Inter-American Development Bank

International Case Studies of Smart Cities

Anyang, Republic of Korea

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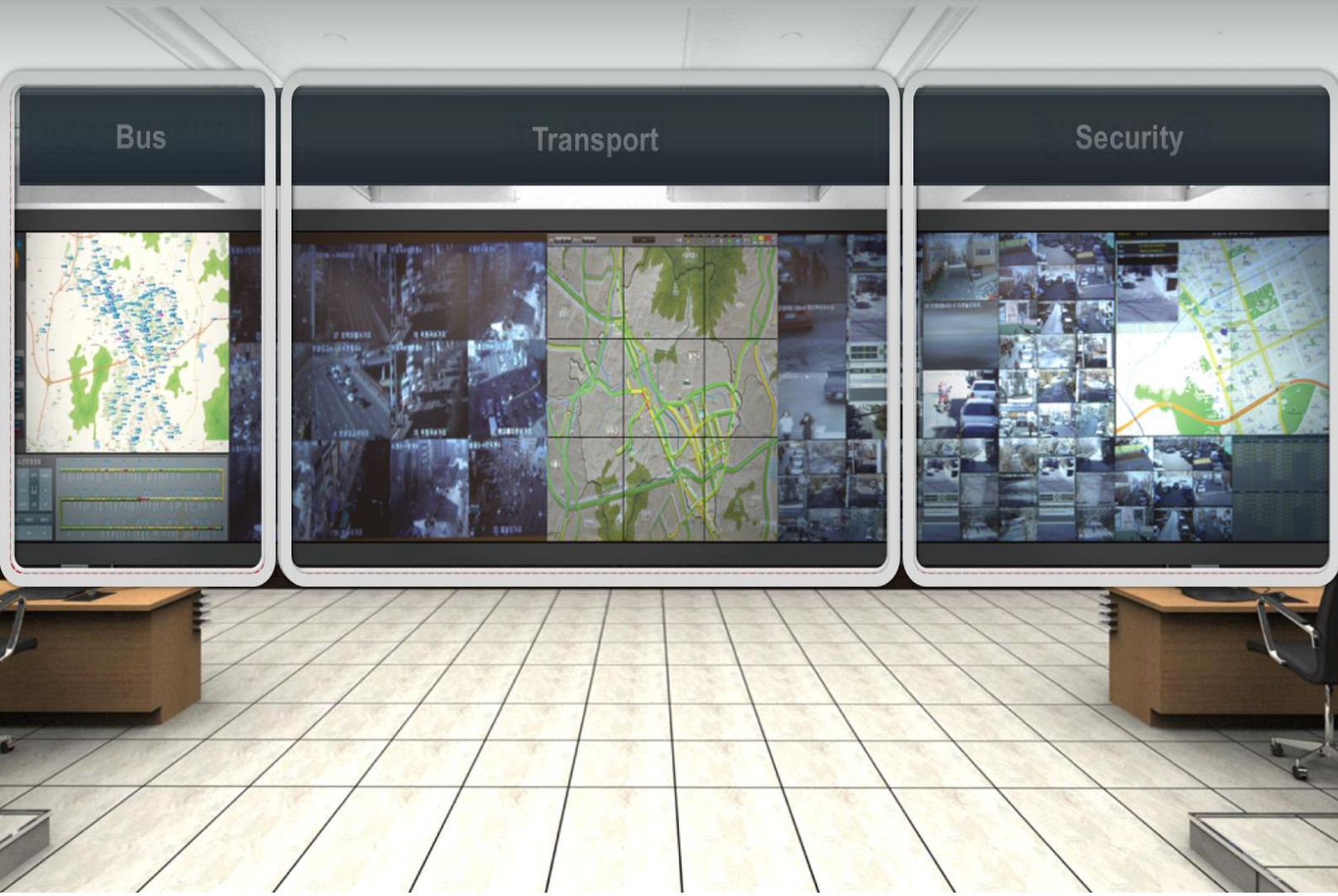

International Case Studies of Smart Cities

ANYANG
REPUBLIC OF KOREA

IDB-KRIHS Joint Research

IDB

THE REPUBLIC OF KOREA

KRIHS Korea Research Institute for Human Settlements

GDPC Global Development Partnership Center

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, Pangyo, 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.

Anyang, a 600,000 population city near Seoul is developing international recognition on its smart city project that has been implemented incrementally since 2003. This initiative began with the Bus Information System to enhance citizen's convenience at first, and has been expanding its domain into wider Intelligent Transport System as well as crime and disaster prevention in an integrated manner. Anyang is evaluated as a benchmark for smart city with a 2012 Presidential Award in Korea and receives large number of international visits. Anyang's Integrated Operation and Control Center (IOCC) acts as the platform that gathers, analyzes and distributes information for mobility, disasters management and crime. Anyang is currently utilizing big data for policy development and is continuing its endeavor to expand its smart city services into areas such as waste and air quality management. Anyang's success factors are the government officials' continuous willingness towards service development and the establishment of cooperation system among the smart city-related organizations.

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

Keywords: Smart city, intelligent transport system, crime and disaster prevention, incremental system implementation, urban management, real-time information

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Table of Contents

Executive Summary

Anyang city, located 25km south of Seoul in the Republic of Korea is developing international recognition on its smart city project that has been implemented incrementally since 2003. Anyang's smart city initiative began with the bus information system to enhance citizen's convenience at first, and has been expanding its domain into intelligent transport system (ITS), crime prevention system and disaster prevention system in an integrated manner in the past 12 years. It is now evaluated as a benchmark for smart city where more than 2,200 domestic and international visitors come every year to learn about the benefits and strategies of smart city implementation.

With this smart city system in the city's dedicated smart city center called 'ubiquitous integrated center', Anyang city has been providing useful information to citizens such as real-time bus arrival information, traffic congestion and optimum route information as well as maintaining the smooth traffic flow within the city through adaptive signal control. The city has also been experiencing approximately 20% decrease in crime rate per year since the installation of over 3,500 CCTVs and cutting-edge monitoring system, and until now there has been more than 1,300 criminal incidents that got resolved through this system. The implementation cost of such smart city system was total approximately USD 33,000,000 which is practically equivalent to the cost of constructing 1~2km of road. The case of Anyang is a good demonstration of how information communication technology (ICT) can bring large benefits to the sector of public administration with relatively low cost. Anyang city's current focus is to effectively utilize the big data such as criminal incidents information, CCTV installation locations, education facility locations and resident information database to identify crime-prone areas and set special strategies for these areas.

Having Anyang's successful smart city implementation case as a benchmark, many other cities of Korea are now equipped with various smart city applications such as bus information system, advanced signal control system and crime prevention system. The success factors of Anyang can be identified as the following.

First is the city government officials' continuous willingness towards service development. The most important success factor of smart city project is the sense of duty of city government officials to provide convenient and safe services to citizens through active utilization of advanced ICT. Anyang could carry on the continuous system integration and development because the city had dedicated professional human resources for smart city implementation only since the development stage of initial bus information system.

Second is the establishment of cooperation system among the smart city-related organizations. Anyang city is reaping synergy effect through the efficient cooperative network system among public agencies such as police, fire department and military agency in terms of information sharing and role allocation in order to secure the convenience and safety of the citizens. This provides an implication that institutional reform is crucial on top of technological reform for the successful implementation of smart city.

Anyang city is continuing its endeavor to expand its smart city services into areas such as waste management and air quality management. It is indeed a recommended case of the Republic of Korea for having integrated system architecture and providing practical smart city services to citizens.

Anyang, Korea (Source: Anyang City, 2015)

ANYANG, Korea

1. Introduction

1.1 General City Overview

Anyang is a city located in the heart of Gyeonggi province of greater Seoul metropolitan area. It is located about 25 km south of Seoul. In 1973, Anyang was expanded to the current city administrative area at 58.46 km2, which comprises of 62% green zone. The population of Anyang stands at 598,801 in 2015 and is relatively densely populated (10,242 people per km2). Anyang is continuously showing a trend of population decrease (refer to Figure 1) and 20 thousand vehicles are registered at the moment. In particular, the city has exhibited signs of coexistence of new and old sections of the city as Pyeongchon new city area of 20 thousand people have been developed after going through new city development in the 1990s. The total GDRP within Anyang in 2010 was approximately USD 12 billion, equivalent to USD 20,000 per person. The internet usage rate for Anyang that is part of the greater Seoul metropolitan area is at 85.6%, higher than the national average of 81.6%. Anyang is well equipped in its communication infrastructure with 287 km of high-speed fiber optical networks and its own access points in 146 stations. During the heavy rain period every summer, the inundated streams are a concern for damages while in the winter season; the dry air is worrisome for forest fires.

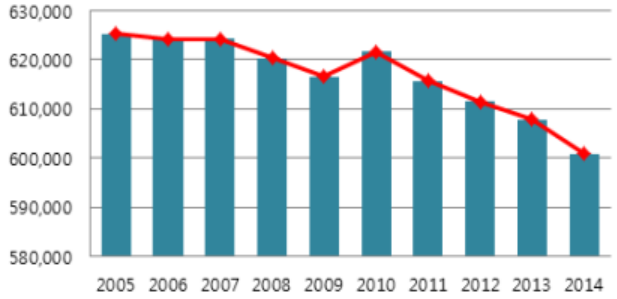

Figure 1 Anyang City's Population Trend (2005~2014)

1.2 Smart City Overview

1.2.1 Development Background and History

Anyang is the model case, which has progressively infused smart city technology from the typical established city and draws attention from over 60 countries as a city to benchmark. The first smart city project was the 'Bus Information System (BIS)' in 2003 which has expanded to 'Intelligent Transport System (ITS)'. In the midst of the transition, a tragic incident involving the kidnapping and eventual killing of two girls in December of 2007 called on for a declaration of war against crime. Henceforth, the need to build a social safety net was acutely recognized and development of a criminal prevention system was started in 2008. Currently, there are 3,500 criminal prevention CCTV (closed-circuit television) around the city, connected in a way resembling a spider's web to limit the blind spots of public order and safety. Furthermore, a synergy effect is gained through closely connecting and jointly utilizing the monitoring network with police stations, fire departments and military units.

Duration	Project content
2003.10–2010.05	Bus Information System (BIS) project - 242 Bus Information Terminals (BIT) - 125 Vehicle Information Devices - Liaison between Seoul and Gyeonggido BIS Centers
2004.03	ITS Basic Plan
2005.12	MOU with the neighboring centers (Suwon, Gwacheon and Uiwang)
2007.05	MOU with the National Police Agency
2008.02 -2010.04	IOCC Construction (over 2 phases) Intelligent Transportation System (ITS) - 32 CCTV, 10 VMS - Vehicle Information Devices on 2,800 t axis, Adaptive Signal Control System etc.
2008.06 -2009.05	Bus Rapid Transit (BRT) - Bus-only lane establishment - 10 lane violation CCTV etc.
2008.08 -2009.12	Criminal Prevention System - 210 criminal prevention CCTV, 15 AVI units - Joint monitoring between police station and patrol division - 25 crime prevention devices installed in patrol cars
2009.02	MOU with Anyang Municipal Police regarding center operation
2009.03	Opening of Anyang IOCC

Table 1 Anyang IOCC promotion process

Anyang, a satellite city of Seoul, recognized the need to cope with various factors including traffic congestion and air pollution stemming from commuting to Seoul, the severity of increasing crime rate and climate shocks which arrive with the change of seasons. To actively cope with these problems, the city employed cutting-edge IT technology that uses scientific and efficient smart city system and integrated operation center that started providing service from March of 2009. As to date, approximately USD 40 million of the city's budget has been funded to smart city's project expense with continued system upgrades since 2003.

1.2.2 Vision, current and future projects

Project	Cost (KRW)	Period	Main Operations
Project Areas	35,528	-	-
Crime Prevention CCTV establishment	16,473	2008.08~ 2014.11	· Crime Prevention CCTV 3,476 cameras in 771 sites · Automatic Vehicle Identification(AVI) 114 AVI in 47 sites
Bus Information System (BIS)	4,740	2003.10~ 2014.11	· 300 Bus Information Terminals · 140 Vehicle Information Devices
Intelligent Transport System (ITS)	14,315	2008.02~ 2014.04	· Anyang Smart City Center Establishment · 119 CCTV, Fiber optical network established, etc.

* 1 USD = approx. 1,200 KRW (as of January 2015)

Table 2 **Anyang Smart City's Main System and Project Costs**

Anyang city's smart city project's vision of happy citizen, and 'serving' administration is what will lead the city into the next generation with its differentiated city plans, encompassing the wisdom and capacity of citizens to create a safe and crime-less city and realizing advanced green traffic and culture city to create a hopeful and prosperous tomorrow. Anyang smart city's goal is to make Anyang a safe and comfortable city through increasing work efficiency by unifying the monitoring duties of criminal prevention, traffic, disaster prevention and city management areas into one department based on wire/wireless communications infrastructure.

