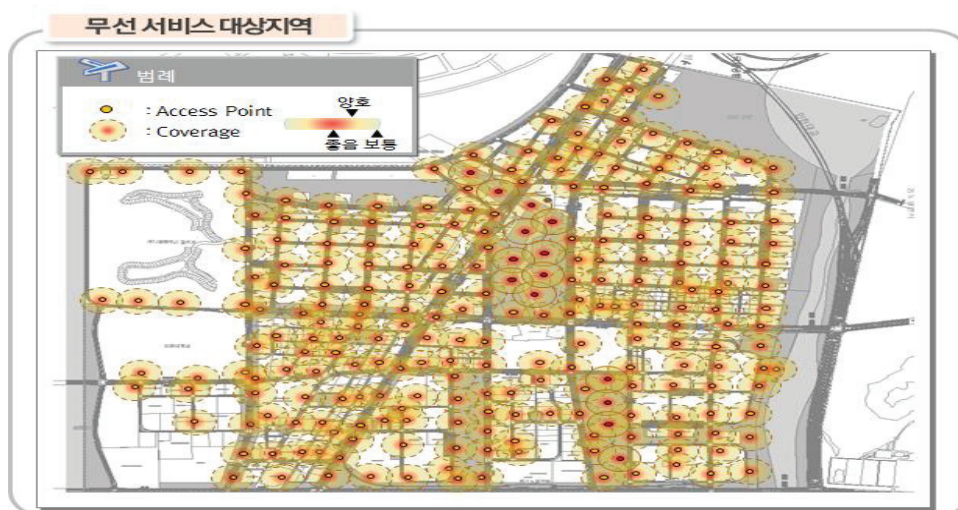


Figure 21 Areas of Songdo U-city subject to wireless service

### 3.7. Sub-systems and functions

#### 3.7.1. Transportation and urban mobility

Songdo U-Traffic system is in charge of providing customized traffic information, intelligent management of traffic flow, and active parking guidance. Main functions include, collecting and providing public transportation information, traffic information, controlling traffic signals depending on real-time traffic flow, managing unexpected situations, guiding illegally parked vehicles and providing parking information. To achieve this, on-site equipment is connected to the center system through the U-

City based network to collect and provide various information by controlling and monitoring equipment. On-site equipment is used to collect, control, and monitor the city; recognition cameras are used to detect illegally parked vehicles, CCTVs are used for monitoring emergencies, and traffic controllers are used for signal controlling. On-site equipment sends information on road traffic flow, intersection traffic flow, CCTV footage, real-time parking availability, to the center. These equipment work as two-way channel with the operation center, which sends information on signal control, facility control, automatic guidance information of illegally parked vehicles, to on-site equipment.

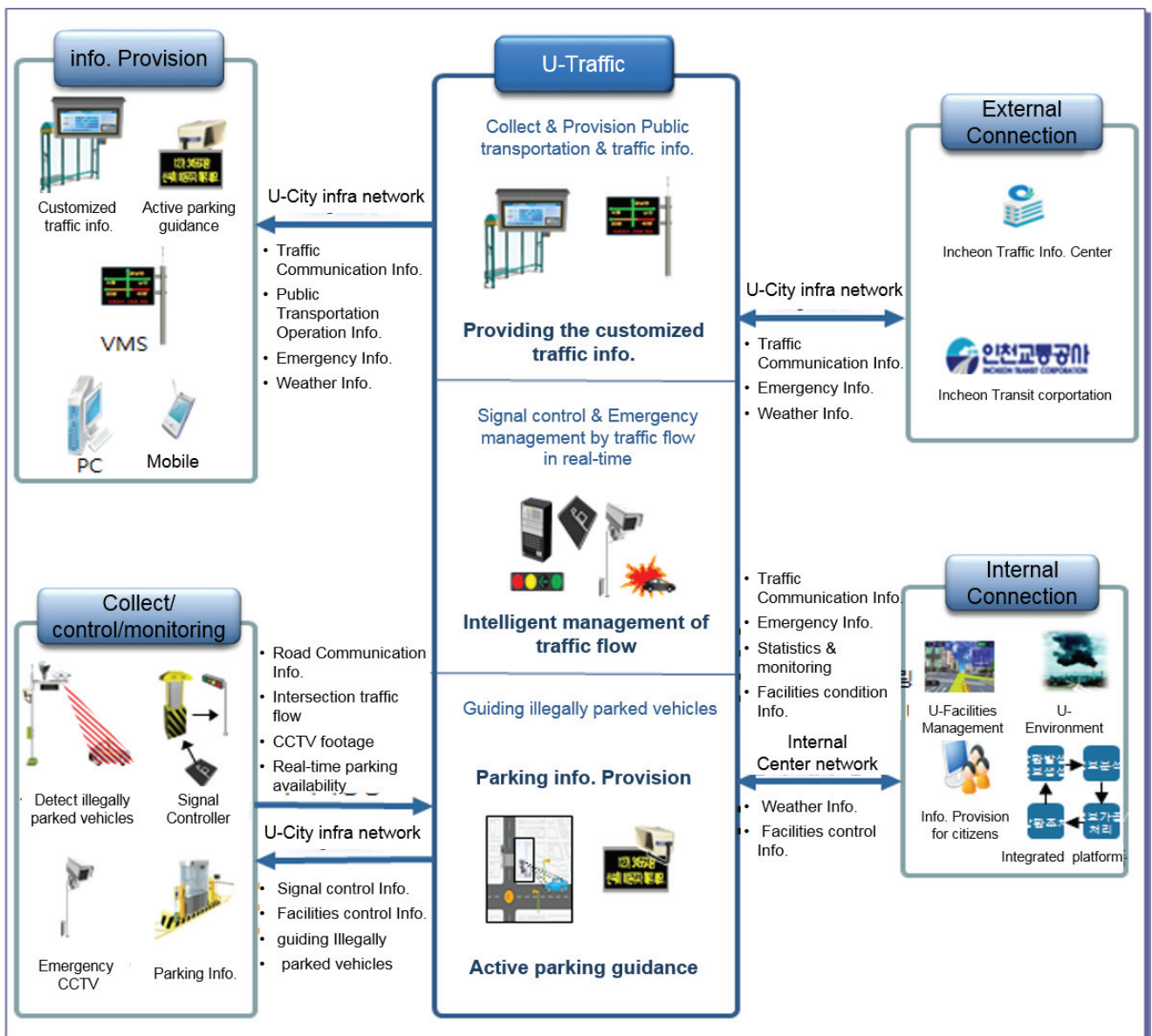


Figure 22 U-traffic system layout

On-site equipment used for providing information include, not only hard field-installed devices, but various customized VMS, mobile devices and online PC. Information regarding traffic flow, public transportation, emergencies, parking, and weather are sent from the center to the field equipment. Most of the information are exchanged by connecting to external organizations such as Incheon Traffic Information Center & Incheon Transit

Corporation.

