A Study on the U-Cadastral Space Data Modeling in Korea

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Key words : Ubiquitous, RFID, UFID, U-cadastre

ABSTRACT

Modern society is mega-trend society based on ubiquitous technology. In order to use it properly, cadastral information such as relative and absolute coordinates of land location and boundary of land described in maps, plays an important role. In this study, cadastral information is used by maps, RFID and UFID, making it easy to perform field working by wireless network. Furthermore, it is possible to maintain cadastral results by unified ITRF, various surveying data and unique ID of RFID boundary point.

1. INTRODUCTION

Korea is seeking a ubiquitous society in which information between human beings and things as well as among men could be shared. It is needed to change management system by applying information technology into cadastral area in which various needs of customers could be satisfied and sharp growth of land demand due to rapid industrialization and urbanization. As the establishment of ubiquitous cadastre shaping U-something is necessary on the field of cadastre which is a basis of intelligence society, at this point f time, it is urgent for cadastre and decision making supporting system to be used as ubiquitous merging technology.

U-cadastre is defined as "by using requesting information of land ownership regardless of place and time, decision making could be made". Namely, the forming circumstances of Ubiquitous could be maximized above all when it is possible to recognize relative or absolute location by space reference system and utilize a number of attribute information related to it. At the "Symposium of IT and Future Vision of Korea" held on 26 October 2005, as a result of research of IT based future national development strategy, twenty mega-trends of future Korea prospect were presented. At the symposium, "The Prospect and Confrontation Strategy in Ubiquitous Society" was discussed. That is, it is said that this coming society will be a society of Ubiquitous.(7 November 2005, Korea Electric Times)

In the ubiquitous circumstance, cadastre fulfills a useful information source because it contains location reference information and various attribute information. In this paper, it is studied for ubiquitous society that surveying results could be maintained both absolute location according to the world reference system and relative location among boundary points by data conversion on land boundary and intelligence of boundary marks on the fields. And the model which manages surveying data on the field will be made so as to meet the requirement of society.

2. THE CURRENT STATUS AND PROSPECT OF UBIQUITOUS ORIENTATION

It is expected in direction of technology innovation in cadastral area that processing and maintenance of cadastral information, efficient access and supply of information and acquisition of data in the area of surveying and mapping will be developed dramatically. Technology plays an important role to build up land administration system. In the area of cadastral surveying, GPS, numerical cadastre and GIS technology will be grafted together in the near future, changing the feature of cadastral data into focusing each land parcel. Due to changeover of surveying system caused by establishing land information system, it is possible to inquire surveying data in real time basis and notification of surveying results and realize a mobile surveying system that is to work at home for one's company. And maintenance of surveyed data on the field could be computerized in a various forms by electronic tag and mobile terminal in order to originally recognize the objectives such as GPS and UFID.

Through these technologies, operation speed enhancement, saving costs, appropriateness, correctiveness, field working simplicity could be achieved. Therefore, current cadastre will be changed to realize multimedia and three dimension application of urban space according to data feature. In acquiring data, it can be further developed from a simple management of vector image to realization of imaginary space combined with images. It is needed to support a human-oriented decision making. It is expected within ten to twenty years that cadastre will develop computerization of current data and combination of them.

In case of cadastral surveying, there has been a progress in correctiveness enhance and acquiring data and analysis of it last twenty years owing to satellite image and GPS surveying. By using this information technology, it can be applied to land management and spread to other areas, connecting new technology makes it possible to provide real time information and to form service system on internet basis. By combining various knowledge systems and operating boundary points management system on the fields relating to cadastral surveying, more research will be done on the new data feature and surveying methods.

Our society started computerization on 1980s and ubiquitous project has been driven from 2003 as one of national strategic projects. Due to the change of cadastral circumstance, past method of land boundary management moved to computerization of land books, forest books, cadastral maps and forest maps, finally completed KLIS(Korea Land Information System). In the future, U-Cadastral Basis such as U-Korea, U-City and DMC(Digital Media City) is oriented as a new national vision by introducing three dimension cadastre, intelligence of land boundary, registration of facilities such as building and coordinate system conversion.

