Introduction of Beacon Control Points Using IoT

JungKyu Lee, Republic of Korea

Key words: Internet of Things(IoT), Cadastral Control Point, Beacon

SUMMARY

Currently in Korea, management of cadastral control points is entrusted by LX(Korea Land and Geospatial Informatix Corporation), but the problems of points managements still occur because of point loss for road pavement, a manpower shortage and so on. To solve these problems, LX corporation is studying and developing cadastral control points system using Beacon.

A beacon is a Bluetooth 4.0-based low-power signal transceiver that detects and manages objects and people within a 50-meter radius. Recently, various attempts have emerged according to the developments in Internet of the Things(IoT). Among them, Beacon, wireless local area network technology, is getting popular.

In cadastral surveying, the advantage of beacon control points is that it can be easily found through a beep sound for control points within a certain distance of the mobile app. Therefore, it is effective to find control points in areas covered with soil, leaves, snow or ice, and forest areas. It is also possible to systematically manage digitized cadastral control points due to computerized surveys. These beacons will bring innovation in surveying and will be the basis for digitized surveying in the future world.

The purpose of this paper is to examine the problems of current control points and introduce the beacon to be used as survey control points in Korea in the near future.

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1. INTRODUCTION

1.1 Summary

In cadastral surveying, boundary surveying is an important measure to ensure the protection of the land property rights of the people. For boundary surveying, the cadastral control point survey for the installation of the control point is carried out first. The position of one parcel boundary point is determined based on these control points. Therefore, accurate maintenance and management of cadastral control points is essential.

Point name	Last year cumulative	Installation performance			disposal	Sum	Management status		
		total	New-install	Re-install			perfection	disposal	ETC
total	784,212	55,146	45,034	5,011	14,095	815,151	800,760	13,058	1,063
Cadastral Triangulation point	4828	74	71	4	12	4,887	4,607	170	110
Sub Triangulation point	33,329	2,798	2,108	112	1,114	34,323	33,744	209	100
Cadastral Supplementary point	746,055	52,274	42,855	4,895	12,969	775,941	762,409	12,679	853

(unit: Point)

Figure1 : Yearbook of Cadastre Statistics, 2015

In the table, the cadastral triangulation point is the point where the initial surveying is made from the origin, and most of it is buried at the top of the mountain, so the frequency of loss or disposal is relatively small. Cadastral sub-triangulation point is installed in the middle of the mountainside or on the roof of the building. However, cadastral supplementary point is the point for boundary surveying, because it is mainly installed around the city road, and the frequency of being lost by various road works is quite high. In this paper, all of the control points I mentioned are related to those Cadastral supplementary points.

Figure2 : Cadastral Triangulation point, SubTriangulation point in Korea

Figure3 : Cadastral Supplementary point in Korea

1.2 Problems of cadastral control point management

Currently, in Korea, the cadastral control point is entrusted and managed by LX(Korea Land and Geospatial Informatix Corporation). However, considering the problem of management, when you pave the road, you lose the control point. The investigation is not timely due to the lack of manpower and equipment to investigate the control point. But the budget is scarce and this vicious cycle repeats. Therefore, proper investigation and management are not being carried out. It can be an important factor to increase the error in setting the land boundary due to the repeated practice of the new installation and restoration of the control point. To solve these problems, we are studying and developing a control point system using IoT.

2. MAIN SUBJECT

2.1 Concepts and Features of Internet (IoT)

The Internet of Things provides the Internet connectivity between various devices by utilizing various network technologies (RFID, NFC, Beacon, WiFi, Bluetooth, ZigBee, GSM, GPRS, 3G and LTE etc.) The term IoT was invented by Kevin Ashton of the 1999 MIT Auto-ID sensor. The term "IoT" was proposed by the Internet connection of objects through RFID (Radio Frequency Identification) technology.

In the International Telecommunication Union (ITU) standardization part, the report "The Internet of Things" shows that "everything in the world". In other words, it is defined as information and communication technology that allows people to communicate with each other and objects and objects anytime and anywhere by connecting various devices to the network.

The Internet of things is the ultimate goal of ubiquitous computing. That is to say, it is possible to freely access the network anytime and anywhere to operate not only personal communication but also various devices located in a separate space, or to share information acquired through such devices in real time. The Gartner Research Institute predicts that the Internet of things will spread in earnest in 2020. Approximately 30 billion to 2 trillion digital devices are expected to participate permanently or temporarily as network entities in the Internet of Things, according to the Gartner Research Institute.

The Internet consists of four core concepts: Connect, Identify, Locate, and Inquire. First, all devices are connected to the network. In other words, the Internet of Things requires a technology capable of integrating various devices into a network away from existing human-centered networks. Second, the Internet of things requires identification. Since a myriad of devices other than humans are connected by a network, the Internet of Things needs the ability to identify each network entity. Third, after the subject of the network is identified, the Internet must have the ability to know where each subject is located. The three existing core concepts have already been technically completed. Nonetheless, it takes time for the appearance of the Internet of things because of the final concept, the implementation of Inquire. That is to say, there is a need for technologies that enable objects (non-human) or devices to actively network and interact with other entities.

2.2 Beacon

A beacon was originally a device for receiving radio waves radiated from a ground wireless base station, etc., in devices such as airplanes, ships, and automobiles, and acquiring various information including positions. However, since 2013, the term "beacon" has been used in a narrow sense to refer to short range data communication technology that detects smart devices within short distance and provides various information and services based on Bluetooth low energy (BLE) technology.

The beacon itself serves as a reference point for locating information, and the actual information transmission is based on a short distance communication technology such as Bluetooth or infrared. Depending on the type of signal transmitted, a low frequency beacon, an LED beacon, a Wi-Fi beacon, a Bluetooth beacon. Since the announcement of Apple's beacon technology, ‘iBeacon’ in June 2013, Bluetooth low-energy (BLE) -based beacon technology is commonly referred to as a beacon. This technology corresponds to a short-range wireless communication technology using a Bluetooth 4.0-based protocol.