Anyang smart city development project was headed by the city's initiative with matching funds from the central government and Anyang city as a public-led project. In the past 12 years of smart city operations, Anyang city provided real-time bus arrival information service,

various traffic information service and cutting-edge traffic signal control service to its citizens to promote their traffic convenience. In particular, the criminal prevention system which led to innovative crime prevention effects and increased criminal apprehension effects was awarded the 2012 Presidential Citation and received attention as a model smart city from other cities.

2. Service Spectrum

2.1 Overview of the smart services and high level functions

Figure 2 Forty-five Operation boards (50") of Anyang Smart City Center

Anyang Smart City provides various services to citizens and relevant public officials related to traffic, safety, disaster prevention and communications with Anyang Smart City Center as the main hub.

Smart traffic section (ITS, BRT, BIS) provides various real-time traffic related service while U Crime Prevention section aims to secure the citizen's safety through installing crime prevention CCTV throughout the city and performs around the clock (24 hours) crime prevention and response activities by connecting police stations, police precincts and patrol cars. U Crime Prevention section which includes city and facility management is operated through a unified process whereby respective departments jointly monitor the CCTV imagery for forest fire surveillance, stream management and road management.

Anyang Smart City Center conducts its role as a U-City control center through identifying and managing every situation in the city related to traffic, crime prevention and disaster prevention. Map based information and video information can be found in real time at the Anyang Smart City Center webpage.

Service Area	Services
Smart Traffic	- Real time traffic information - Bus information terminals - Real time bus information - Parking space information - Facility location and traffic use information - Fast route information - Traffic signal control - Speeding, traffic signal violation, illegal parking crackdown
Smart Safety	- Smartphone safety helper service - Intelligent crime prevention service
Smart Disaster Prevention	- City facility management - Forest fire surveillance - Flooded river and flooded area surveillance - Winter snow conditions surveillance

Table 3 Services provided in Anyang City

2.2 Transportation and urban mobility

2.2.1 Intelligent transportation system

Anyang city is operating a well-established Intelligent Traffic System (ITS) to provide traffic management and traffic information services. ITS is a new traffic system that integrates cutting-edge technology such as electronic, communication and control with existing traffic systems of road, vehicle, railroad, aviation and shipping which secures comfortable and safe traffic environment and maintains maximum efficiency in traffic management.

Various sensor devices installed in the sites send real-time traffic situation information to the center, which then manufactures it to useful and reliable information for citizens and it ultimately aids for free flowing traffic.

Table 4 depicts ITS services and areas in Anyang city. To provide effective and useful real-time traffic situation information to its citizens, Anyang city collects, manufactures, process large amount of ITS big data that is sent in real-time via internet and mobile application services (refer to Figure 3, Figure 4). Specifically, ITS services provide traffic and road conditions by roads, travel time for each sections, CCTV imagery information and VMS information. In regards to bus information, current location of bus, bus status by routes, bus transit information, personal customized information, bus terminals and route search services are provided. In regards to geo-spatial information, main facility location, transportation information and nearby parking space information are provided.

Area	Services
Traffic information collection and processing	- Store information in collective database gathered from Image detector, Signal control detector, CCTV, WEB, BIS - Manage link status, operation status and configuration of site equipment - Process control command for site equipment
Traffic information manufacturing and analysis	- Produce manufactured and analyzed information through use of appropriate algorithm of collected raw data - Produce traffic information, statistics information and pattern information - Detect unexpected situation and recurrent congestion situation
Traffic information provided	- Provide traffic information to ordinary citizens and external institutions - Provide WEB service via internet - Provide actual traffic information to drivers via VMS - Share mutual information through information connection with other institutions and centers
Maintenance and Management	- Information management of site facilities - Monitor site facilities - Request control of site facilities - Manage fault history of site facilities - Monitor and manage road status
Electronic map	- Provide information on operating system, situation board and electronic map for WEB
Center Operations management	- Manage unexpected situation and recurrent congestion situation - Set-up and manage VMS message - Check traffic situation, unexpected situation and recurrent congestion situation - Manage traffic situation board - Manage center and basic data

Table 4 Anyang City ITS service and contents

Figure 3 Traffic and bus information service (online)

Figure 4 Traffic and bus information service (mobile)

2.3 Safety and citizen security

2.3.1 Intelligent crime prevention service

Anyang smart city center operates intelligent crime prevention system in connection with crime reporting center of Anyang police station. Therefore, if a citizen reports a crime (call number 112), the surrounding CCTV will operate and the responding patrol car will respond while watching the crime scene's CCTV footage. The suspect's escape path will be tracked by the surrounding CCTV and automatically relayed to the patrol car. In addition to the existing crime prevention CCTV and vehicle number detection CCTV, CCTV used in detecting illegal parking and public parking lot will be employed for the same purpose.

The suspect surveillance and tracking system was established based on GIS map. Considering GIS map characteristics, when a certain point is clicked, the imagery for that certain point will be broadcasted as the surrounding CCTV automatically adjusts its direction.

If the suspect is moving, the escape path will be automatically tracked without the need for altering CCTV direction and the suspect's description and on-site situation will be relayed to the device installed within the patrol car.

Vehicle surveillance and tracking system detects and tracks moving suspect vehicles using the vehicle number detection system (AVNI). This database strengthened its vehicle detection capacity by integrating all crime prevention CCTV DB, illegal parking CCTV DB, and public parking lot CCTV DB. Therefore, through DB search results, Anyang smart city has systemized the swift capture of the suspect based on the suspect's expected escape route by displaying the 'vehicle path' of the frequent routes used by the suspect's vehicle.

Figure 5 Pattern analysis of suspect vehicle through personal database

2.3.2 Smartphone safety service

Anyang city was the first in the country to develop a customized application that connects individual smart phone users and local government crime prevention CCTV, which begin as a means to solve frequent crimes on females and students in streets during nighttime. Anyone can download and use the application in app store or Google play free of charge by searching 'safety helper service'.

Figure 6 smartphone safety service

By starting the application, the user's location is sent to the CCTV center and periodically tracks the user's real time location. The center's crime prevention CCTV tracks and protects the smartphone user's path and in case of emergency, an alarm will sound in the center and the site by shaking the smartphone. Simultaneously, the location and SOS text that is previously set to a guardian will be sent and the police will be swiftly dispatched to the GPS location of the smartphone. Furthermore, the service notifies nearby safety helper members (voluntary patrol, mother police group, etc.) for rescue alert.

Figure 7 Smartphone safety service workflow

2.4 Emergency and Response

2.4.1 Incident management

Figure 8 Traffic monitoring

Anyang smart city center monitors traffic situation on intersection and main points through

CCTV in real time. In case of traffic accidents and unexpected situations, police and fire station are notified upon CCTV confirmation that allows for swift response and recovery of road traffic.

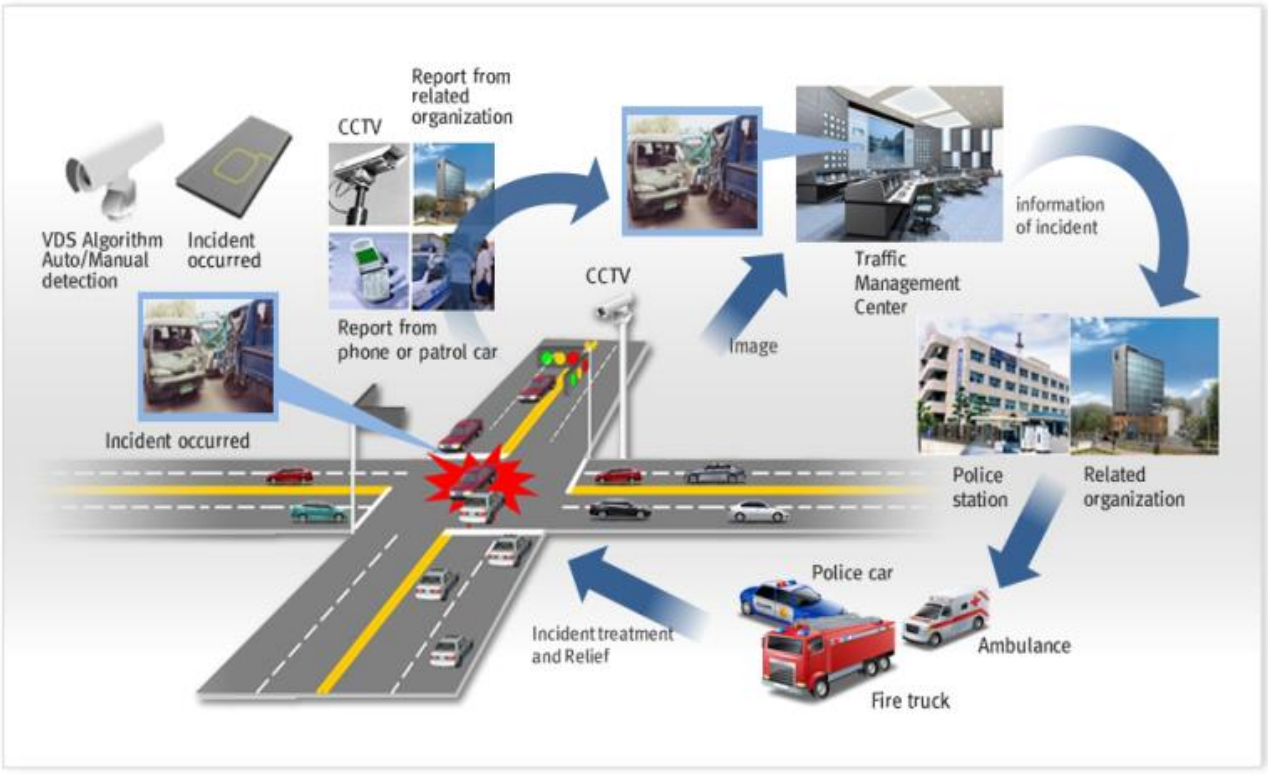

Figure 9 Road incident management service workflow

Figure 10 is actual monitored CCTV footage of a traffic incident in an intersection in Anyang city. When traffic incident arises, it is immediately detected and swift measures are undergone to protect the victim, prevent secondary accidents and minimize traffic congestion. Further, recorded footage before and after the accident is used for analysis in investigating the exact cause of the traffic accident. Upon the winter forest fire season, the mountainous region nearby Anyang city is closely monitored to prevent and put out the fire in the early stages (Figure 11).

Also, the snowfall and icy road status is checked to determine the priority insertion of snow ploughs in order to maintain flowing road conditions and prevent accidents. Figure 12 depicts footage of deployed snow ploughs removing snow after monitoring the snowfall. During the days with much snowfall, limited snow ploughs must be effectively assigned. Anyang Smart City Center does not place monitoring personnel at the site but checks the amount of snowfall on the roads through CCTV and determines the priority of snow ploughs insertion. As some section of the road closes and creates congestion due to snow removing operations, detour information is provided to VMS that is installed in the roads or various mobile information-providing services to reduce driver's traffic time.

Figure 10 Intersection traffic accident monitoring – CCTV images

Figure 11 Monitoring of forest fire detection (left) and road surface freeze status and snow-removing (right)

Figure 12 Road snow clearing service – CCTV images

During the summer monsoon season, especially during the heavy rain period, the riverside parking lot that might be flooded by the Anyang stream and frequent flooded areas are centrally managed to limit rain damage. If there is a high concern for flooding in the parking lot due to extensive rain, Anyang smart city center assembles tow trucks to the area while sending SMS text for immediate evacuation of parked vehicles to the vehicle owners. If the vehicle owner does not appear after the safety evacuation period and vehicle is unable to move, tow trucks will be inserted to safely move all vehicles out of the flooding prone parking lot.

To operate the emergency measure system, vehicles that wish to use the flooding prone riverside parking lot must register its vehicle number information and driver's phone number in the system beforehand. Further, the city must enact the evacuation measures such as forcible towing of vehicles during urgent times to ensure and protect the safety of the citizens and their properties. In this process, the driver must comply to endure any inevitable damages.

Therefore, Anyang smart city not only protects public property but is used to protect the lives of citizens and their property as well.

Figure 13 Ubiquitous Integrated Center CCTVs – moni toring of flooding and flooded area monitoring

Figure 14 CCTV monitoring for typhoon and heavy rain

2.5 Environment

2.5.1 Waste, water and sewage management

Services in environment areas are mainly surveillance of illegal trash dumping and water quality management of water and sewage. First, recorded footage is used for evidence collection and to catch people in the act of illegal trash dumping. Anyang city operates road environment watch group comprised of 126 taxi drivers to maintain surveillance on illegal trash dumping. The group is in charge of collecting evidence through smartphones and black boxes of people who throws out trash illegally or throws out cigarettes while driving. Further, guidance activities are conducted to prevent and stop illegal trash dumping. Anyang city analyze the reported footages and impose fines, while on the other hand, award small prize money to the reported watch group member.