The future prospect is that intelligence on the ground boundary(electrical recognition, acquiring location coordinate, recognition of ownership information and registration of facilities) and changing data supply method positively from the past method of negative acquiring method. Cadastral service should be spread to mobile administration focusing field working and cadastral data used mainly from management centered to users. In order to support this goal, surveying method should be changed to conversation type management system by GPS and computerization. This will make it possible to work at home due to simple and minimizing working process caused by computerization, necessity to a small number of worker and data

processing regardless of space.

In dealing with space recognition, it will be possible to recognize address and parcel number location by electric chips, enhancing current address and parcel number system. By installing this intelligent mark, it will be easy to perceive the boundary and to confirm visually, diminishing the number of dispute. Our society requires to reestablish national cadastral system through cadastral resurvey and NGIS(National Geographic Information System)

Table 2.1 Developing Steps of Ubiquitous Orientation

Classification	Computerization	Information -orientation	Knowledge -Orientation	Ubiquitous -Orientation
Times	1980s	1990s	late 1990s	2003~?
Objective	handwork	information flow	knowledge level	things
Goal	automation	Sending & receiving information freely	knowledge share	optimum function
Result	manpower reduction	information circulation	knowledge study	space management

U-cadastre is also to give intelligence space location and attribute information on land and things, optimizing the functions and connecting network each other. This will make a circumstance in which digital land information can be used regardless of time and place, enhancing citizens' living quality dramatically.

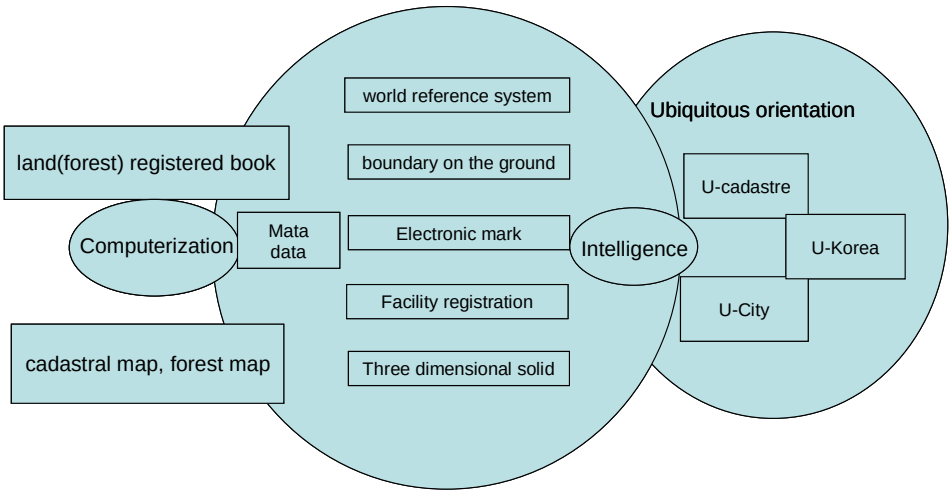

Figure 2.1 Ubiquitous and U-Cadastre

The function of U-Cadastre is to establish infrastructure of national land information by electric-tag recognition of GPS surveying results and to endow unique ID, forming the address, parcel number, location of coordinate, surveying information and additional information. In case of ubiquitous location, it supplies both absolute coordinate according to world reference

system and relative location information around the area, playing a role of standard location of Korean types of U-Korea. It also establish a service network of Ubiquitous, performing inquiry of parcel, boundary point, image, ownership and statistical analysis.

By the interface of human-maps-space, it provides location information which is unique characteristics of Ubiquitous and connections between human, geo-features and things. U-Cadastre is to digitalize the existing analog type surveying results and combine them into computer technology. And it is possible to survey by connecting the various communication networks while moving regardless of time and space, forming mobile circumstances. The current status is to operate in the form of digital cadastre, focusing on management of cadastre according to on-line system. However, because a mobile service system has been formed nationwide due to the development of the internet, GPS surveying and electrical equipments, it should be prepared for the circumstances of wireless mobile, censer and intelligence of boundary points by using them efficiently in cadastral area.