U-Traffic field equipment can be divided into customized type and intelligent type. Customized equipment includes 61 Bus Information Terminals (BIT) and 5 Various Message Signs (VMS). Intelligent equipment includes 432 real-time traffic signal control devices, 10 video image detectors. 11 CCTVs used for monitoring emergencies.






Service	Item Name	Function	Quantity
Customized	BIT 	<ul style="list-style-type: none"> <li>• Provide bus arrival information</li> <li>• Information guide service</li> </ul>	61
	VMS 	<ul style="list-style-type: none"> <li>• Provide communicative information</li> <li>• Provide emergency information</li> </ul>	5
Intelligent	Real time Signal Control 	<ul style="list-style-type: none"> <li>• Remote control traffic signals &amp; manual control</li> <li>• Collect information on traffic amount</li> </ul>	432
	Video Image Detector 	<ul style="list-style-type: none"> <li>• Collect traffic information</li> <li>• Collect video image of vehicles</li> </ul>	10
	Emergency CCTV 	<ul style="list-style-type: none"> <li>• Collect traffic information</li> <li>• Send footage of emergencies</li> </ul>	11

Table 3 List of U-traffic equipment

### 3.7.2. Safety and citizen security

Songdo U-Crime Prevention System is responsible for city safety and prevention of crime using vehicles. Main functions include collecting video image information, storage & management of monitoring footage, responding to emergency calls, active monitoring, and monitoring troubled vehicles etc. For such system, on-site equipment is connected to the center system by the U-City infrastructure network. On-site video image related equipment include, CCTV, warning lights, emergency alarms, speakers, fixed type cameras, sound detectors etc. If an event occurs, on-site equipment sends to the center image information, emergency alarm information, voice information of alarm

user, equipment condition information. The center on the other hand sends to on-site equipment, warning announcements, vocal center order information, and equipment control information. The center then finds the location of the problem.

Based on the information collected from cameras and sound detectors, video images and on-site sounds are analyzed according to patterns. Vehicle crime prevention facilities are installed with vehicle number recognition cameras and infrared light projectors. This equipment sent vehicle footage information, vehicle license number information, and equipment condition information to the center. The received information is then analyzed and sorted to monitor problematic vehicles. Incheon

city and Yeonsu-gu office shares safe living video images, vehicle number recognition information, and the license numbers of problematic vehicles. Information regarding on-site equipment, pictures of passing vehicles, event related

information, CCTV images are shared in real-time through integrated platforms and internal center networks. If problems arise, location information is spread and images are shared for swift action.