Water quality management of water and sewage requires direct management on the site due to the nature of the job. To do this, Anyang city operates the Water and Sewage Project Office as a separate organization whereby it conducts direct operations in the water and sewage treatment plant. It is physically separated from Anyang Smart City Center but is in close working relationship in real time through the city hall webpage.

Anyang city is operating resource recycling and safety trash incineration system. Trash is incinerated at a designated location and information of the pollutant generated from the incineration process is released to the citizens.

Figure 15 Anyang's environmental facilities

2.6 Energy Efficiency

2.6.1 Facility sharing and LED street lights

Anyang smart city center is conserving energy by maximizing space use through integrating a necessary system of city management for single space. Furthermore, eliminating overlapping use of various electronic equipment and air-conditioning and heating system have considerably reduced electricity bills.

On the site, street lights and security lights have been switched to LED system to enhance energy efficiency in the public domain. Moreover, the scale is small at the moment but there is an alternative energy supply through wind and solar power generation are being considered.

Joint campaign with public institutions to conserve energy during electricity peak hours in the summer and winter season within the lives of citizens is ongoing. Especially, the city is taking the leading role to crackdown on business establishments used by the public that operate businesses with doors open in an air-conditioned and heated environment.

Figure 16 Anyang's energy saving campaign

2.7 Citizen Interaction and Communication Mechanisms

2.6.1 Citizen participation

Anyang city citizens may submit their opinions on improvements or inconveniences that they experience in their everyday lives through accessing smart phone application or city hall webpage. In addition, there are various communication channels for citizen's participation through the reform regulation 119, voices of citizens, request to Anyang city, Ombudsman for Civil Complaints, Monitoring and Evaluation Group of City Affairs and Public participation led Budget system.

Furthermore, Anyang city is continuously promoting its smart city center to contribute in citizen's insecurity and citizens sympathize with city's efforts to realize a secure and safe city. Anyang Smart City Center is providing education program by periodically inviting voluntary patrol group, green mother's association and mother's college members.

As the central government and domestic U-City experts have recommended Anyang Smart City Center as a success story, the center is utilized as the knowledge acquisition and information sharing center to colleges, researchers, academic society and public servants. For instance, as Korea Ubiquitous Association yearns to learn the integrated system operations know-how of the center, related field personnel conduct on-site training 3 times during the year.

Figure 17 Civil target promotional activities of ubiquitous integrated center

3. System Configuration

3.1 Overview

Figure 18 Anyang smart city center

Anyang Smart City System is centered through Anyang Smart City Center that is located in the 7th floor of Anyang City hall and is operated 24 hours through various field equipment connected wired and wireless communications.

The center's system, located within Anyang Smart City Center, is 648m² and equipped with unified database covering traffic, crime prevention, disaster prevention and city management.

Anyang Smart City Center at current 2015 may be physically divided as crime prevention, ITS and Bus Information System. This is merely a division in administrative, management aspect due to project and budget reasons. All hardware and software is operated by converged and integrated unified system without boundaries, creating greater services for citizens.

Anyang Smart City Center is in charge of assessing and managing all situations within the city including traffic, crime prevention, disaster prevention and safety as the U-city control center.

Classification		Content of Construction	
Center System		Area : 648m² Established Integrated DB of Traffic, Crime Prevention, Disaster Prevention, City Management	
Field system	Crime Prevention System	Crime Prevention CCTV : 735 ANPR[1] CCTV : 7 Patrol Car Device: 27 System Operations Device : 7	Establish Optical network: 161km Connect Police station and Police precinct Establish Public Safety Guidance Establish Safety Helper Mobile Service
	ITS System	VMS[2] : 12 Traffic Information CCTV : 43 Road-Side Equipment(RSE[3]) : 5 Cutting-edge Signal Control Equipment : 82	Establish Optical Network: 71km Car Navigation System(CNS[4]) : 2,800 Personal Digital Assistant Device[5]: 150 Vehicle Number Detection CCTV(AVI[6]) : 40
	Bus Information System	Bus Information Terminal(BIT[7]) :275 Driver Information Device: 610 Established Mobile System Mobile Application	Establish Optical network: 68km Red Bus Information Provided
Communications System		287km High-speed Optical Wire Network 32 Wireless Communications Base Station	186 Wireless Connected Network Sites

Table 5 Anyang Smart City System's center system, equipment, types and numbers of communication network.

1 ANPR : Automatic Number Plate Recognition
2 VMS : Variable Message Sign
3 RSE : Road-Side Equipment
4 CNS : Car Navigation System
5 PDA : Personal Digital Assistant
6 AVI : Automatic Vehicle Identification
7 BIT : Bus Information Terminal

3.2 Level of physical system integration and interoperability

Figure 19 Ubiquitous integrated center and related organizations

Anyang Smart City Center stores, manages and provides all information that is collected and manufactured in Anyang City. The related information and footage may be mutually shared according to the state designated methods to reduce budget and maximize operational capability to the following institutions: Ministry of Land, Infrastructure and Transport, Gyeonggi Provincial Government, Anyang Police Station, Anyang Fire Station, Military unit and Korea Railroad Corporation.

Table 6 depicts the working organizations and its information with Anyang Smart City Center. This information linking is operated based on the standard node system link defined by the Korean government. The linked information may be exchanged in the cycle of seconds (short) to 5 minutes (long). In an emergency situation, swift response system through immediate transmission is considered. The linked information varies from real time dynamic information to manufactured static information. All linked information is strictly guarded by the Korean government's designated technical information exchange standard according to the type, definition, characteristic, information exchange method, information provider's rank and authorization.

Agencies	Information
Ministry of Land, Transport and Infrastructure (MOLIT)	Exchange Traffic, metropolitan area BIS, TAGO information with National Traffic Information Center
National Police Agency	Link traffic information of Anyang and city area with Central Traffic Information Center
Gyeonggi Province BMS Center	Link all connecting bus information of Gyeonggi, Seoul, Incheon, Anyang, etc.
Anyang Police Station	Link Anyang Police Station dispatch office, precinct and patrol cars (Install incident and crime prevention CCTV joint monitoring system)
Fire Station and Military Unit	Utilize joint CCTV footage of Fire Station and Military Unit (Swift support system during emergency situation including forest fire, flooding and heavy snow)
Link to Related Department	Link CCTV footage of forest fire, road and flooding to related city department
Korea Railroad Corporation (Korail)	Link real time subway arrival information
Mbn (Maeil business news)	Link domestic/international headline and life information news to mbn news channel

Table 6 Linked information among organizations

3.3 System architecture, system layout and information flow

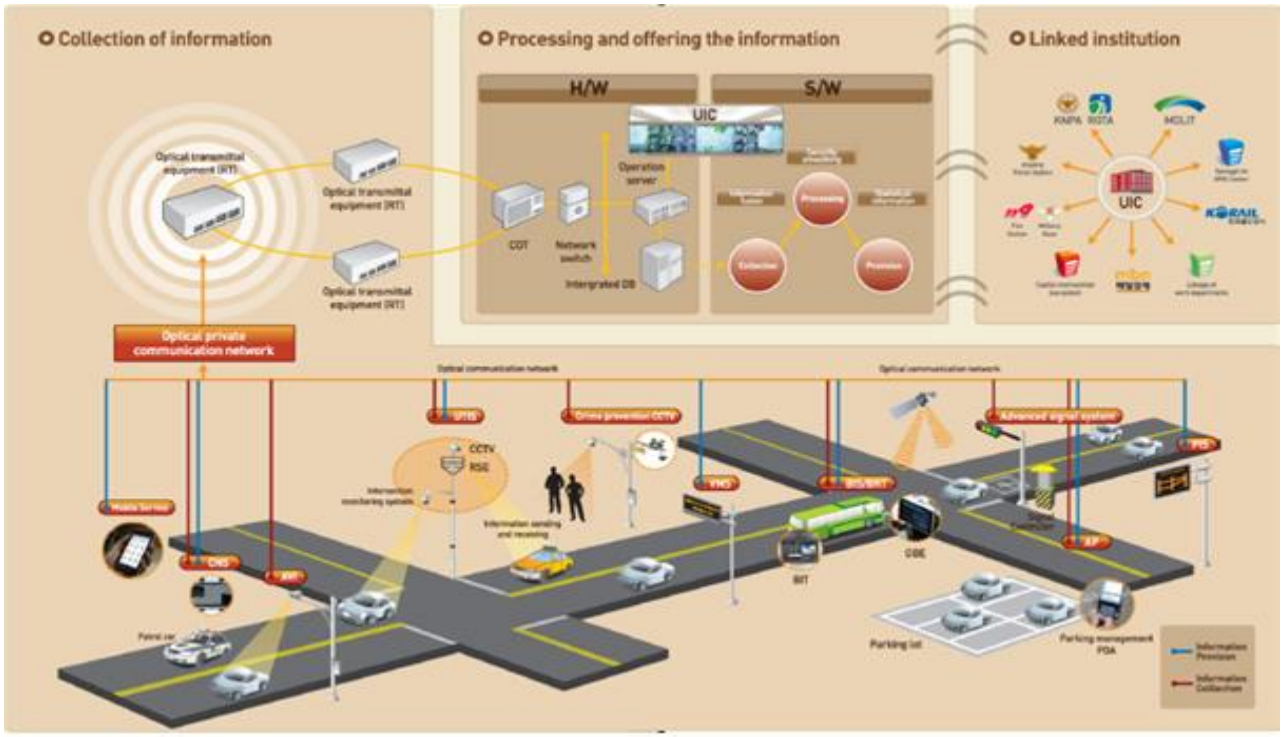

Figure 20 Anyang Smart city whole system block diagram

Anyang Smart City System is connected to various on-site equipment and Anyang Smart City Center through Dedicated Fiber Optic Communication Network. There are following on-site equipment: Cutting-edge traffic signal control system, monitoring CCTV, information collective equipment, information providing equipment and communications equipment.

Anyang City's cutting-edge traffic signal control system is installed in the loop detector at the critical intersection to detect real time traffic situation, generate optimal signal control parameters, maximize traffic flow, apply COSMOS system for safety and ensure compatibility with Seoul city's traffic signal system. Monitoring CCTV is divided by main functions of traffic use and crime prevention use, but is actually integrated for utilization. Information collection equipment is divided into detectors installed in fixed location such as AVI, signal control loop detector, ANPR (Automatic Number Plate Recognition) and equipment installed in vehicles (OBE). Information providing equipment includes VMS, BIT and OBE. Communications equipment includes OBE and RSE, which oversee wireless communication.

Anyang Smart City Center collects in real time various detection data on the site. Collected data undergoes supplementary and smoothing process to provide useful and worthy information to citizens. The data is then made into statistics and saved. Further, Anyang Smart City Center exchange information with institutions in a designated method. Figure 20 depicts Anyang Smart City's entire system composition, Figure 21~Figure 23, depicts BIS system that collects, manufactures and provides on-site information, crime prevention system and ITS system.