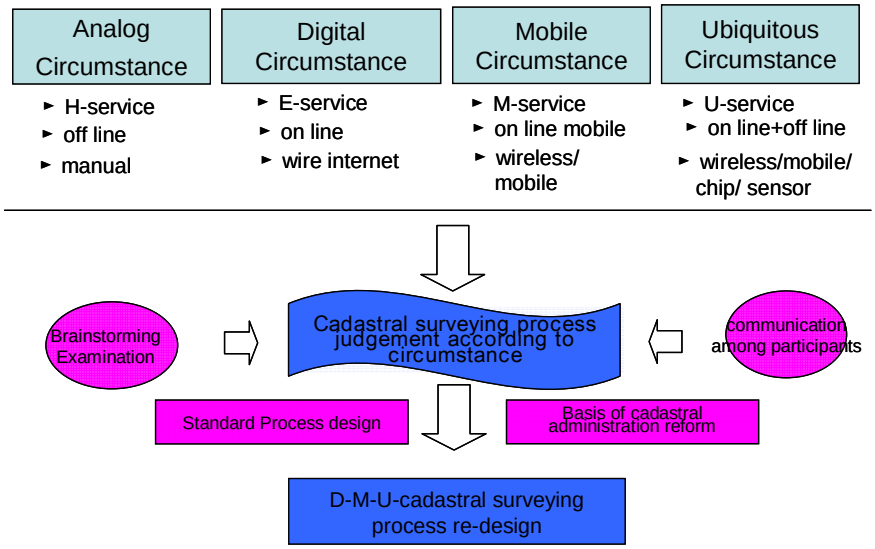

Figure 2.2 Changes of Cadastral Circumstance

In current Korean cadastre, land boundary surveying is operated by realizing boundary in maps into on the ground. In this case that the degree of realization of maps on the ground is high or land owners are not much care about their boundary, there is little problem of it. The ideal is that maps and the realization on the ground is always consistent. As is seen in the table 2.2, if the current system is complemented to maintain boundaries on the ground, the adjacent landowners will definitely be aware of their boundaries on the ground, helping to diminish disputes on boundary location. Therefore, surveying workloads will be decreased, focusing on services on the field oriented rather than customer's appeal on land boundary. However, there will be occurring new surveying workloads and needing huge investing costs in the first stage.

The map(cadastral map) information service could provide the GPS location, message, voice and image for object location, connecting handicapped person information system, supporting statistics, national resource management and preventing natural disasters. It is also established

by linking topographic information, distribution, properties and financial system. And by using a positive type RFID, it is possible to recognize the location of facilities inside the building. Whereas the current cadastre has functioned mainly to show the boundary limit on property ownership, the new U-cadastre should be possible to manage additional information service. Therefore, it is needed to set up electrical intelligence data system connecting the various attribute information rather than simple geometric location information acquired by surveying.

Table 2.2 The Comparison between U-Cadastre and current cadastre

Classification	Current Cadastre	U-Cadastre	Remarks
boundary relocation survey	boundary on map	boundary on the ground(coordinate)	
Administrative service	applicants visiting administration	field focused administration	
no of Surveyor	2~3 person	1~2 person	change of surveying method
registration method	two dimension	three dimension	change of dimension
management cost	continuous spending	huge investment at first stage	
data type	analogue	digital	
boundary mark	wood pile	UFID	intelligence
boundary recognition	need to survey	need not to survey	
reference system	regional reference system	world reference system	