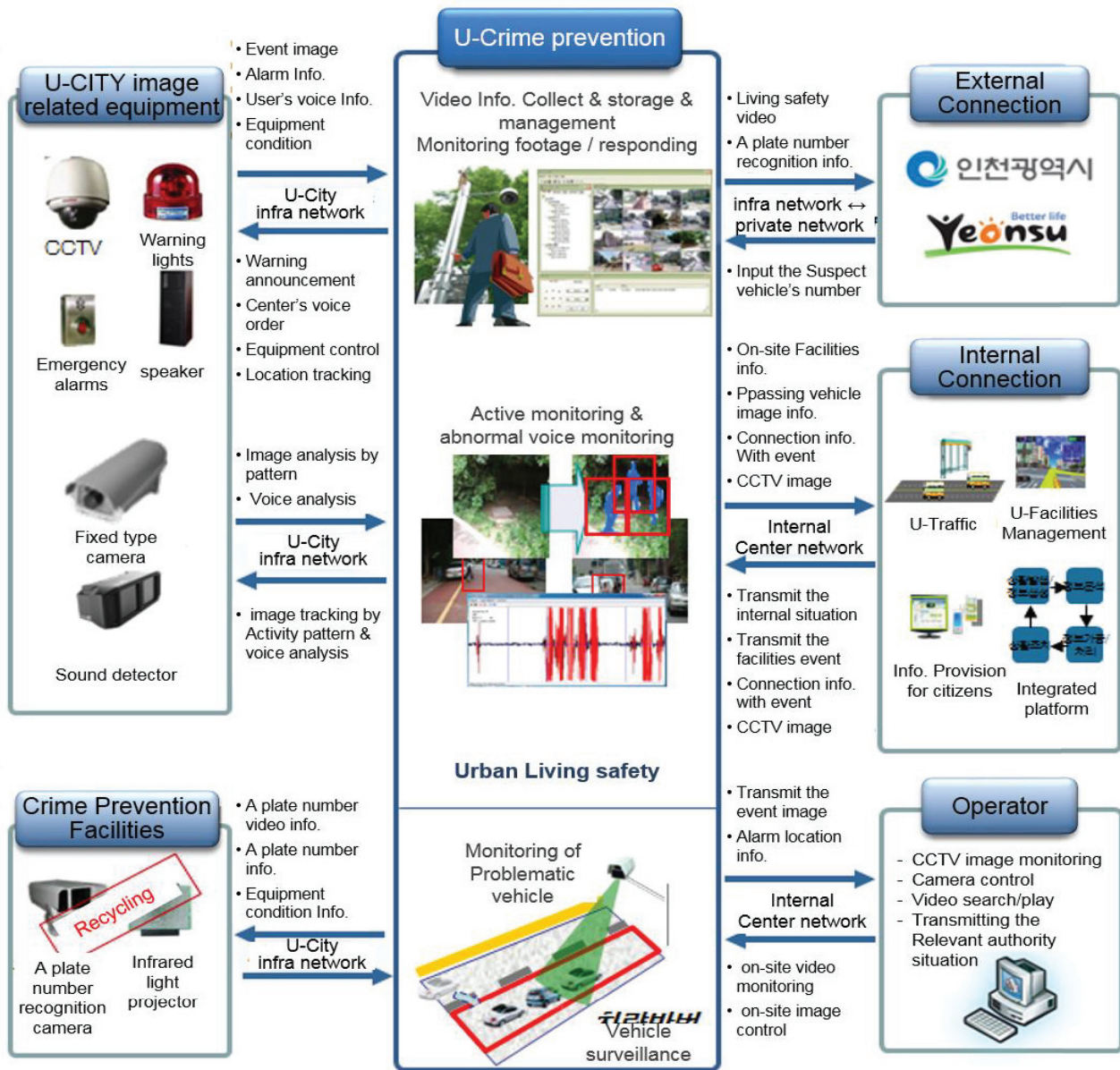


Figure 23 U-city safety(crime prevention) system layout

The types and installment methods of U-Crime prevention equipment differ depending on the characteristics of the area. Speed dome cameras, park type cameras, speakers, AMP, emergency bells, warning lights, and switches are installed on 15M poles for equipment installed at 18 park sites. Speed dome cameras, fixed type cameras, speakers, AMP, emergency bells, warning lights, switches, and abnormal sound detecting microphones are installed on 6M poles for

equipment installed at 19 school areas and 16 shopping areas. Speed dome cameras, speakers, AMP, warning lights, abnormal sound detecting microphones, and switches are installed on 6M poles for equipment installed at 25 road sites and 8 housing areas. Center services are installed with data exporting servers, active video image monitoring server, image improvement servers and operator terminals to process on-site collection equipment.

Area	Contents	Quantity
Park Area	<ul style="list-style-type: none"> <li>•15M Pole</li> <li>•Speed dome camera</li> <li>•Park type camera</li> <li>•Speaker, AMP, emergency alarm</li> <li>•Warning light, Switch</li> </ul>	18
School Area	<ul style="list-style-type: none"> <li>•6M Pole</li> <li>•Speed dome camera</li> <li>•Fixed type camera</li> <li>•Speaker, AMP, emergency alarm</li> <li>•Warning light, Switch</li> <li>•Abnormal sound detecting microphones(9 sites)</li> </ul>	19
Shopping Area	<ul style="list-style-type: none"> <li>•Speaker, AMP, emergency alarm</li> <li>•Warning light, Switch</li> <li>•Abnormal sound detecting microphones(9 sites)</li> </ul>	16
Roads	<ul style="list-style-type: none"> <li>•6M Pole</li> <li>•Speed dome camera</li> <li>•Speaker, AMP</li> <li>•Warning light, Switch</li> <li>•abnormal sound detecting microphones(4sites)</li> </ul>	25
Housing area	<ul style="list-style-type: none"> <li>•Warning light, Switch</li> <li>•abnormal sound detecting microphones(4sites)</li> </ul>	8
Center Composition	<ul style="list-style-type: none"> <li>•Data exporting server</li> <li>•Active video image monitoring server</li> <li>•Image improvement server</li> <li>•Operator terminals</li> </ul>	Based on center virtualization

Table 4 U-city safety(crime prevention) equipment list

### 3.7.3. Emergency and response

Songdo U-disaster prevention system is in charge of spreading information when disaster occurs, monitoring for land subsidence, flooding, and corresponding to fires etc. Main functions include civil defense, spreading situation information to the National Disaster Management System, monitor weak lands for subsidence/flooding, monitor using CCTVs with high magnification during fires, and corresponding to fires. Because Songdo is built upon reclaimed land, monitoring for land subsidence and flooding is important. On-site equipment are connected to the center system through the U-City infrastructure network to control, monitor equipment and collect information.

Crime prevention cameras are used to correspond to fires by collecting and intelligently analyzing collected information in real-time. CCTVs installed on-site are used to monitor land subsidence and flooding by checking for important levels and using sensors to measure and record on-site levels. Administration networks, internet networks, and hot-lines are connected to external organizations such as Incheon fire department,

Incheon 119, LNG production site of Korea Gas Corporation. On-site video footage, hot-line voice records, disaster situation information are shared with these organizations and civil defense, disaster warnings, NDMS situations are swiftly spread to these organizations in case of emergencies. The center operator monitors fire footage, send the situation to related organizations and provide information and guidance to citizens.

Equipment that are exclusively used for U-disaster prevention are satellite dishes, subsidence and flooding sensors, water level monitoring cameras, as well as fire corresponding cameras. The satellite dish is 1.2M and receives IF signals. This is then divided into audio and data. 3 subsidence and flooding sensors are installed to examine the level and movements of grounds and measure the level of land subsidence, the safety of the ground depending on the level of water pressure etc. 3 water level monitoring cameras are installed with functions in counter light correction, Day and Night, waving image correction, OSD etc. 2 fire corresponding cameras are installed, the cameras are high magnification EM CCD cameras that can provide clear images even with little light.