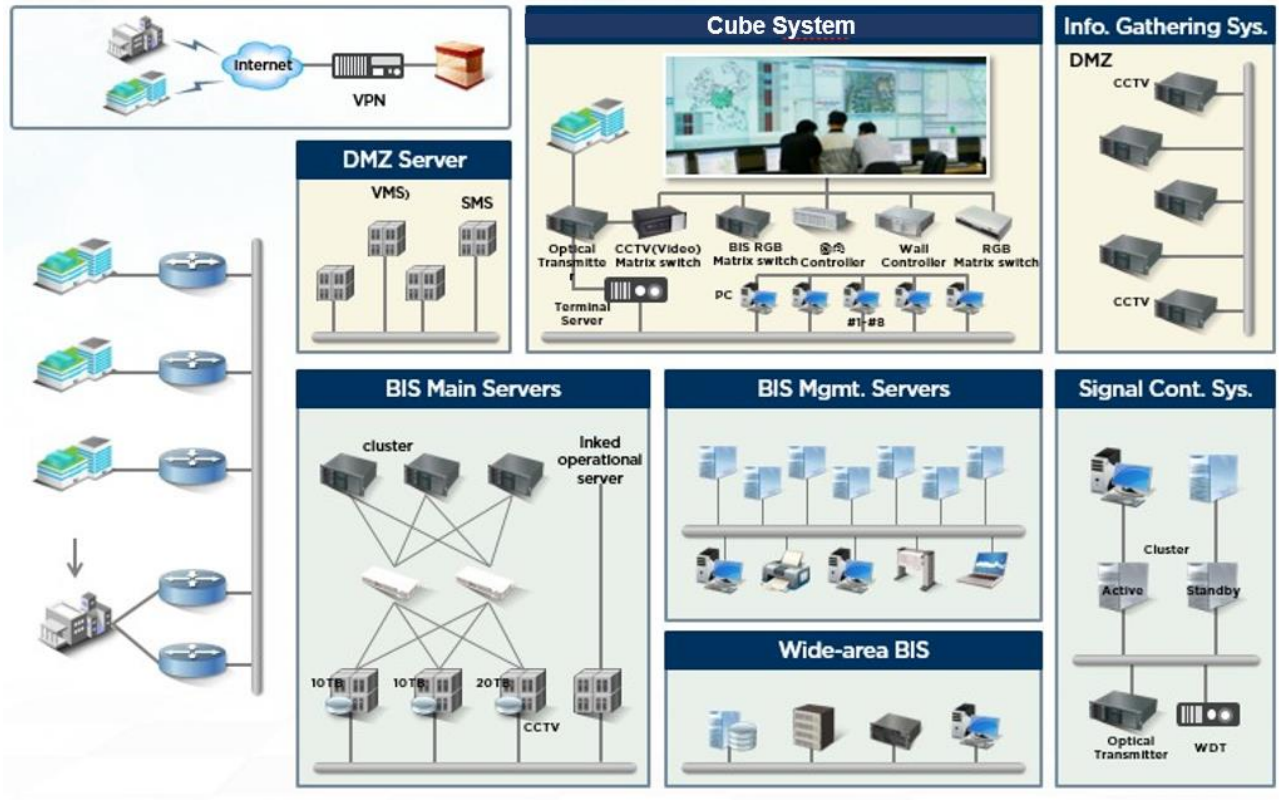

Figure 21 Anyang BIS system block diagram

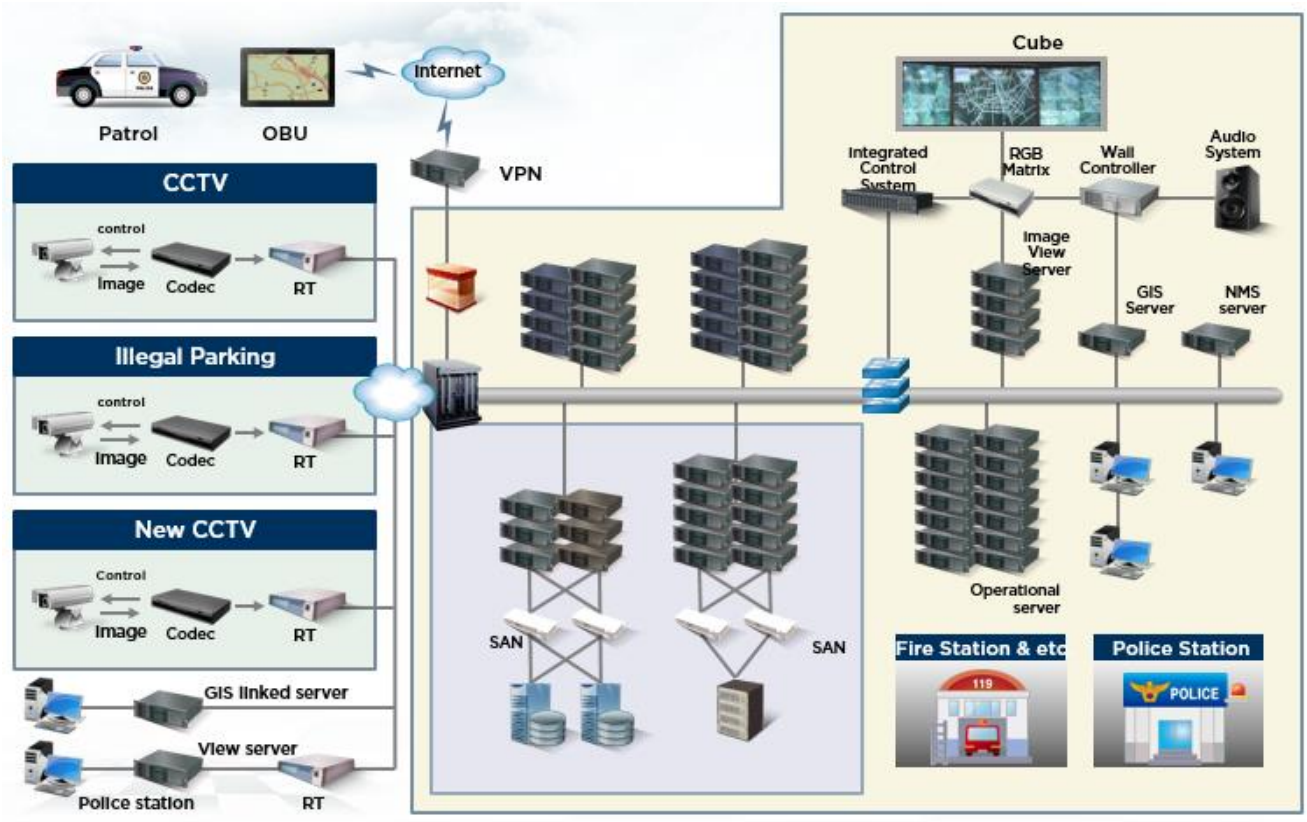

Figure 22 Anyang crime prevention system block diagram

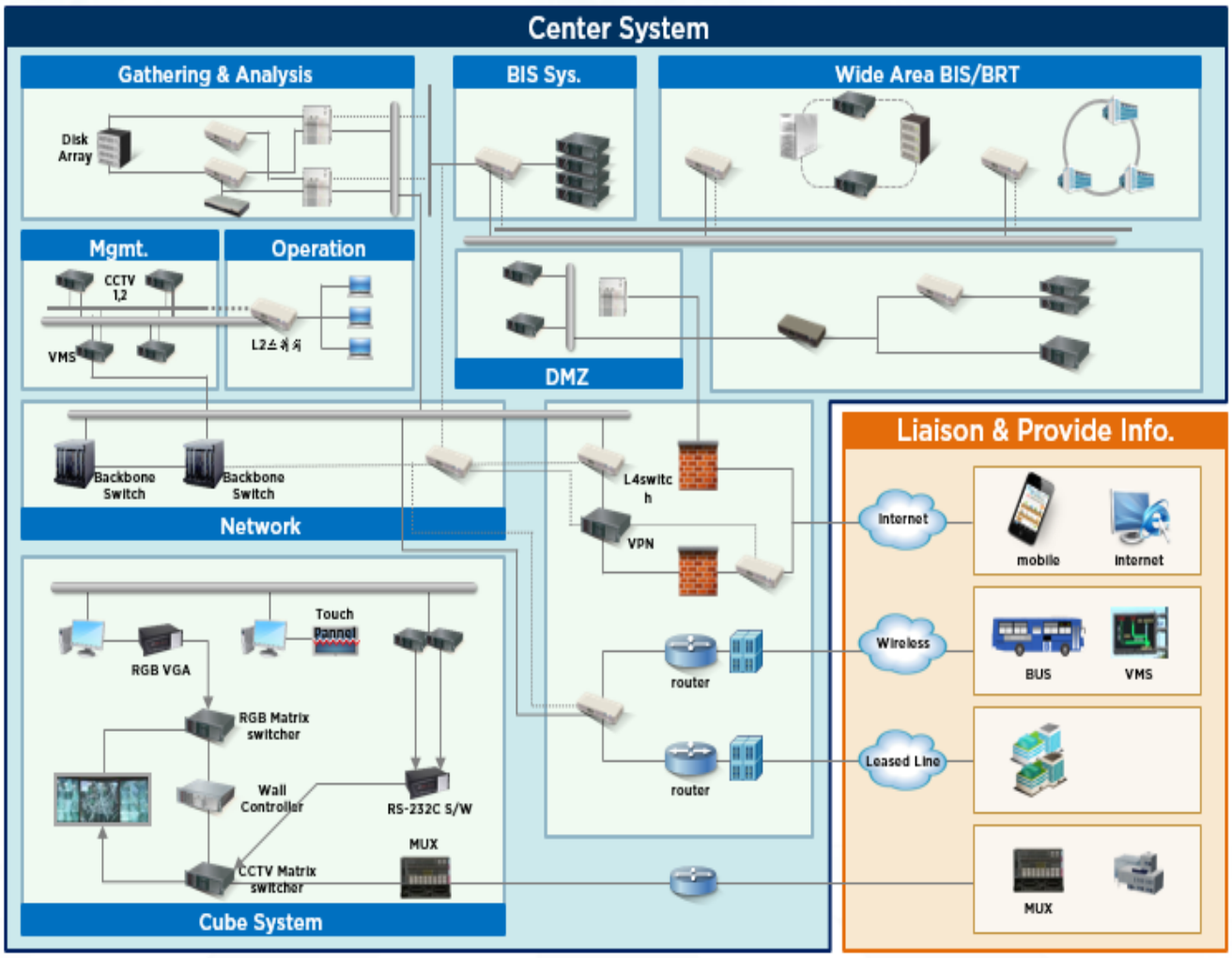

Figure 23 Anyang ITS system block diagram

In order to manage Anyang Smart City Center, numerous information flow through its core. In other words, information is bilaterally transmitted in real-time amongst the city center, field equipment, and related agencies. First, countless of information are collected in the direction of Anyang Smart City Center – field equipment such as traffic signal controller, CCTV, AVI, and ANPR, receive terminals installed in vehicles, and various types of traffic, city, and several types of traffic information from related agencies. Second, information being collected from Anyang Smart City Center's field equipment is mainly control signals from the center operators' field equipment. Last, information providing devices that are installed on the field – such as, VMS, BIT, receive terminals installed in vehicles, and mobile terminals used by citizens – are useful information which are processed at Anyang Smart City Center.

Likewise to the information collecting devices, information providing devices also send their operation condition related information in the direction of Anyang Smart City Center, which helps provide normal system operating conditions and failure occurrence situations. Figure 24 roughly depicts necessary information – information collection, processing analysis, and construction for information providing systems – for Anyang City's ITS service.

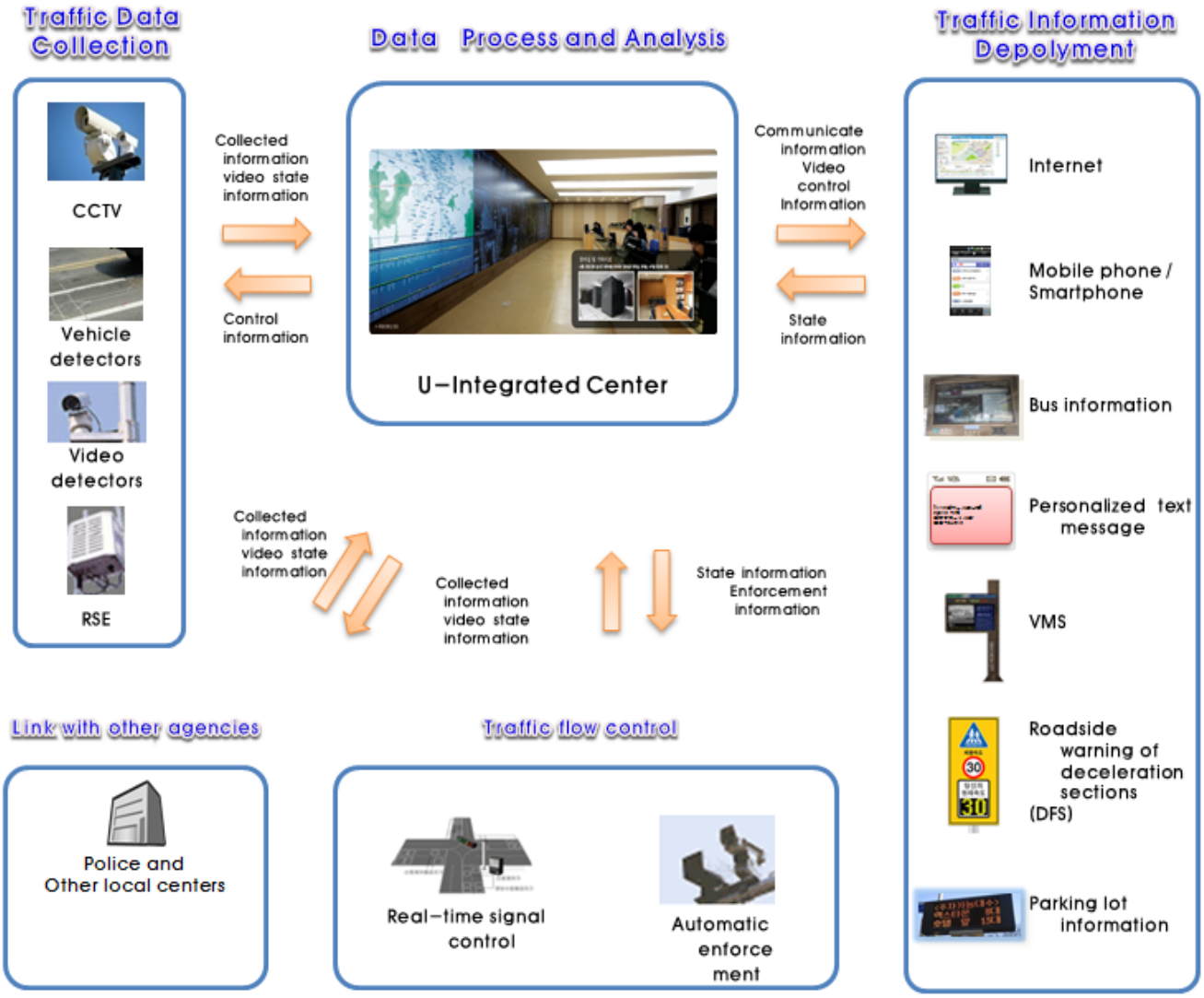

Figure 24 System composition of conceptual diagram for Anyang ITS service

3.4 Integrated center system

Figure 2 in chapter 2, depicts Anyang Smart City's situation board. As the figure displays, situation board encompasses BIS, IT'S and crime prevention situation board, and in case of disaster, the entire situation board can be turned into disaster situation board. A team of H/W, S/W and N/W systems engineers and various services operators work in a mutually-cooperative manner at Anyang Smart City Center.