3. DATA ESTABLISHMENT IN BOUNDARY POINT OF U-CADASTRE

3.1 Land boundary management of Korea

The general definition of land boundary in Korea is "the tool which defines legal right of land ownership and the scope of right, and is section line forming land right unit. The location of land boundary point is consisted of absolute location and relative location among the locations of boundary points. The boundary relocation is a matter of civil law between adjacent land owner towards the binding force of boundary marks of boundary points on the ground. Boundary also could be divided into three parts. These are limitation of place which is boundary of criminal law in case of ownership invasion, the boundary of civil law which endows legal effect on physical boundary by configuration of ground and objects, the administrative boundary by cadastral surveying. Thus, the boundary location of land is examined by the distance from adjacent boundary point, graphical maps showing direction, numerically relative location and absolute location by coordinate value. The boundary relocation is operated to restore location correctly which is registered as a boundary in cadastral book. In case of the Cadastral Law of Korea, there are several principles which apply to it, namely, principle of registration method following, scale file, registration periods, and the

acknowledgement of possession limitation.

3.2 UFID transforming by NGIS

To realize boundaries of maps into on the field, it is needed to secure confidence in map boundary management system, the land owner's recognition of boundary location, and historical maintenance of it. Because the three dimension cadastre manages registration objects horizontally, it is needed to introduce facility management system by three dimension Ubiquitous in order to meet to variously utilize urban space such as underground facilities and underground roads. Land information by Ubiquitous can be used surpassing time and space, making it possible for people to acquire and use location of land and building, processed information regardless of time and space. The objects which compose main body of Ubiquitous should be endowed with usefulness. In order to do so, the identification method of objects should be simple and standard as is seen on figure 3.1, conforming to NGIS system.
For example, the number of UFID, like '2 21 11061 4611 3591300300 0009907652' has administrative division(2 21 11061), topographic classification code of factories(4611), code of maps(3591300300), topographic identifier of each organization(0009907652) and error check(7). The thirty two unit of UFID can be stored by the type of ASCII or Binary. Moreover, all types of topographic features are endowed with UFID such as buildings, cultural assets, railways, roads, streams, lakes, coasts, administrative boundaries, surveying control points, cadastre and contour.(http://isel.cs.pusan.ac.kr)

The technology development of electrical identifier application of topographic feature is needed for national land computerization to manage and use topographic features systematically. And it could also lessen the inconsistency of Database of National Geographic Information System. Research on UFID, especially, definition method, endowment system, management method should be done and the method of Database connection and integrity among organizations by using UFID developed. The management system of electrical identifier application is constructed by Applied Geographic Information Database Using System, General Application Database Using System, and Basic Geographic Information Database Management System. At the first stage of construction, it contains ID topographic feature information, UFID endowment, transfer of updated data, updated data propagation, UFID topographic feature information, and non-space data, UFID management system and connected to application system.