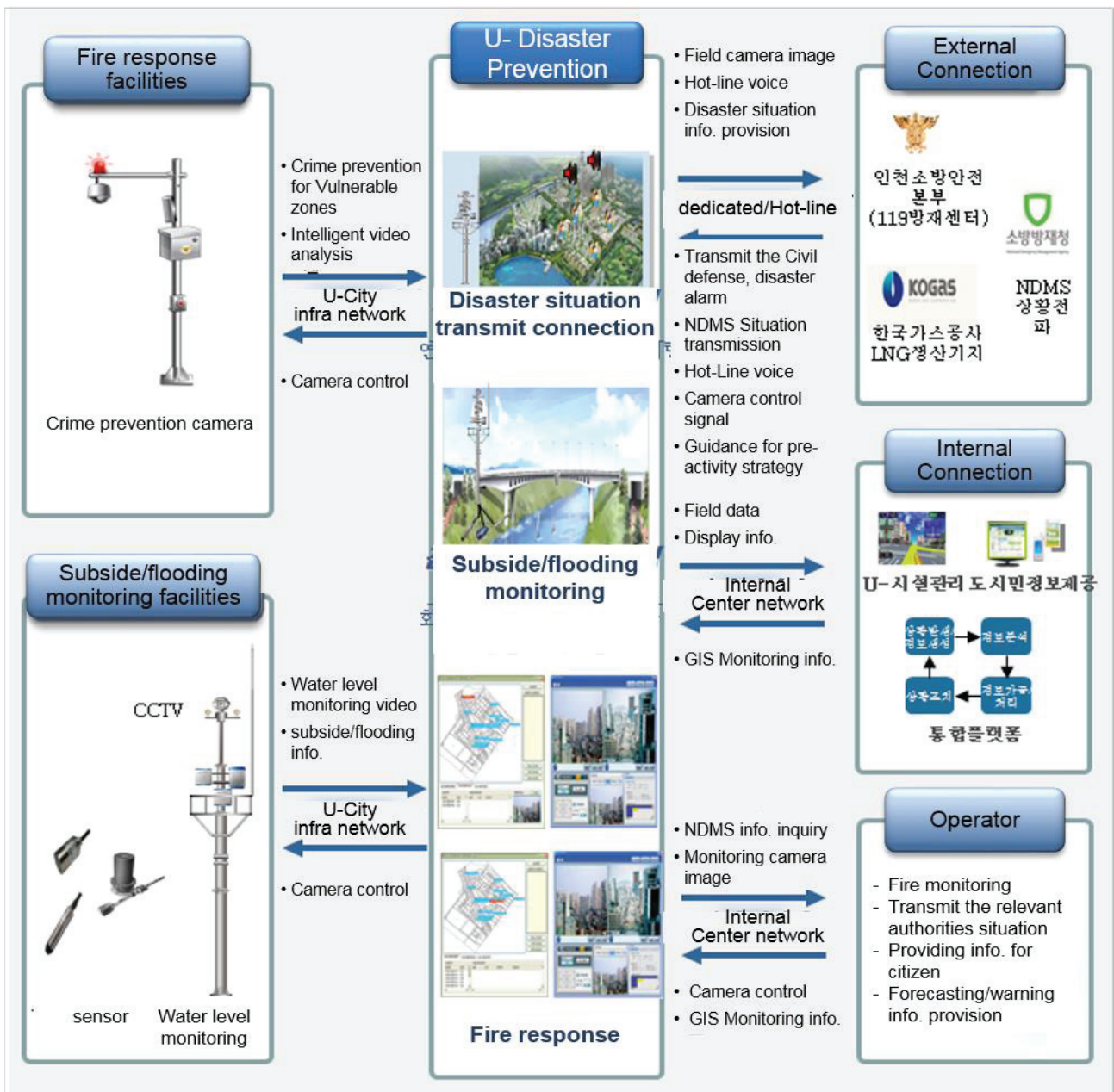


Figure 24 U-Disaster prevention system layout





Equipment Name	Function	Quantity
 Satellite Dish	<ul style="list-style-type: none"> <li>Dish size : 1.2M</li> <li>Receives IF signals and divided into audio and data</li> </ul>	1
 Subsidence/ Flood Sensor	<ul style="list-style-type: none"> <li>Detect subsidence by monitoring movement of land levels</li> <li>Detect ground safety according to water pressure levels with in grounds</li> <li>Detect changes in ground levels</li> </ul>	3
 Water level Monitoring Camera	<ul style="list-style-type: none"> <li>Correct counter light, Day &amp; Night, correct waving images, realize OSD function</li> </ul>	3
 Fire Corresponding Camera	<ul style="list-style-type: none"> <li>High magnification EM CCD camera</li> <li>Provide clear image with only little light</li> </ul>	2

Table 5 U-Disaster prevention equipment list

### 3.7.4. Environment

Songdo U-Environment system is in charge of providing real-time environment information and road weather information. Main functions include collecting and providing real-time information on environment, road visibility, weather, and road condition. On-site sensor equipment is connected to the center system through the U-City infrastructure network to control, monitor equipment and collect and provide information. To collect weather information, wind velocity sensors, temperature

and humidity sensors, insolation amount measuring sensors, UV ray sensors, sunshine sensors, rainfall sensors, air pressure sensors, yellow dust measurement sensors, road surface sensors, visibility sensors, visibility cameras are each installed on-site in 3 quantities. Information collected from this equipment include real-time visibility, video image of visibility, sunshine amount, wind direction and velocity, yellow dust amount, temperature and humidity, UV ray amount, air pressure, rainfall amount etc. Real-time information is collected and sent to the center.