In contrast to other local governments, which operate separate ITS center in charge of traffic control and BIS and crime prevention center, Anyang Smart City Center provides situation board, server, network equipment and UPS equipment in one place. This provides space-saving and cost-saving advantages. At the same time, Anyang Smart City Center can dramatically save operations costs and labor costs because it can co-manage operations and maintenance tasks. Figure 25 depicts space configuration of Anyang Smart City Center.

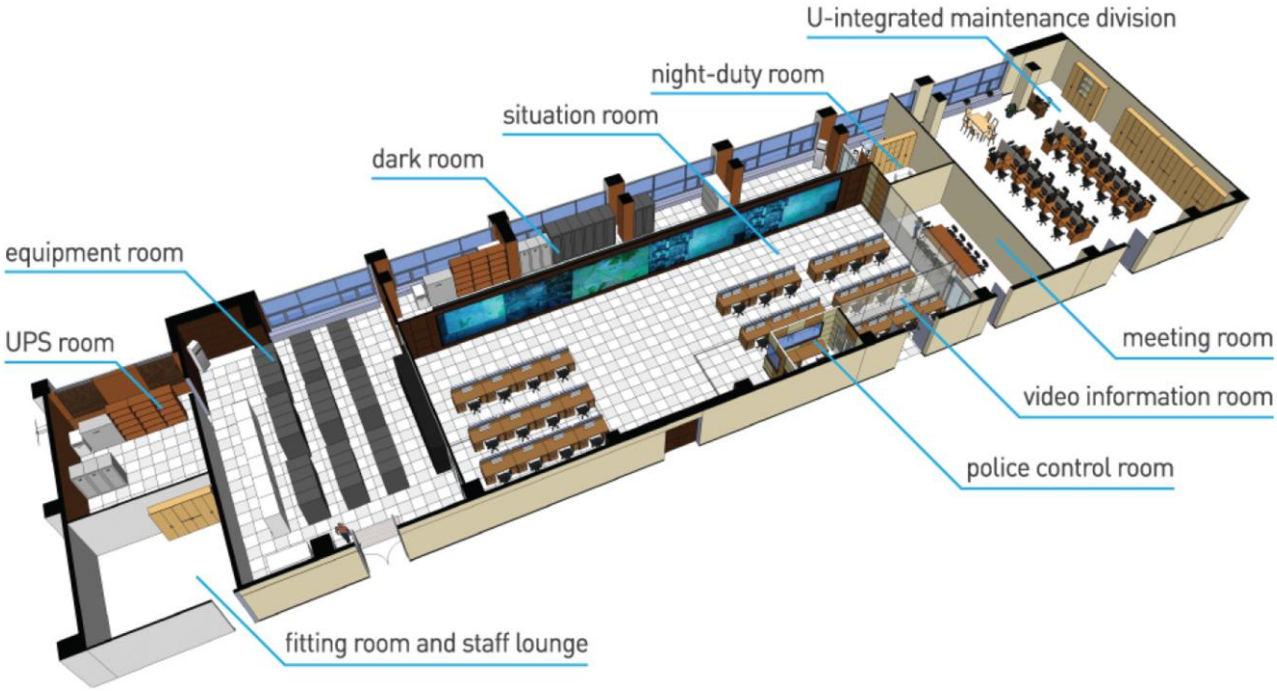

Figure 25 Layout of Anyang smart city center

3.5 Field System

Anyang Smart City's field system includes traffic control system, BIS system, CCTV, VMS and various types of vehicle mounted equipment. This system can be accessed to optical communications network, which is then connected to Anyang Smart City Center. Figure 26 depicts Anyang Smart City's field system configuration. Anyang Smart City's crime prevention AVI, which is capable of identifying vehicle plates, is integrated with traffic AVI so that the integrated system can provide not only traffic information but also crime prevention information.

Figure 28 depicts traffic and crime prevention AVI installed points in the road which operates on the main roads with the inflow and outflow points. AVI provides vehicle plate numbers of all the vehicles on the road, the time at which the vehicles were on the road and the pictures of the vehicles to Anyang Smart City Center so that the center can use these data in assessing traffic situation and in cooperating with police in their attempt at crime investigation.

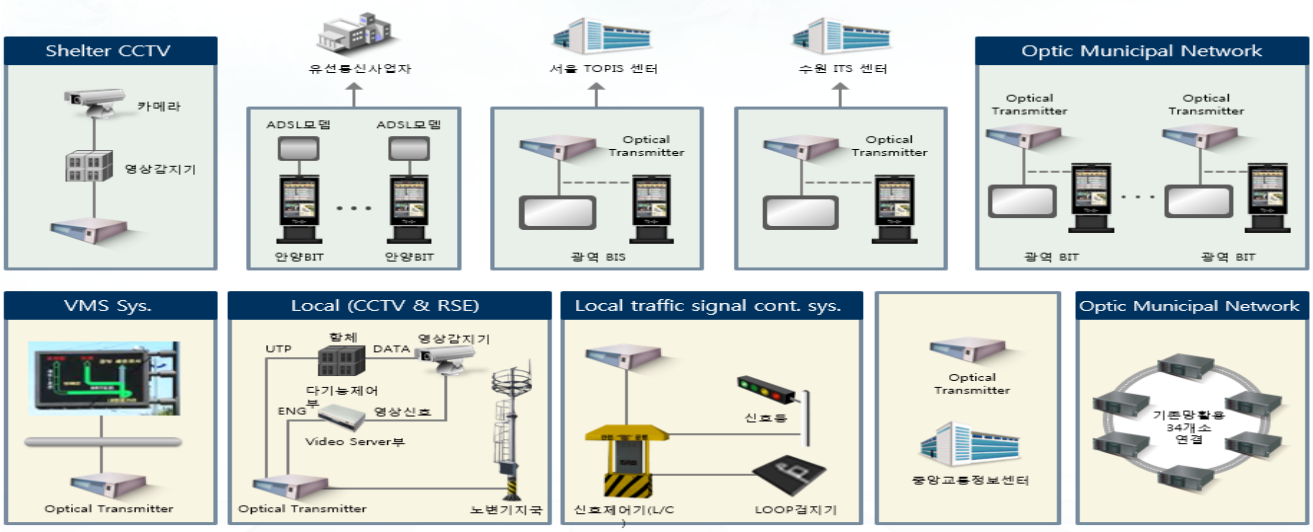

Figure 26 Anyang Smart city field system block diagram

Figure 27 Field devices installation point map

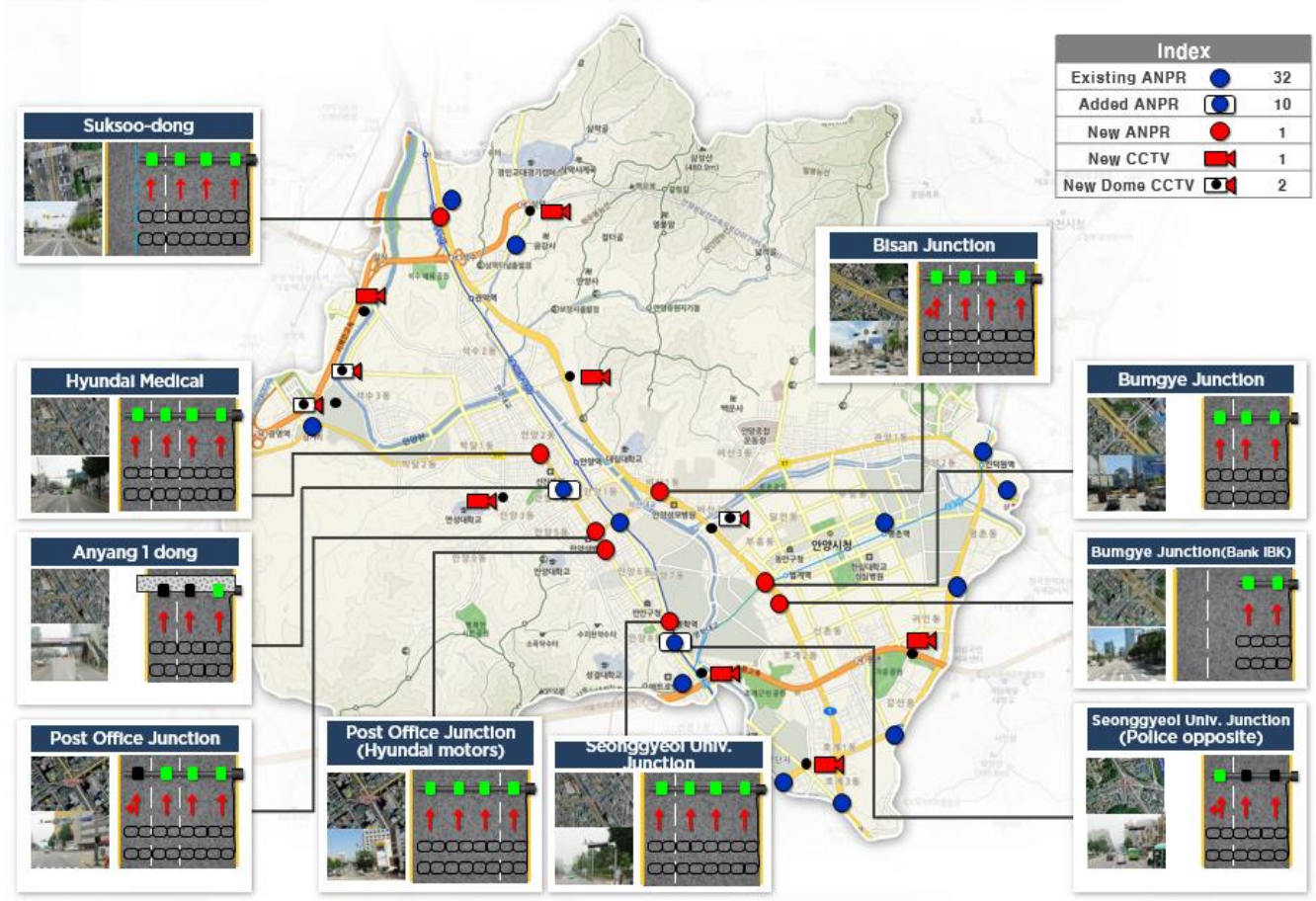

Figure 28 Traffic and crime prevent purpose AVI installation point map

Moreover, OBE (on board equipment) is field system equipment that transmits vehicle locations to Anyang Smart City Center through wireless communication channels. At the same time, OBE can receive useful information from Anyang Smart City Center. Anyang City installed OBEs in 2,800 taxis in the city, thereby collecting information on the movement of taxis. This information provides basic data upon which the city can track the flow of traffic, producing traffic information. At the same time, the city installed RSE and antennas at 32 sites so that OBEs and the city can communicate with ease. RSE and antennas were installed at the 20m point of CCTV pole on intersections. OBE transmits information on vehicle speed and time to Anyang Smart City Center through RSE. Upon receiving the information, Anyang Smart City Center processes this information and transmits to vehicles on the road through RSE. As a result, OBE is able to receive traffic information as quickly as possible.

Figure 29 RSE (left) and antenna (right)

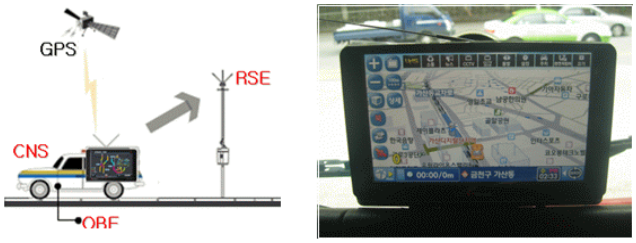

Figure 30 Communication between OBE and RSE (left) and OBE display

3.6 Communication System

One of the factors that contributed to the success of Anyang Smart City businesses was the construction of fast and stable communication infrastructures. The gradual communication infrastructure establishment project resulted in total 287km of high-speed Dedicated Fiber Optic Communication Network and 146 wireless network connection sites (Refer to Figure 31). At the same time, the Center established 32 RSE sites for the 5.8GHz communications with OBE. RSE and Anyang Smart City Center are connected through optical communications system.