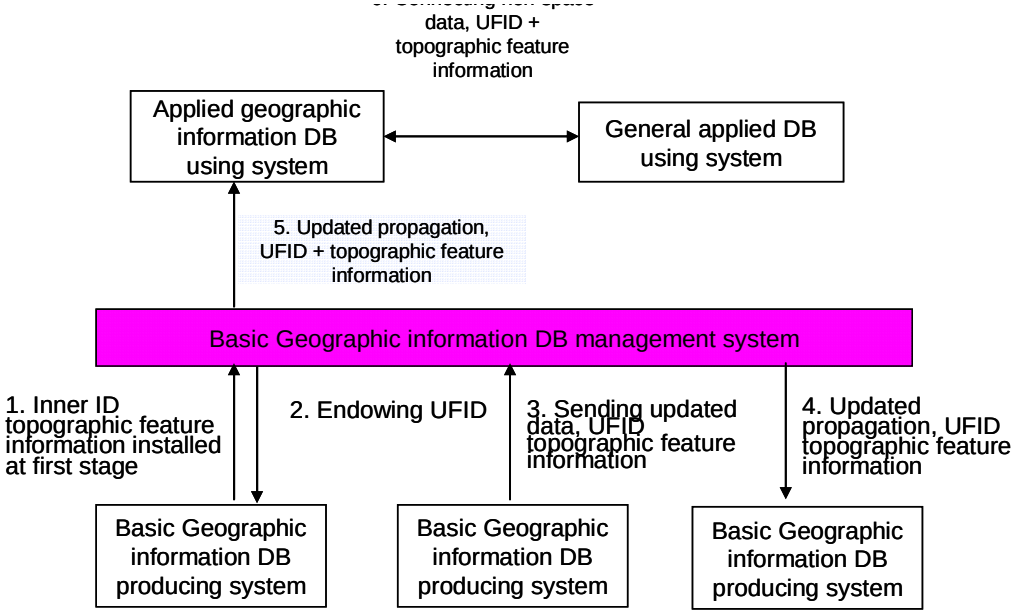

Figure 3.1 UFID Management System

3.3 Modeling of Cadastral Data on Field

To acquire cadastral data on the field, installation of instrument point, information of orientation points such as orientation of back-sighted point, and observation indicator. Most of surveyed data are the results of reconnaissance survey, dealt by computer processing. In case of computer processing, it is decided whether to operate computer processing by adjusting observational vector on the basis of current control points or to maintain originally observed results. It is also decided that both of them to be managed. The field structure of observed file is composed of more than one field by identifiers of each field which is the simplest structure of surveyed text file, having the standard structure.

3.4 Data Communication & Network

Traditionally, in mobile surveying, a serial communication method by wire of less than ten meters. However, due to the development of hardware, wireless communication technology could be applied to surveying equipments, solving problems of exchanging equipments and access to remote equipments. In recent years, UFID management system by RFID has been installed in order to manage various objects in Ubiquitous circumstance using sense technology. The bluetooth is for short distance communication, having several layers not only serial communication but also TCP/IP, and internet voice. The components of RFID system and operation flows is shown on figure 2.1.

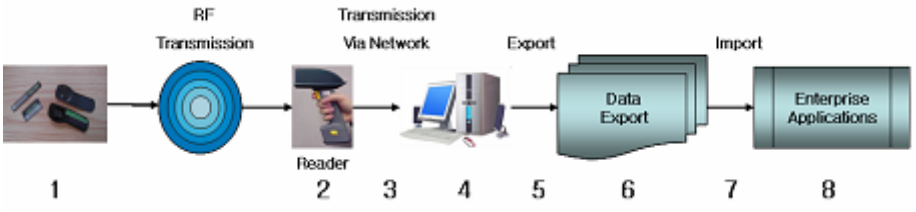

Figure 2.1 RFID operation Flow(IBM, Korea)

The components are a tag for storing data like feature information into the memory chip, the Reader for recording or reading data in tag through RF antenna, the Wire decoder and Network which are located between data storages. The Reader Manager orders to read data from the Tag and also interpret data transferred, sends the data from the tag. In this case the Tag data is transformed to a suitable types for to be transferred. The tag data is to be input by applying Back-end work. The application part deals with the tag data processing in order to apply for practical business affairs.

3.5 Method of Modeling Land Boundary Data Establishment

For land boundary, in order to distinguish ownership, intelligence on boundary points followed by electric intelligence, coordinates of boundary points and surveying result management model should be formed. In order to do this, it is studied in this paper that the problems of the management system of current cadastral data and the data modeling for new Ubiquitous will be illustrated.

3.5.1 Intelligence of Boundary Signal

The current boundary signal of land is just to show the surveyed location on the ground and has a function of specification. And the feature of signal is extremely simple. It does not have unique information. Also it is not compulsory to nominate officer who is in charge of, causing national economical loss. Therefore, by being intelligent of it and recording the date of surveying, name of surveyor, absolute and relative coordinates, it will be possible to manage it more efficiently. It could be a convergence type parameter which can be applicable to different usage. Currently, this type of being intelligent is widely used in the area of transportation, distribution management and hospital. It can be possible to obtain rising effect by using information technology.