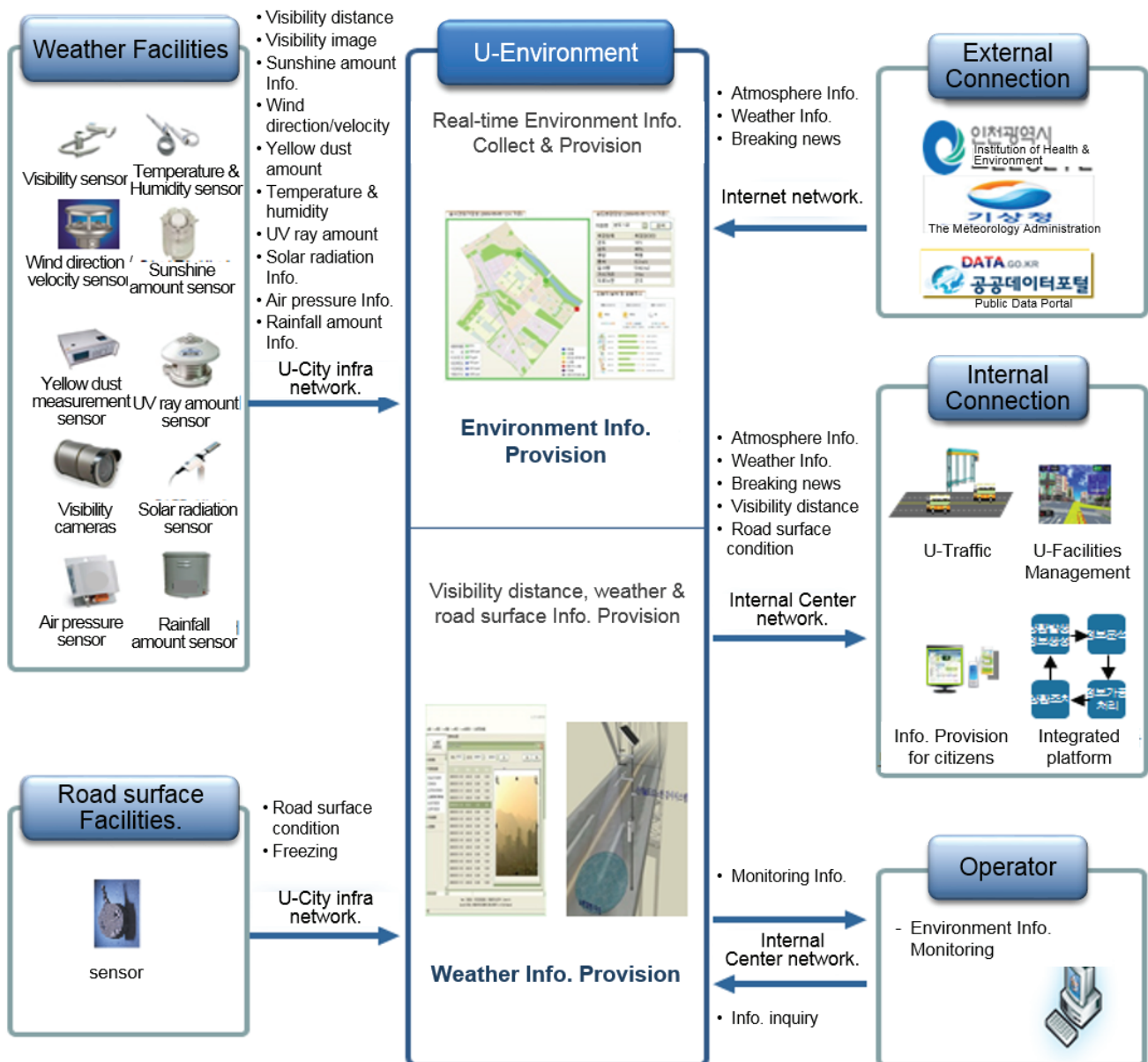


Figure 25 Block diagram of U-environment system

Equipment Name	Function	Quantity
Wind Velocity Sensor	•Measure 15 samplings per second of wind direction/wind velocity using ultrasonic waves	3
Temperature/Humidity Sensor	•Measure temperature & humidity in wide scope	3
Insolation Amount Measuring Sensor	•Measure precise insolation amount through high sensitivity	3
UV Ray Sensor	•Measure UV A, B, C in wide scope	3
Sunshine Sensor	•Measure exact amount of sunshine by using rotating measuring method	3
Rainfall Sensor	•Predict winter snowfall amount by using internally installed heater	3
Air Pressure Sensor	•Measure exact air pressure by using capacitance method	3
Yellow Dust Measurement Sensor	•Measure yellow dust (PM10) using Beta-ray	3
Road Surface Sensor	•Measure water thickness by using contact method radar	3
Visibility Sensor	•Observe exact visibility and fog my measuring size and velocity of particles	3
Visibility Camera	•Film if visibility falls below a certain level	3

Table 6 U-environment equipment list

### 3.7.5. Citizen interaction

Songdo U-City provides citizens with useful daily living information through special purpose terminals made especially for IFEZ. The duplex media board not only provides citizens with information on traffic, weather, disaster, and living in real-time, but also allows for citizens to search for the information that they need.

The information provided is prepared by collecting real-time data on traffic, environment, disaster prevention, and facility management through the integrated platform. The collected data is then analyzed and manufactured at the U-Integrated Operation Center and provided to citizens through media broadcast and control servers. Songdo U-City is installing 6 duplex media boards at 6 main subway stations within the Songdo district.