By building wired and wireless communications infrastructure, and with direct ownership of these infrastructure, the city could have reduced approximately 500 million won per year compared to using a commercial network.

Figure 31 Anyang optical self-network and wireless communication base station location map

3.7 Sub-systems and Functions

3.7.1 Transportation and Urban Mobility

A. Intelligent traffic signal control system

Anyang City's traffic signal control system is constructed in accordance to Korean National Police Agency's standardized COSMOS system. Anyang's COSMOS traffic control system contributed to the service improvement by detecting traffic changes and adjusting traffic signs that optimizes traffic situations. For example, by setting optimal traffic signal cycles and signal time based on simulated analysis, the traffic control system can maximize traffic flows. To this end, the city installed signal detectors on the road to collect traffic information. Furthermore, linking effect can be maximized by systematically dividing the intersections with similar traffic patterns into linking groups.

Figure 32 Cycle and signal management (left) and signal detector (right)

B. Intersection surveillance system

Intersection Surveillance System is a system that encourages traffic accident monitoring through CCTV images thereby helping quick normalization of the traffic. The city installed Intersection surveillance cameras in addition to existing CCTVs on main intersections so that the city can better monitor traffic violations and accidents. These images are used in clearly identifying causes of traffic accidents. The cameras are installed on one pole.

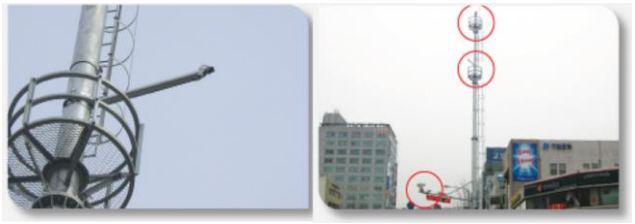

Figure 33 Intersection monitoring CCTV (left), CCTV video image (center), CCTV integrated pole (right)

C. Bus information system

Bus information system collects bus operations information on real-time and provides accurate bus arrival time to the residents. BITs are installed in main bus stops in the city that provides information on bus arrival time, bus operations information, traffic information, news and advertisements. At the same time the system provides information on other buses and their locations to bus drivers while the same information is transmitted to Anyang Smart City Center.

Figure 34 Bus information terminal (left) and on-board equipment inside buses (right)

D. Parking information system

Parking Information System is the system that provides real-time Information on parking lot to the users. As depicted in Figure 35, the system sends information on available parking lot to Anyang Smart City Center, which, in turn, provides the information to the users through VMS (Variable Message Sign), internet and mobile apps. This system optimizes parking facilities and alleviates traffic jams by helping vehicles find available parking lot faster, while at the same time, reducing illegal parking and thereby contributing to the reduction of carbon emission.

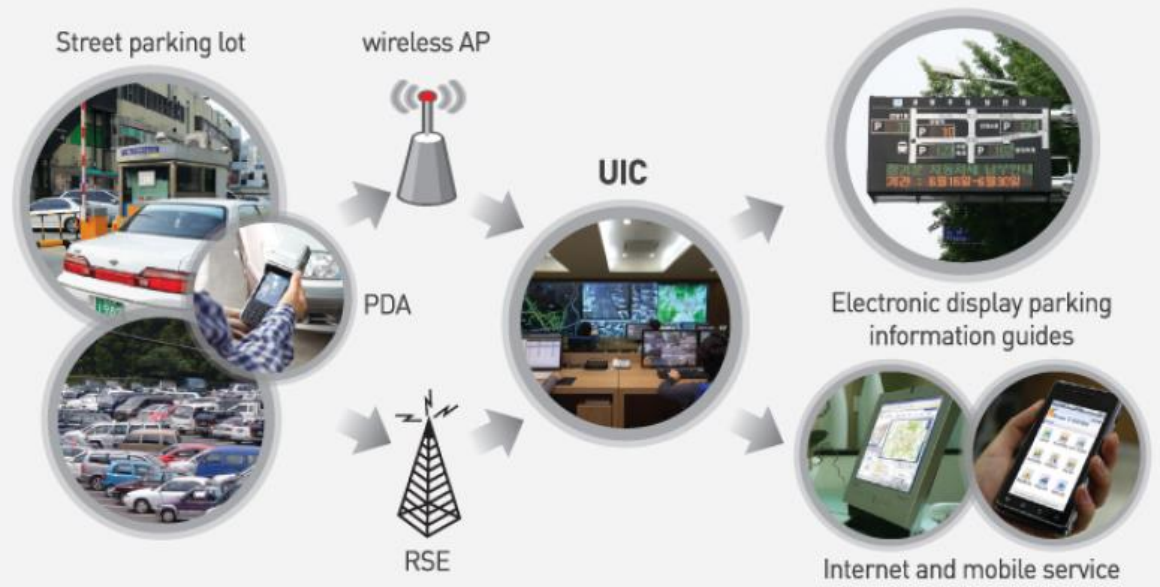

Figure 35 Composition of parking information system

E. Traffic Information Collection System

Faster and accurate collection of real-time traffic information is the most critical factor in Intelligent Transport System (ITS). This task requires various collection equipment. Anyang is Korea's first city to have installed HD CCTVs with 1 million resolutions at main intersections so to monitor traffic and potential accidents. Additionally, vehicle detectors are installed on the main roads to collect basic data on traffic volume and speed. Moreover, the City also collects vehicle location information through RSE, which are installed on main intersection. Information thus collected is transmitted to Anyang Smart City Center. Antennas of various angles such as 40 and 90 degrees for 5.8GHz and 360 degrees for 2.4GHz creates an optimal communications environment.

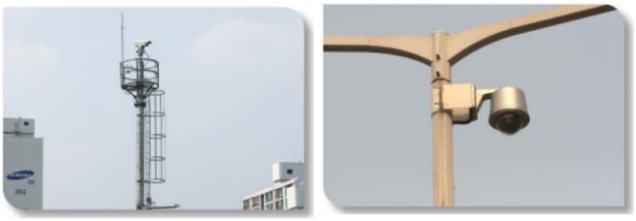

Figure 36 Closed circuit television (left) and vehicle detection systems (right)

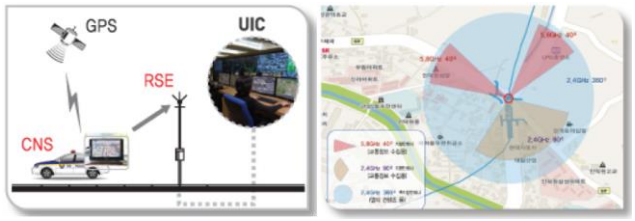

Figure 37 Road side equipment (left) and antenna range of various angles (right)

F. Traffic Information Provision System

Anyang City installed 10 VMS, providing general information on traffic including traffic jam and accidents to the drivers. This can help drivers find optimal traffic routes. At the same time, drivers can receive information on traffic situations, CCTV footages of main intersections and bus information to drivers through internet and mobile phones. Also, car navigation system on the city vehicles such as police cars and fire trucks provide officials with information on real-time traffic, missing persons, wanted vehicles, disaster and emergency incidents etc. (Figure 38)

Figure 38 Variable message sign (left) and internet a nd mobile services (right)

Figure 39 Key functions of car navigation system

3.7.2 Safety and citizen security

A. On-site crime prevention system

As depicted on Figure 40, Anyang installed omni-directional cameras and directional cameras to minimize the scope of blind spots, protecting citizens from potential crimes from occurring. In particular, the city can secure clear images even at nights with its infrared light projectors. The images thus acquired are sent to police simultaneously so that the police can act in a swift manner. At the same time, speakers and emergency bells are also installed on crime prevention poles so that in case of emergency, the citizens can communicate with Smart City Center.

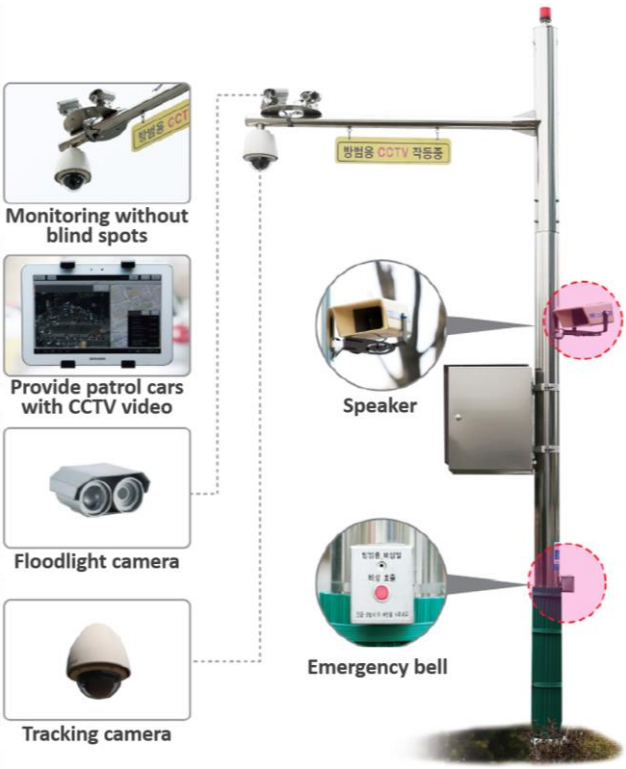

Figure 40 Smart city pole with crime CCTV, speaker and emergency bell

B. Plate number identification system

Plate Number Identification System secures vehicle plate numbers, time of passage, and the images of the vehicles, and calculates traffic speed and identifies crime-related vehicles (Figure 41). Anyang integrated traffic-purpose Plate Number Identification System with Crime Prevention Plate Number Identification to reduce costs and to increase the accuracy of the collected information.

Figure 41 Automatic vehicle identification system

3.7.3 Emergency and response

B. Social safety net linked with traffic infrastructure

Social safety net is strengthened through linking Anyang Smart City Center with real-time vehicle parking information collected through street/off-street parking lot and PDA parking agents which makes early apprehension of suspect and suspect vehicle possible.

Figure 42 PDA for parked vehicle management

B. Intelligent surveillance system

Anyang city succeeded in unifying responsibilities with Anyang Police Station and maintains close working relationship to jointly utilize CCTV of both institutions, especially in case of crimes including robbery and kidnapping. Thus, CCTV around crime scene is automatically linked to police station, precinct and patrol cars as well as providing CCTV footage to bring swift resolve.

Figure 43 Intelligent crime prevention system

3.8 Knowledge generation

3.8.1 Integrated database management

Anyang City may collect more than 10,000 number plates on average per day through utilizing 45 parking lots, 47 traffic CCTV and 535 crime prevention CCTV. By integrating the vehicle registration database, notification of the location of criminal, suspect vehicle and tax delinquent vehicle to the relevant authorities is possible. If the automatically detected number plate matches the National Police Agency database of suspect vehicle, the alarm within the Police Station situation room will sound leading to police dispatch and real-time apprehension.

Related to taxation, number plates will be detained and collection will be enforced after tracking down tax delinquent vehicles through the relevant database. If a citizen left its belongings in public transportation, the vehicle may be tracked through identifying the vehicle number, transit time, vehicle picture with the CCTV link as well as comparing the data with the reported lost property information.

Related to heavy rain due to unusual weather, the driver or owner of parked vehicles near the river will be immediately notified via SMS text message to limit flood damage through the database and pre-set mobile number. By linking the database in vehicles without exhaust fume reduction equipment, the city is contributing to air quality improvement through the possibility of enforcing exhaust fume vehicles in real-time. Currently, Anyang Smart City Center's real-time number plate database garners 10,000 new plates every day.