In case of boundary points, the National Geographic Information System and standardized feature code are to be connected to create electric identifiers. Likewise, in case of having insufficient memories of the chip, by using ASCII code which has thirty two bytes or binary information, the Key should be comprised so as to connect the server database by code method. As is seen on Figure 3.1 and 3.2, various electrical signals are currently used and the most suitable scope and eternity should be examined to adopt it in cadastre. In installing boundary marks, a number of materials such as glass, fabrics, magnetic, irons can be composition of them, and they have to be eternal and easy to track. The figure 3.2 shows the material type, records and reader of RFID and application programs which are suitable for cadastre are to be

connected to operate it.

Table 3.1 Utility of RFID by frequency

Frequency	**Utility**	**Remarks**
135㎑	ski gate, automatic factory, exact calculation of restaurant	output of electric wave is low
13.56㎒	transportation/public car, IC public phone, management of admission	widely used at the moment
900㎒/UHF	distribution management, history management, items management, car management	frequency assignment by Ministry of Information and Communication

Table 3.2 Feature and Characteristics of RFID

Type	Electricity/electric wave	Price	reaching distance	Characteristics	Manufactured Company
Inactive type RFID	having no battery its own electric wave	Cheap (500~5,000 won)	a few ㎜~ a few m	small, less weighted using semi-permanent	Hitachi, Phillips
Active type RFID	battery/electricity supply transmission of electric wave	expensive (10,000won ~)	tens of m ~hundreds of m	battery lifespan (~10year), sense attached, high function	Omlon RFC Code

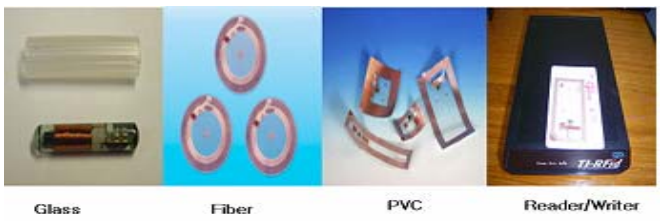

Figure 3.2 Materials of RFID and Reader

By unified national control points system, a number of Location Based Service(LBS, Telematics, Home-network) can be connected, progressing to the stage of cutting edge city. The gradual strategy to enhance current land information and geographic information towards the new concept of model containing complexity, solidity, large scale and collection by using core IT technology and convergence, is through following steps in cadastre.

The first step are unification of national control points, measuring absolute location by GPS,

establishing unified coordinate system and connecting them to relative location.

The second step is to make boundary marks to be electronic by using electronic tag and to be signified as conversational type. In this step, location basis service will be standardized to connect public service systems.

The third step is to enhance registration system, registering ground features into three dimension. Land classification which specifies land usage will be simple and specific.

The fourth step is to enhance cadastral information management system, changing from management at offices to the field by mobile system. This will solve the inconsistency of cadastral results in particular areas. In this case, cadastral resurvey and the surveying for intelligence are to be accompanied.

The last step is to enhance a service system. Namely, by applying wireless internet information technology in mobile cadastre, the obstacles of time and space will be solved. And it could be possible to supply real time information service to the public, enhancing work process of pubic administration. Additionally, it will be connected to U-Information Project(U-Administration, U-Welfare, U-Environment, U-Distribution, Helper Service of Handicapped Person, Automatic Sending of Rubbish Location, Food Bank, Supporting Distribution, Location of Pollution).

3.5.2 Physical Model of Boundary Point Data Modeling

It is possible to read and write electronic information on boundary points and to manage necessary information. The information is connected to current communication network and wireless internet by terminal and the boundary point management server in real time, operating searching, registration, acquiring of information. The data on the web can be used by multiple users through the internet.

Figure 3.3 Boundary Point Management System of RFID

In case of the current numerical surveying, the coordinate of boundary point is achieved by direction angle and interior angle and horizontal distance from cadastral triangulation point and cadastral traverse point and is registered. It is desirable that relocating coordinate on the ground is performed through the procedure of surveying process. However, it is done by obtaining the interior angle and distance by converse calculation of absolute coordinates, sending the error of

the control points to the boundary point. In case that boundary relocation is impossible due to physical obstacle at the time when the surveying is operated, surveyors select one of control point at his convenience to do boundary relocation survey. To use in survey the different control points rather than the one used at the time of registration, the surveying results of relocation have the same error which the control point had. In order to solve the problem of error transfer by control points, a couple of methods can be applied. One is to enhance the absolute location results on boundary points by using GPS, and the other is to record location information into electronic chip by RFID.