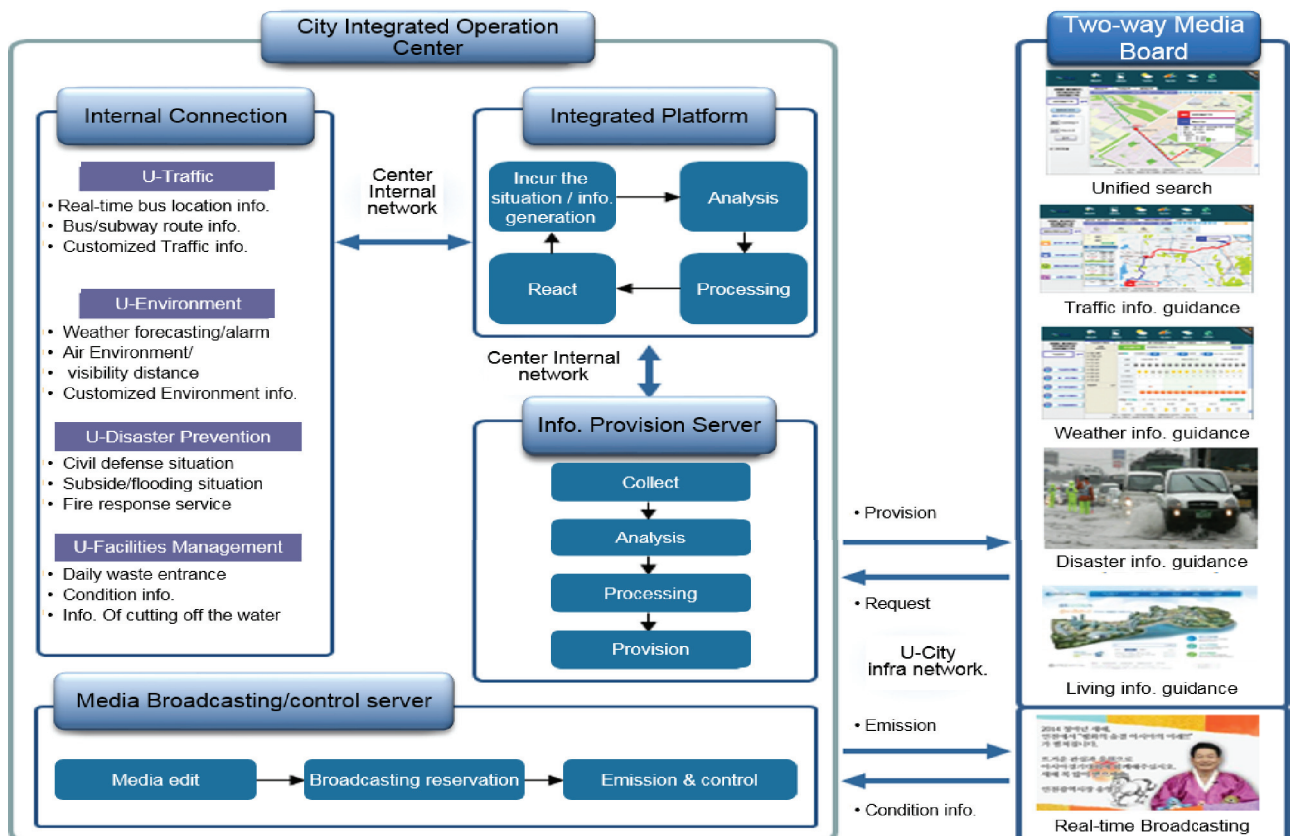


Figure 26 System of IFEZ's Special purpose terminals

Item Name	Function	Quantity
Duplex Media Board	<ul style="list-style-type: none"> <li>• Provide weather information, air quality index</li> <li>• Alarm incase of disaster &amp; provide guidance</li> <li>• Administration PR &amp; provide information on IFEZ</li> <li>• Provide traffic, living information &amp; news etc.</li> </ul>	6

Table 7 Details of IFEZ's special purpose terminals

### 3.7.6. Integrated Facility Management

The conditions of various facilities of Songdo U-City are managed in real-time. Main functions of U-facility management include integrated monitor control, data management, real-time field support, integrated management of common duct etc. Taking a closer look, duties include real-time and remote reset of facilities, management of 2D spatial data, facility location guides using RFID, maintenance support of on-site equipment including history management, and monitoring and situation notice of common duct.

U-City facilities are traffic facilities, crime prevention facilities, disaster prevention facilities, environment facilities, media boards and communication facilities that connect these facilities to the center. Information on the conditions of these facilities is sent to the center and when there is a problem, the centers order remote reset information to the facilities on-site. Urban infrastructure facilities include common duct, and street lamps. Video image information and condition information are sent to the center. Facility management information is shared with Incheon City Facilities Management Corporation and Common Duct Management Offices. Information on monitoring for fires, information on CCTV intruders are shared and actions are taken.

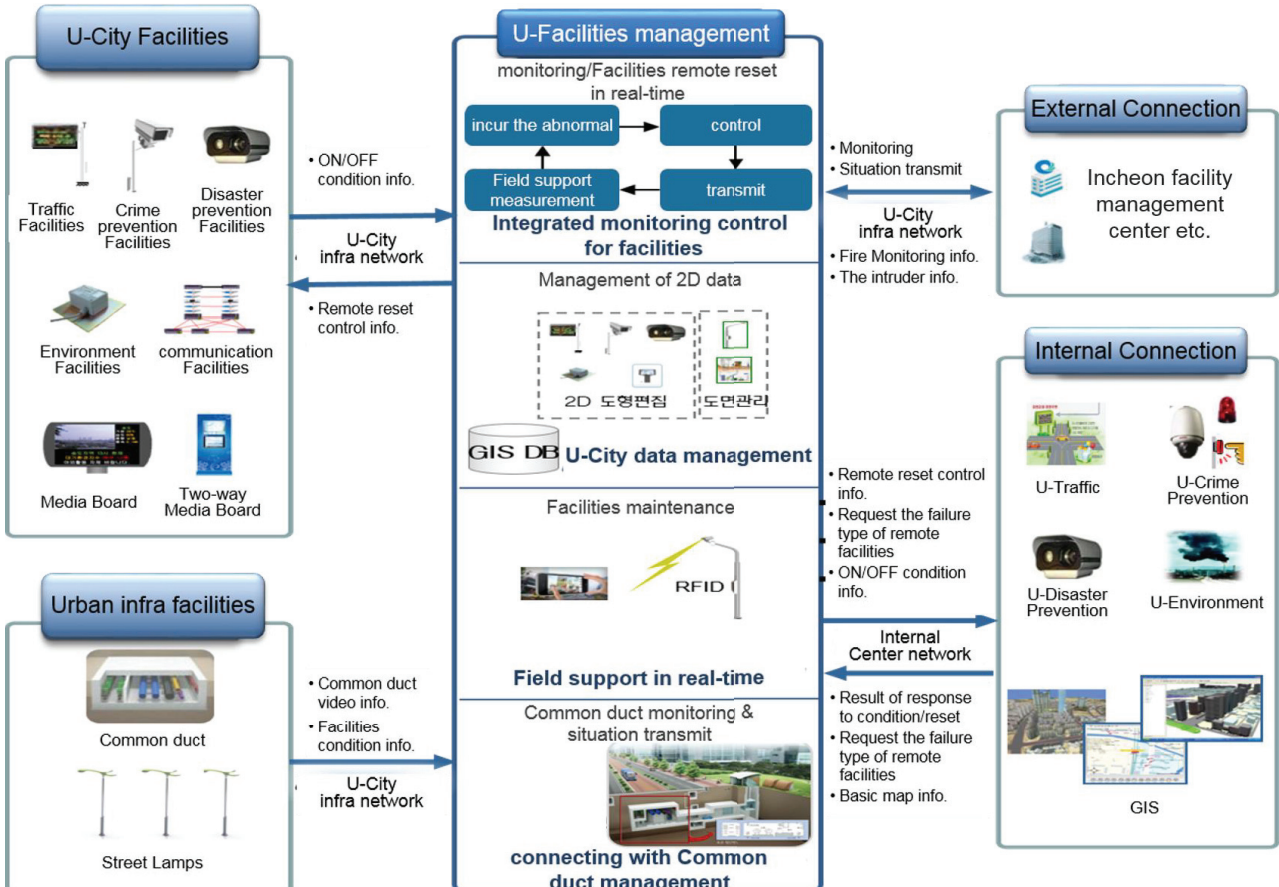


Figure 27 Block Diagram of U-facility management system

## 4. Organizational Structure

### 4.1. Governance Model

As mentioned previously, Songdo plans to establish a U-City at zone1~4, by investing KRW 164.7 billion by 2016. Construction is currently led by Incheon U-City Corporation. Incheon Metropolitan City & the IFE are in charge of making plans and decisions regarding the U-City, whereas related technology, construction, and operation are outsourced to Incheon U-City Corporation.