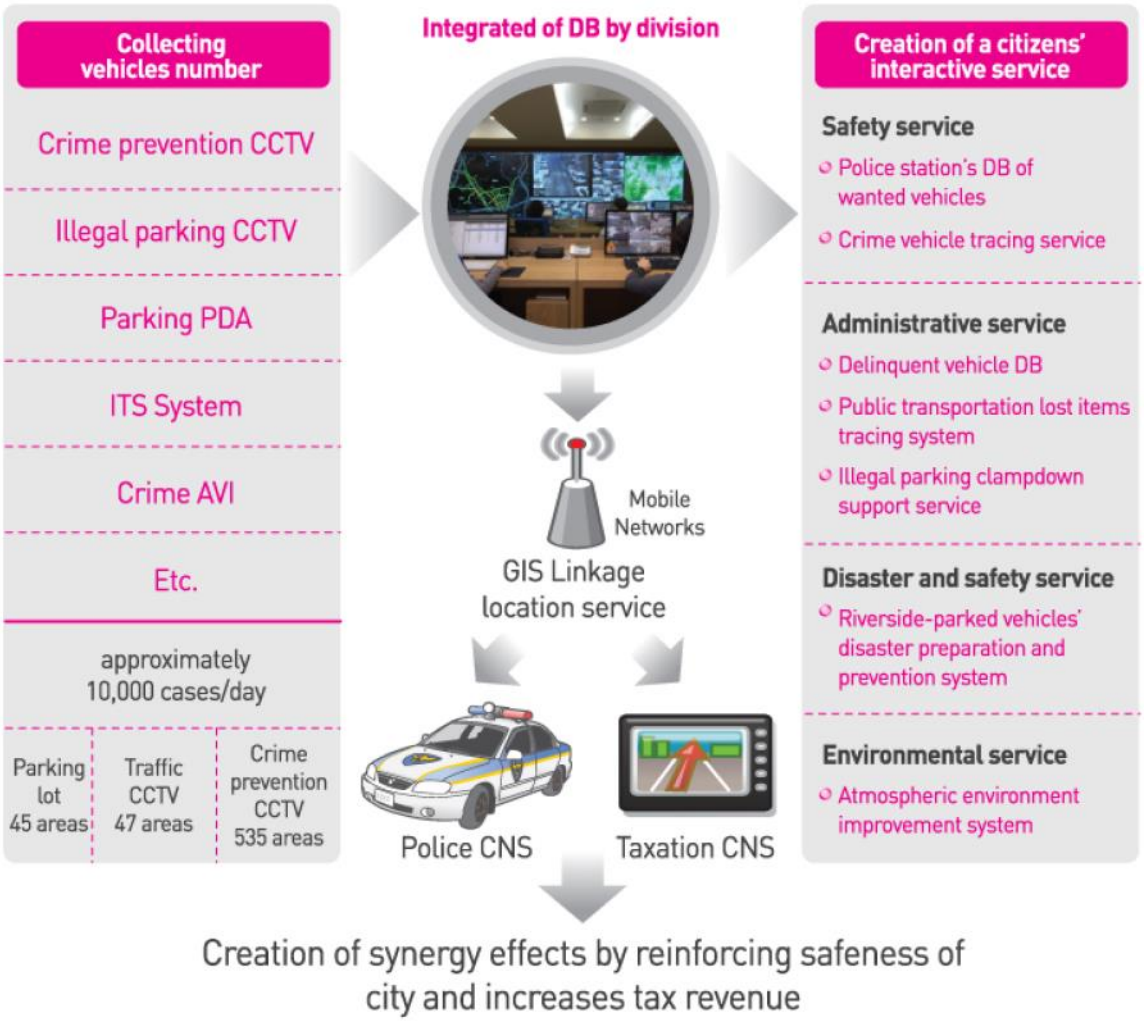

Figure 44 Overview of integrated DB management

3.8.2 GIS and safety map

Anyang City developed citizen's safety map through its cutting-edge GIS (geographic information system) software differentiating dangerous area and frequent accident area after a composite analysis with special focus on the 5 crime occurring sites, CCTV installation requested sites and educational facility sites. To do this, individually managed public database related to safety and disaster area in each department and institutions were combined with the consideration of GIS area to go ahead with the integrated database establishment. Figure 44 and Figure 45 depicts six GIS layers used in creating the citizen's safety map including public order, disaster prevention, traffic safety which is also used in diverse ways as policy information.

Therefore, patrols by police and voluntary groups are increased in danger areas prone to frequent acts of violence and robbery; close monitoring is undergone in flooding and disaster prone areas while reinforced traffic safety facilities are installed in traffic accident prone areas. CCTV monitoring while utilizing citizen's safety map enables central control system's effectiveness and maximizes CCTV installation by assigning limited personnel to vulnerable areas.

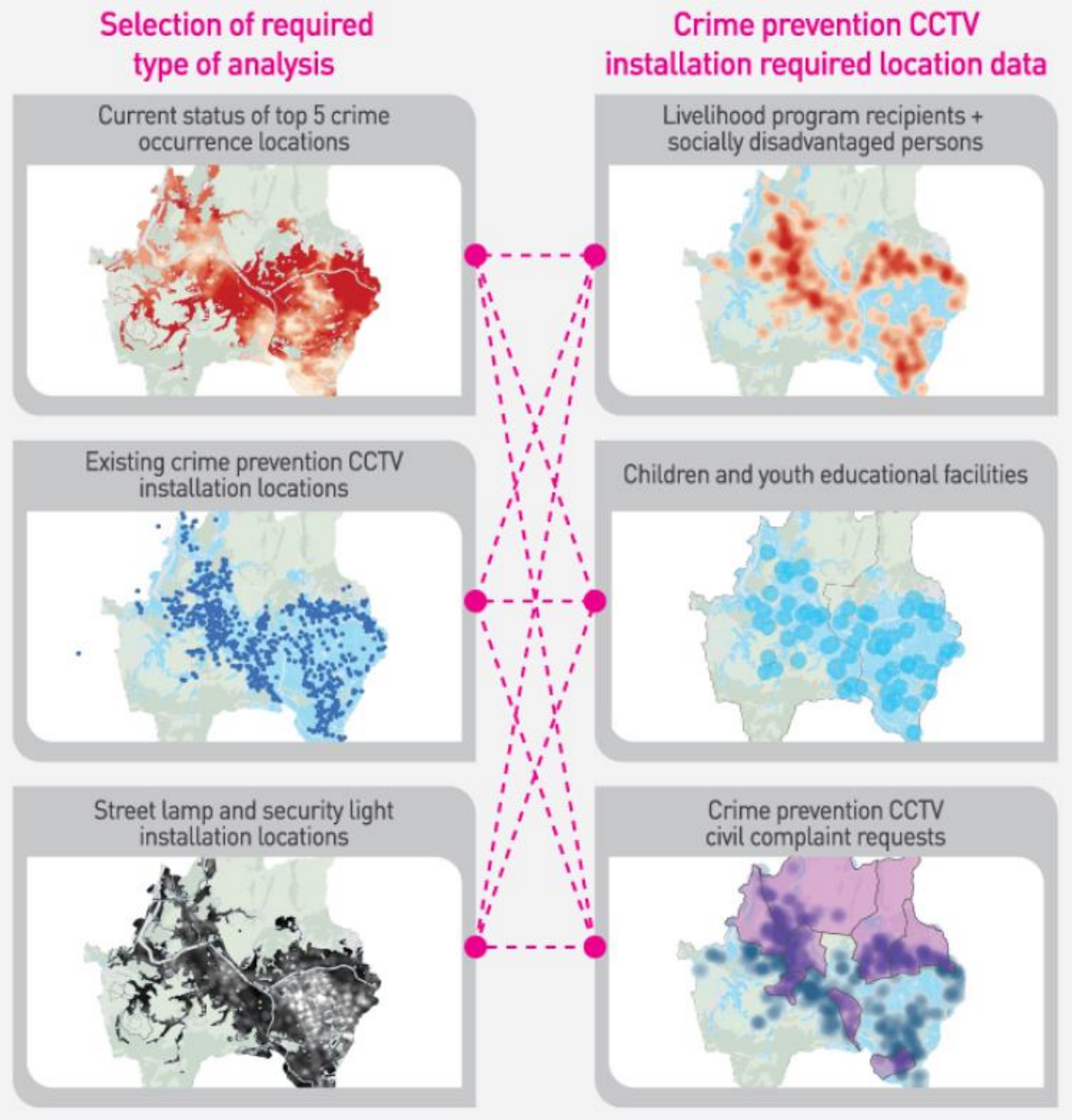

Figure 45 Overview of the establishment of a life safety map

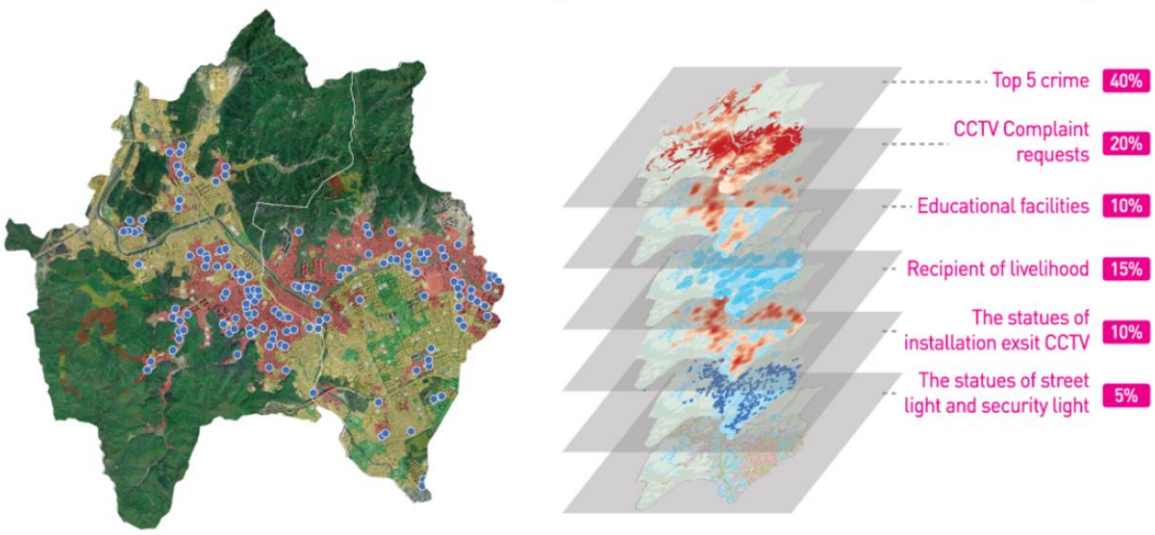

Figure 46 Layer overlay analysis and identification of crime-prone and extra attention-needed areas

4. Organizational Structure

4.1 Governance Model

Anyang Smart City Center is divided into Operation unit and Monitoring unit in the Traffic policy division under the Anyang City Road Traffic Office. Operation unit is headed by Anyang City public officials while the Monitoring unit is headed by police officers and 30 civilian personnel under its supervision to oversee crime prevention tasks in the city.

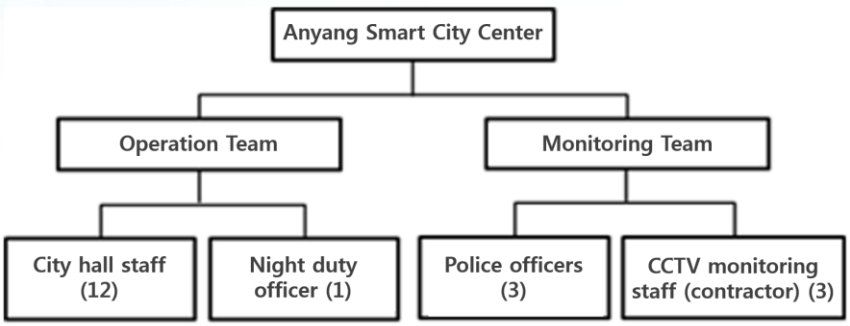

Figure 47 Anyang smart city center organizational structure

4.2 Human Resources

Anyang Smart City Center operates for 24 hours as a joint duty system. As depicted from Table 7, CCTV monitoring personnel are 30 contracted out personnel divided into 4 groups in 3 shifts for 24 hours. Operation unit is composed of integrated operations team and integrated information management team that maintains the situation room in shifts with 3 police officers. Table 8 depicts the tasks of the teams.

Classification	Total	Public Officials	Police	Contractor	Night Duty	Note
Total	46	12	3	30	1	Control personnel(30 personnel) 24hr duty system - 5 personnel per 1 group, 6 groups work 4 shifts (5am, 5pm, 10pm, 10 off day)
Operations Personnel	13	12	-	-	1	
Control Personnel	33	-	3	30	-	

Table 7 Anyang Ubiquitous Integrated Center workforce

Position	Integrated operations team	Integrated information management team
Team leader	In charge of overall U-integrated operations team tasks	In charge of overall integrated management team tasks
Team member	Establish project of Intelligent Traffic System(ITS) and Bus Information System(BIS), Operate and maintain/manage crime prevention CCTV and U-integrated situation room	Establish intersection CCTV and related tasks
	Provide ITS and crime prevention CCTV footage, manage safety helper service members	Maintain ITS CCTV, plan crime prevention CCTV planning
	Maintenance service project for Anyang Smart City Center, establish private footage protection and management system, establish and operate road crime prevention system	Establish operations plan for BIS equipment, Maintain cutting-edge signal system fiber optic equipment, Maintain dedicated fiber optic communication network, etc.
	Launch new crime prevention CCTV system (Construction of information network)	Operate and maintain crime prevention CCTV, manage maintenance items, pay public cost
	Provide and manage crime prevention CCTV footage	-
	Promote bus information system establishment project, establish and operate riverside parking lot control system	-

Table 8 Tasks of integrated operation team and information management team

4.3 Information control, ownership and sharing

All CCTV footage and related information collected through Anyang Smart City Center is shared in real-time to fire station, military unit, district office and 10 related organizations as of 2015. Table 9 depicts each organization's responsible departments and tasks and mutual coordination system is in place in case of emergencies.