In case of data model, the information of surveying points on surveying equipment point, back-sighted point, forward-sighted point, and surveying results by interior angle and distance will be maintained, finally being changed into ITRF results on each field. If the capacity of field tracking and information possession which RFID has can be used, efficient management of it will be possible, having being exchangeable with the current system and connection with the computer file data.

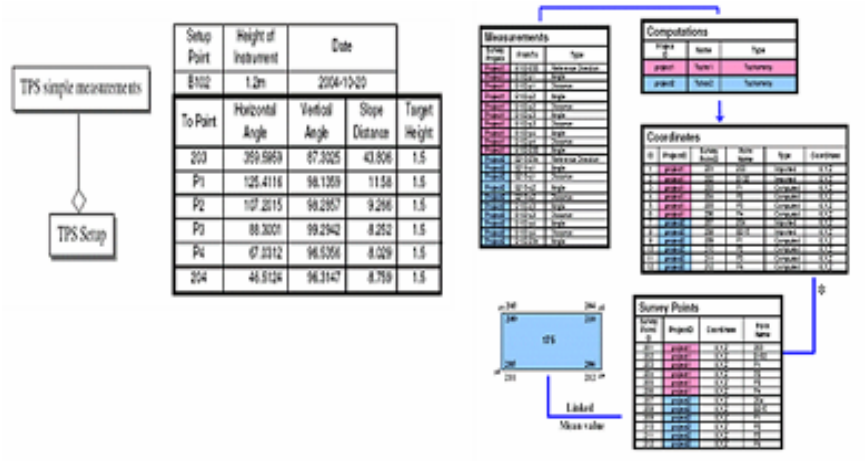

Figure 3.4 Data Model of TS Surveying Results

3.5.3 U-Cadastral Surveying Data Model

While forming data model on the surveying results of geographic map is difficult, modeling on numerical data is quite flexible. Currently, cadastral boundary information in Korea are computerized by KLIS, and is possible to operate numerical surveying by using cadastral file in a electronic plane. By using electronic plane, it is possible to survey in real time by connecting Totalstation and RTK-GPS. Because it is also to survey by reiterating current cadastral map file, not only surveying on the field but also field relocation such as boundary relocation work can be operated. In this case, absolute coordinate and relative surveying results are to be recorded at the first stage in order to utilize intelligent boundary signal. Thus, as the development of surveying methods and paradigm change of management method on boundary points, a new model of surveying data should be established. All information on each boundary point such as unique identifier, absolute coordinate, boundary point around the area, surveying results on feature and descriptive data should be combined.

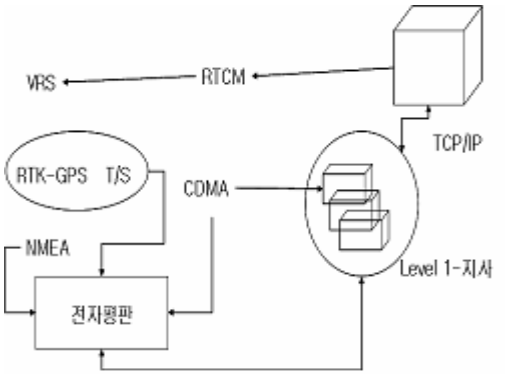

Figure 3.3 Capture the absolute coordination by VRS

As is seen at figure 3.3, in dealing with RTK-GPS surveying, the current control points are used or VRS(Virtual Reference System) by GPS permanent station which Korean government established. From the moving station, RTCM correcting service is received through RF or CDMA modem, operating coordinates transformation. By virtual reference station or the control points on the ground, absolute location of boundary points of world reference can be obtained by ITRF. The absolute coordinate is recorded in RFID. In order to manage relative location among current maps, standard model will be formed to contain the information of boundary points nearby, name of point, absolute coordinates, name of artificial points and details of measurement, and attribute information.