Incheon U-City Corporation was jointly established with Incheon city, and two private firms; KT, and CICSO, in May 2012, with capital

amount of KRW 3.5 billion. Incheon U-City Corporation is established with a goal to carry out a stable, efficient, and sustainable U-City project, to ease financial burdens by raising U-City operation costs, to enhance the convenience of citizens by creating private-public synergy. Incheon U-City Corporation is a private-public cooperative corporation that is established exclusively for U-City. Shareholders are composed of Incheon Metropolitan City, Incheon IT Corporation & Association. Incheon Metropolitan City has 28.6% of shares whereas the rest is divided among Incheon IT Corporation & private corporations.

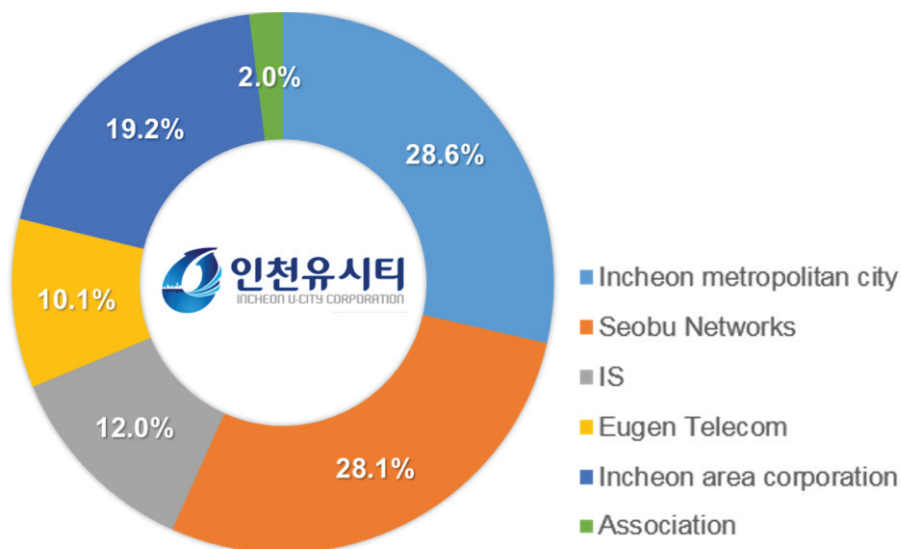


Figure 28 Shareholders of Incheon U-city Corporation

Main duties of the Incheon U-City Corporation include establishing U-City within the IFEZ, carrying out maintenance projects, designing ICT of private city development projects, operating by establishing & managing broad area facilities, developing & providing private U-service, and developing overseas U-City etc.

Incheon U-City Corporation provides stable U-services with competitiveness, by fully utilizing the vast amount of information asset acquired from the public sector and combining this with the expertise and capital of the private sector. U-

City service models are continuously developed and established through efficient integration between public and private sectors. Base on this experience, developed city models are exported overseas.

Currently, the consortium of Incheon U-City Corporation and IFEZ is working on examining the validity of establishing a U-City in Columbia. This project was initiated by the IDB to support the well balanced development of rapidly expanding mid-small sized cities of Center and South America, and to minimize the problems of

these cities. Two cities under the project are Valledupar and Villavicencio. Main contents of the project include, analyzing city problems and the Information Communication Technology (ICT) infrastructure status of the 2 new cities, analyzing U-City establishment cases of Korea, comparing the cases of Korea to the two cities of Columbia, suggesting technological solutions in building an IOCC, and training Columbia government officials to strengthen their abilities.

## 4.2. Human Resource

Incheon U-City Corporation consists of 3 departments and 5 teams. 25 permanent employees and 33 contract workers work at the company as of October 2014. Table 8 shows the main duties of Incheon U-City Corporation's management support department, business sales department, and operations department.

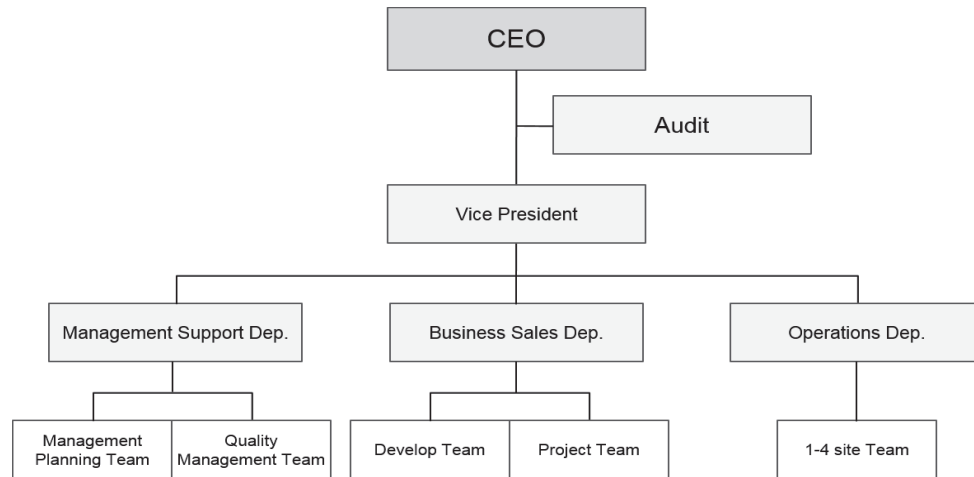


Figure 29 Organization structure of Incheon U-city corporation

Management Support Department	Business Sales Department	Operations Department
<ul style="list-style-type: none"> <li>· Business plan, organization, management assessment duties</li> <li>· Finance Duties(Manage budget, risk)</li> <li>· Manage general affairs</li> <li>· Manage investment related duties</li> <li>· Manage purchase &amp; contract duties</li> </ul>	<ul style="list-style-type: none"> <li>· Develop domestic &amp; international projects</li> <li>· Sales of public &amp; private projects</li> <li>· Find partners &amp; acquire investments</li> <li>· Find business models</li> <li>· Manage duties regarding external organizations</li> </ul>	<ul style="list-style-type: none"> <li>· Establish and operated U-City</li> <li>· U-City related technology consulting</li> <li>· Manage/direct projects</li> </ul>

Table 8 Duties of each department

## 4.3. Information control, ownership and sharing

Songdo U-City is still currently under construction. When the on-site facilities and center system are established by the end of 2016, the entire city will be connected by a single communication network. Administration, traffic, crime prevention, disaster prevention, environment, and facility management services will be mutually integrated to share information.