Furthermore, Figure 48 depicts the CCTV in related organizations that are unified to maintain crime prevention, traffic incident and traffic flow, surveillance of forest fire and flooding. Recently, 336 CCTV from 42 elementary schools within the city that had been independently installed and operated have been additionally integrated. Further, crime prevention system has been fortified with additional 353 CCTV integrated to monitor underground walkway, pedestrian overpass elevator, and illegal parking. Other related organizations are operating control monitors for real-time monitoring and information exchange. Table 10 depicts Anyang Smart City Center CCTV's control mode, conditions for control by mode and activity details

Organization		Department	Task
Police Station	Traffic Patrol Division	Traffic Team	Traffic Monitoring
	Public Safety Division	Control Team	Suspect Apprehension
Fire Station	Support Division	Situation Room	Fire Monitoring
Military Unit	Capital Defense Command	Command and Control Room	Defense
	Capital Defense Command	Defense Security	Military Operation
Anyang City	Green Park Division	Green Area Team	Forest fire Surveillance
	Construction Division	Road Maintenance Team	Road Maintenance
	Disaster Management Division	Recovery Support Team	Disaster
A District Office	Traffic Construction Division	Road Maintenance Team	Road Maintenance
	Road Management Division	Green Area Team	Forest fire Surveillance
B District Office	Traffic Construction Division	Road Maintenance Team	Road Maintenance
	Road Management Division	Green Area Team	Forest fire Surveillance

Table 9 Joint monitoring organizations and linked businesses

Figure 48 Monitoring rooms at different agencies

Control mode	Monitoring of suspect apprehension	Monitoring of traffic incident	Monitoring traffic flow
Operation conditions	Criminal activity occurrence	Recurrent signal violation section	Congested area during commute
Details	Aid suspect apprehension through utilizing all surrounding CCTV including crime prevention and traffic CCTV	Utilize evidence for traffic incident upon signal violation	Check for congested areas in main roads and secure smooth traffic flow
Control screen			
Control mode	**Monitoring forest fire**	**Monitoring flooding**	**Monitoring heavy snowfall**
Operation conditions	Dry period (optimal for forest fire)	Typhoon, heavy rain period	Heavy snow fall warning issued
Details	Closely monitor forest fire in mountainous area surrounding Anyang City	Closely manage recurrent flooding area and riverside parking lot surrounding Anyang river	Secure traffic flow and prevent Incident through monitoring icy road status and snow fall during winter season
Control screen			

Table 10 Control modes of Anyang smart city center CCTVs

4.4 Protocols and procedures of decision making between agencies

The decision-making system of related organizations is pre-determined by smart city function and the responsible department is in charge. The typical decision-making example of a smart city operator is the regular monitoring function of the traffic situation of main roads. However, for monitoring of forest fire surveillance, flooding, road conditions (construction and freezing), the IP and PW must be granted by the city's disaster prevention and construction division, green park division and each district office's relevant department (traffic construction and city management) in order to jointly monitor and control. In matters of defense and disaster management, swift integrated response is possible during emergency situation by joint monitoring with related organization person in charge and giving direct CCTV footage control with close coordination of Anyang City, Police Station, Fire Station and Military unit. Figure 48 depicts Anyang Smart City Center's CCTV control screen whereby the police and Defense security unit is implementing the control mode with the right to control. As such, Anyang Smart City Center's various collected footages are jointly utilized and operated by related departments and organizations which prevents overlapping investment and provide for an effective disaster management system possible.

Figure 49 CCTV integrated solution control rights provision

4.5 Cost System

Anyang Smart City's yearly maintenance costs are largely divided into service costs for operations, system maintenance costs, electricity and communications costs. Personnel costs for CCTV monitoring require yearly 920 million won. Maintenance costs is divided by CCTV maintenance cost and Traffic maintenance costs including the center's system, ITS and BIS. Anyang Smart City's 2015 operations budget is 1 billion 995 million won, comprising 5.6% of the system establishment cost of 35 billion 528 million won.

Area	Cost (KRW 1 million)	Main tasks
CCTV monitoring service project	920	·Personnel cost for 24 hour crime prevention CCTV of 30 control personnel
System maintenance of the center	300	·Center server and system malfunction maintenance
Traffic (ITS, BIS) maintenance	245	·On-site maintenance for ITS, BIS system malfunction
CCTV maintenance	420	·On-site maintenance for crime prevention CCTV, AVI malfunction
Operations	110	·Electricity cost, Communications cost, etc.
Total	1,995	

* KRW 1,200 = approx. USD 1

Table 11 2015 operations budget structure and costs

5. Monitoring and Control

As we have seen previously, Anyang City's Smart City has gradually progressed from BIS to ITS and onto crime prevention projects. The results from operations revealed that public transportation users benefited from increased convenience. Before BIS introduction, public transportation users had to wait unknowingly of the bus arrival time at the bus station. However, the satisfaction level of public transportation users increased after BIS service provided real-time bus location and arrival time at the bus station.

Furthermore, order of operations could be maintained under the supervision of the bus operators by identifying whether bus drivers followed normal routes and bus lanes. In the end, management conditions of bus operators improved while overall public transportation users increased as individual car drivers were absorbed into public transportation, following improvements in bus services.

The effects in crime prevention area have shown remarkable success after operating the Anyang City's U-integrated situation room. Upon comparing the before and after U-integrated situation room operations, the crime rate in Anyang City marked a significant annual average decrease of 17.8%. Therefore, the crime prevention effect proved widely successful for the realization of a safer city through implementing the smart city system.

Classification		Total	5 Major Crimes(Case)							Other criminal offense(Case)			
			Subtotal	Murder	Attempted Murder	Robbery	Sexual Harassment/ Assault	Theft	Assault	Subtotal	Kidnapping	Fraud	Others
Before(2009)		**20,854**	6,266	1	5	39	180	2,483	3,558	14,588	3	1,535	13,050
After (2012-2014 average)		**17,149**	5,497	5	5	46	196	2,685	2,560	11,652	4	1,836	9,812
Changes	**Change**	**Δ3,705**	△769	4	0	7	16	202	△998	△2,936	1	301	△3,238
	%	**Δ17.8**	△12.3	400	0	17.9	8.9	8.1	△28	△19.6	33.3	19.6	△24.8

Table 12 Operation results of the Ubiquitous Integrated Center

Crime occurrence in open spaces such as roads or parks showed a decrease in a wider margin than the overall average compared to crime occurrence in closed spaces and indoors. This results from Anyang City's active crime prevention activities. Thus, activities of prevention, crackdown and arrest were accordingly conducted by dispatched police officers upon detection of crime signs in open spaces capable of real-time monitoring. In reality, the achievement of crackdowns and arrest of 1,266 crime activities on the scene was achieved by June of 2015 following the start of U-integrated situation room. Other crimes noted are of plain criminal offense such as arrest of a wanted criminal, crackdown on drunk driving and disturbance and admonition of teenagers.

Classification	Total	Robbery	Rape	Theft	Assault	Others
Total	1,266	10	1	387	78	790
2015(~June)	234	0	0	75	26	133
2009~2014	1,032	10	1	312	52	657

Table 13 The number of arrest for criminal behavior through monitoring

6. Lessons Learned

Anyang City's U-integrated situation room combined and integrated ITS as well as various services such as safety, disaster prevention, facility and communications into one platform. The platform is assessed as the standard for integrated CCTV system in Korea as related departments may respond in a timely manner upon urgent situations. By December of 2014, 2,226 people of 312 cities in 85 countries including United States, Japan, China, Columbia, Mexico and Vietnam have visited. Many difficulties were experienced to complete the current Anyang City's U-integrated situation room such as technical problems in establishing the system as well as understanding mutual organization's duty and reaching a mutual agreement of a common goal.

The process was full of overcoming limits and obstacles including internal conflicts of project group, lack of information sharing between organizations, lack of mutually balanced development, inadequate development of convenient content for citizens and other issues not addressed. The following is a list of efforts made by Anyang City:

First, Anyang carried out projects methodically that it could take on capacity-wise. Much needed services for citizens were analyzed and pushed ahead step by step. With the start of BIS in 2003, small and big trial and errors were undergone to develop the system and operations.

Second, separate group were organized to effectively operate the system and professional staff were trained. Traffic area related department is often avoided by public officials in Korea. Hence, it is regarded as a department which continuous duty is undesired in the circulating post system. In this environment, professional public officials were specially appointed who can continue working with great passion to operate a consistent and stable system for a long term.

Third, the drive for the project was successfully steered to create a network for mutual exchange of know-hows of development and maintenance of related organizations as part of work innovation as well as fostering mutual win-win strategy and consensus making. Moreover, a special team was needed to be in charge of mediating decisions during any conflict of interests between related organizations and establishing a cooperation system during the project.

Fourth, the project was pushed forward actively to include the various needs of experts of all fields and citizens while implementing cutting edge system and technology fitted to Anyang City to establish a differentiated and reliable system.

Fifth, operations-efficient software access was preferred instead of a hardware centered access. Operations method and system were improved to provide safe and convenient services to citizens by making the most out of the given infrastructure and available resources.

Organization	Roles and Responsibilities
Central Government	- Policy support of overall department of national information oriented project and local government's information oriented project
Anyang City	- Drive the project initiative and implement plan for specific information oriented project
Anyang Citizen	- Cooperate with survey and collect various opinions to form a consensus for public and private coordination
Related Organization	- Administrative and technical support for police station, fire station and military unit
Advisory Committee	- Advise on policy and technical issues of information oriented project
Project Management and Inspection Team	- Assess and certify related technology of information oriented project - Responsibly supervise with placed authority on issues pertaining to contract and related statute
Business operator	- Establish and operate system - Run trial test, prepare education and training, and establish maintenance management guide

Table 14 The roles of each participating organization for Anyang Smart city

Table 14 illustrates the roles of each organization that led to the successful establishment of Anyang city′s smart city initiative. Coordination between Anyang city and the police agency was especially vital in establishing the current smart city center. The following are main factors that contributed to the success of such center establishment. First, Anyang city focused on customized software improvements and safety measures as solutions from the early stages. Moreover, stable and successful system establishment was pushed ahead through the city and police agency′s coordination and overcame limits to seize the main operating position through mutual trust to strengthen the established social safety net. Second, operations management system was established for stable operations after agreement was finalized to divide the roles of each organization. Third, professional staff with wealth of project experiences including experiences in IT system integration projects from 2003 was prioritized to oversee system establishment and operations.

The needs of the city, police agency and citizens has evolved and expanded in varied ways to go beyond the plain system of mere installing the system and monitoring. Therefore, CCTV installation, which has been the forefront of the project, will be expanded and diversified to meet the changing crime surroundings in the future. Currently, Anyang City is actively seeking development direction for the system after gathering citizen′s opinions on the spot as Anyang shifted from a lean-to-one-side system to ″citizens″ and ″results″-centered focus. Anyang City′s smart city center’s degree of completion and employment will be substantially improved to provide heartfelt administration procedures, going beyond mere satisfying citizen's convenience. Further, Anyang city expects to create synergy by maximizing existing facilities without any additional cost.

Furthermore, Anyang seeks to pioneer in the innovative administration area, proposing ubiquitous vision for society which is in line with the information age while clearly defining our goals as providers of integrated service centered on citizens and establishing our city as the cutting-edge IT city delivering U-service compatible to local surrounding.

7. Conclusion

Smart city system of Anyang city, which has been constructed for over 10 years since 2003, is a representative smart city development case of Republic of Korea. With initial introduction of the Bus Information System (BIS) that allows citizens to be informed of real-time information of bus arrival time, Anyang has gradually expanded the scope of its smart systems to provide services that secures urban security, prevents disaster and much more. Currently, Anyang city is considered to be offering one of the most stable smart services for a wide public. Not surprisingly, for the past 10 years, Anyang has been a benchmark smart city for other cities of Korea and it has even been awarded by the President of Korea as a model city. Anyang has shown impressive performance through smart services, especially with regards to the crime prevention, and hence contributing in creation of safe living urban environment.

One of the reason behind the rather successful continuous development of Anyang smart city service may have been creative and sincere efforts of the city officials. The success factor of Anyang's case that should be emphasized is the willingness of the authority as well as the financial and technical supports they received. Therefore, the construction of successful smart city and maintenance of high quality service, may only be possible by utilizing groups of city officials that are highly equipped with relevant knowledge and skills, and by supporting their efforts.

ANNEX A - Bibliography

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Interviewed stakeholders

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