From the KCRF(Korea Cadastral Reference Frame), the boundary point of current maps are observed and a parameter variable is calculated, recording and maintaining physical feature on the ground and the transformation relation. By using the results of NMEA GGA obtained by GPS, horizontal projection is operated. And the transformation of equal angles or projection are done. In case of using jointly with total station, vector transformation among surveyed points should be done to utilize both the surveying results of GPS and Totalstation. Accordingly, transformation process are operated by electronic plane in real time, indicating it to be piled one on another with results of map. Field examination is done by using RFID. In case of data model, the surveying results of field are to be obtained in the first place. And RFID result is indicate on the map.

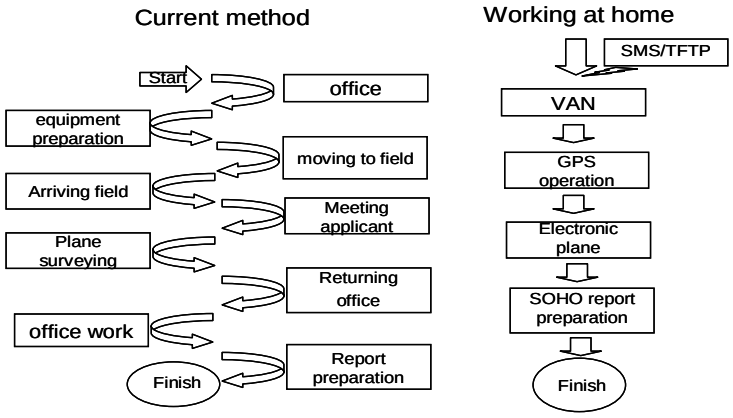

Table 3.1 Structure of Home Working System

Classification	Equipments	Remarks
Center Office (Local Office)	Desktop Computer	
Center Office (Local Office)	FTP Server	
Center Office (Local Office)	Web Program	
Center Office (Local Office)	SMS	
Center Office (Local Office)	Plotter	
Center Office (Local Office)	Surveying VAN	
Center Office (Local Office)	Wireless Radio	
Field	GPS(RTK Option)	
Field	GPS(Vehicle Use) + Map	
Field	Totalstation	
Field	Pen-computer(Internet)/PDA	
Field	Mobile Phone/SMS	Connecting customers
Field	Printer	
Field	Wireless Internet	
SOHO/Home	Desktop/Laptop Computer	
SOHO/Home	Printer	
SOHO/Home	FAX/Telephone	
SOHO/Home	Internet	
SOHO/Home		
Submit Data & Recognition	Recognition System	

4. CONCLUSION

In order to achieve U-Korea which Korea is seeking, the role of cadastre is to used as a referring location in location based information. Besides, cadastre has a variety of attribute information on ownership, being distinguished from geographic information. In order to enhance pubic service by using the characteristics of cadastre, use of computerized graphical cadastral maps has to be more frequent. In order to support the function of surpassing time and space, reforming method as follows are needed. Namely, U-Cadastral Data Model is connected to the Ubiquitous communication system of electronic tag method which can maintain descriptive data on boundary on the ground, and should be developed as follows.

1. In cadastral management system, it is one way system focusing managing it. However, in case of Ubiquitous, it plays a role of a provider of information by n:m free space, supplying service both ways in real time.

2. Through the method of setting up database of boundary point and standardization of it, the model of U-Cadastre is established. In this case, coordinate system for space recognition is maintained in RFID by data application of current cadastral map system and ITRF.

3. Both the descriptive type of relative location information and absolute type of information on the field should be obtained in order to form management model of cadastral boundary points, operating mutually and being more stable than the current system.

As is mentioned above, information system of the current boundary point management as a gradual approach for a new model of U-Cadastre should be developed. As a concept of absolute and relative coordinate of location, it is possible to support to maintain boundary points and U-Korea in a various convergence types.

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6. BIOGRAPHIC NOTES

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