The future plan of Songdo U-City and IFEZ is to unify control of Songdo, Cheongna, Yeongjong at a single location on an integrated platform.

Various information collected from on-site equipment will be shared among each services. Moreover, integrated networks for external purpose, internet networks, and hot-lines will be connected to organizations such as Incheon Metropolitan City, Incheon Traffic Information Center, Incheon Transit Corporation, Incheon Institute of Health and Environment, LNG production site of Korea Gas Corporation, National Emergency Management Agency, and Korea Meteorological Administration, in order to share real-time information and to take swift action if problems arise.

## 4.4. Protocols and procedures

## of decision making between agencies

In terms of administrative system, Songdo International city belongs to Yeonsu-gu of Incheon Metropolitan City. However, since the IFEZ is a special city that is developed in accordance with the law regarding 'Designation & Operation of Free Economic Area', the city is guaranteed of its independence. For this reason, Songdo U-City will have an independent operation system that is different from other centers of Korea. The average centers of Korea are vertically connected to upper level centers, whereas, Songdo U-City integrated operation

center is expected to have much independence in operations and decision making. This will make the daily lives of citizen's more convenient and simplify decision making procedures when problems arise thus making swift actions possible.

## 5. Lessons Learned

Songdo U-City will finish establishment and development by January 2016 and go through unit and overall tests for 4 months. After all tests are finished, services will be carried out in November 2016.

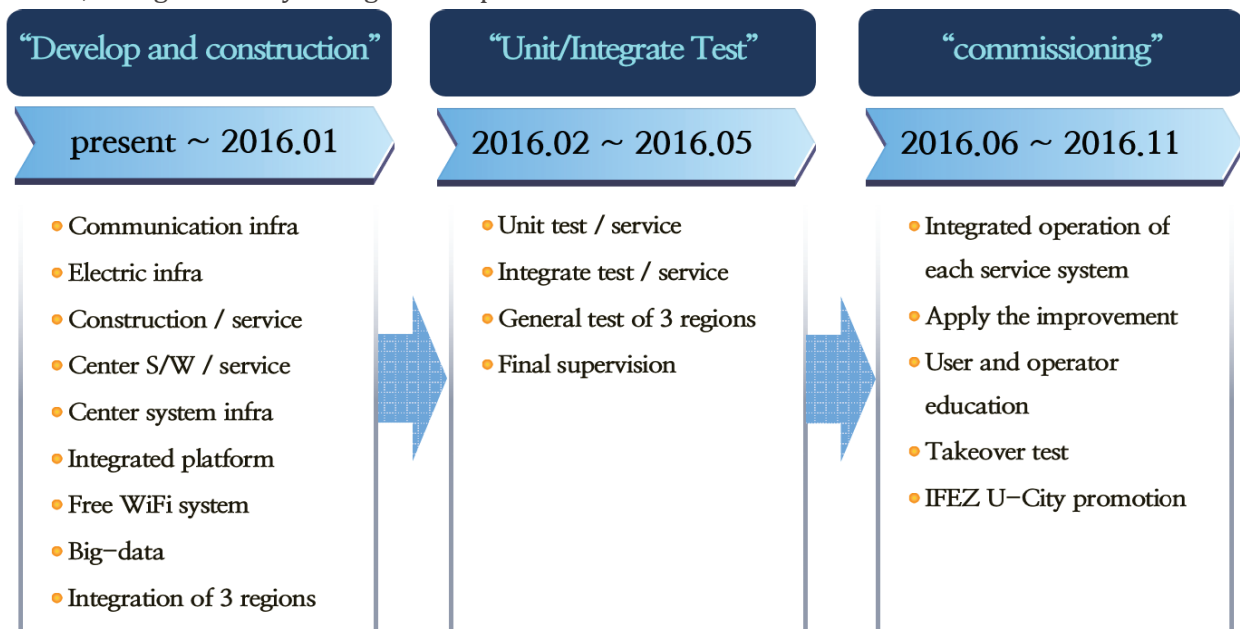


Figure 30 Schedule for establishing Songdo U-city

As seen from above, Songdo U-City is carried out according to detailed preparing, plans and construction procedures. However, several designs need to be altered before services are to be implemented. The changes that are necessary are as follows. Existing illegal parking detecting cameras only function for that single purpose. However, these cameras need to be changed to function as crime prevention cameras during the night time. In addition, environment sensors and measurement equipment are checked before installation to make sure locations do not overlap with those of Korea Meteorological

Administration, and Institute of Health and Environment.

Some problems as such tend to arise due to the differences in requested and required levels at the planning stage of the project and the establishing stage of the project. Technologies are rapidly developed and citizen's request levels and standards also are increasing. Also, the plans of related organizations and on-site equipment need to be clearly identified to make sure that no budgets is wasted due to duplicate installations.

## 6. Conclusion

The U-city project of Songdo that followed the construction of Incheon International Airport, was planned and developed as a smart city from the first step. Songdo wishes to promote its symbolic reputation as global business city, and currently, it is towards the end stage of smart city construction (began in 2008, aims for completion by the 2017). The city will continue to strive to become an iconic smart international city by establishing unique smart services such as RFID/USN, U-bike, U-street, and smart CCTV.

Special attention should be drawn to the establishment of Incheon U-city Corporation. Incheon U-city Corporation holds private-public partnership (PPP) formation, where the city of Incheon holds 28.6% of the share and the rest are held by private firms. The ultimate purpose

of such PPP was to create stable and efficient smart city construction, securing funding for system operation and management, forming an effective business model, and maximizing benefits for citizens. Incheon U-city Corporation is currently handling general system construction, maintenance business, as well as international consulting business for countries that wishes to create smart cities. It is important to emphasize that the success factor of Songdo had perhaps been this attempts to maximize public-private partnership. For sustainable development of the smart city projects, not only public initiatives are important, but it should be developed along with private companies and their business ideas, engaging with other parts of the society.



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