The beacon can operate with a small amount of packet transmission, does not require pairing to connect the two devices, and communicates at low power, so it can recognize the location at a lower cost than other short-range wireless communication technologies.

Near-field communication (NFC) can communicate only within a distance of less than 20 cm, while beacons are non-contact, supporting up to 50 meters of distance. In addition, it is possible to locate the device within the error range of 5cm. Since it is possible to provide both one-to-many and many-to-many services, it can provide a variety of active services such as advertisement and information transmission, home automation and payment.

This can be used to automatically give coupons or points to shop visitors according to whether they are visiting the store or to provide an automatic explanation service for works currently watched by visitors at exhibitions or museums. It is also possible to remotely grasp the state of crops and machines by installing beacons with acceleration sensors or temperature / humidity sensors.

2.3 Domestic and overseas related industries

2.3.1. Domestic

(SKT) SK Telecom has developed the world's first IoT hybrid network (low power wireless internet network), and 'Keyco' which is child and companion animal location tracker, 'Smart Talk' which informs the car owner about real time vehicle information through shock sensor, IoT black box Products.

(KT) KoreaTelecom has developed NB-IoT (low-power long-distance network) and has plan to provide child safety, personal high-priced assets, and companion animal location service using 'Multi-use Position Tracker' which is a mobile terminal.

(Samsung) Samsung acquired SmartThings, an American IoT company, and has signed an MOU with KEPCO(Korea Electric Power Corporation). And they will provide automatic electricity usage control services using smart home appliances.

2.3.2. Oversea

(Google) Google is taking advantage of the Android platform, which takes up half of the mobile market. IoT platform 'Android Things' and 'smart home' smartphone 'Google Home'.

(GE) In order to apply IoT to the industrial internet field, General Electronic has developed a cloud-based predix platform to promote the IoT platform based on world-class technology in the healthcare and medical devices as well as the precision aviation industry.

(IBM) Based on intelligent CEP / analysis platform and world-class artificial intelligence computer Watson, we are building various IoT services around the world in connection with superior technologies such as large data analysis and real-time data analysis and cloud. And plans to provide intelligent services through the linkage of Siri and Watson.

2.4 Implementation and testing of IoT control point system

2.4.1. Exclusive beacon of LX

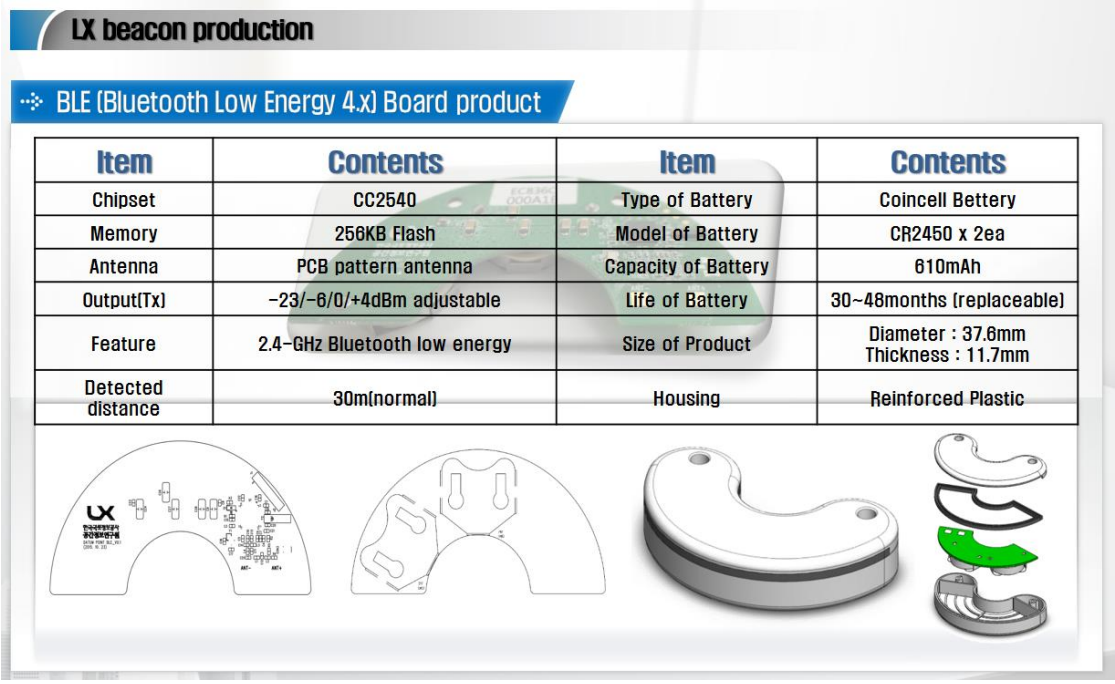


Figure4 : BLE Board product

• We designed a small beacon shape (hereinafter referred to as LXcon) that can be inserted into the head of the control point because it is buried under the ground according to the characteristics of the cadastral control point.

It transmits and receives BLE information by communicating with AP (Access Point). We have developed a battery attachment unit that can accommodate several coin cells on the back side of the PCB so that it can support more than double the lifetime of existing beacon from control through firmware development.

• When existing beacons are buried in the ground, it is difficult to send out normal signals. Therefore, a press antenna is implemented and mounted on the cover part to improve the Bluetooth receiving distance performance.

• An antenna sample is prepared and tested. We concluded that maximum efficiency occurs when the length of the antenna is extended by 3mm. We have also asked a certified signal testing and certification company to compare the signal strength.

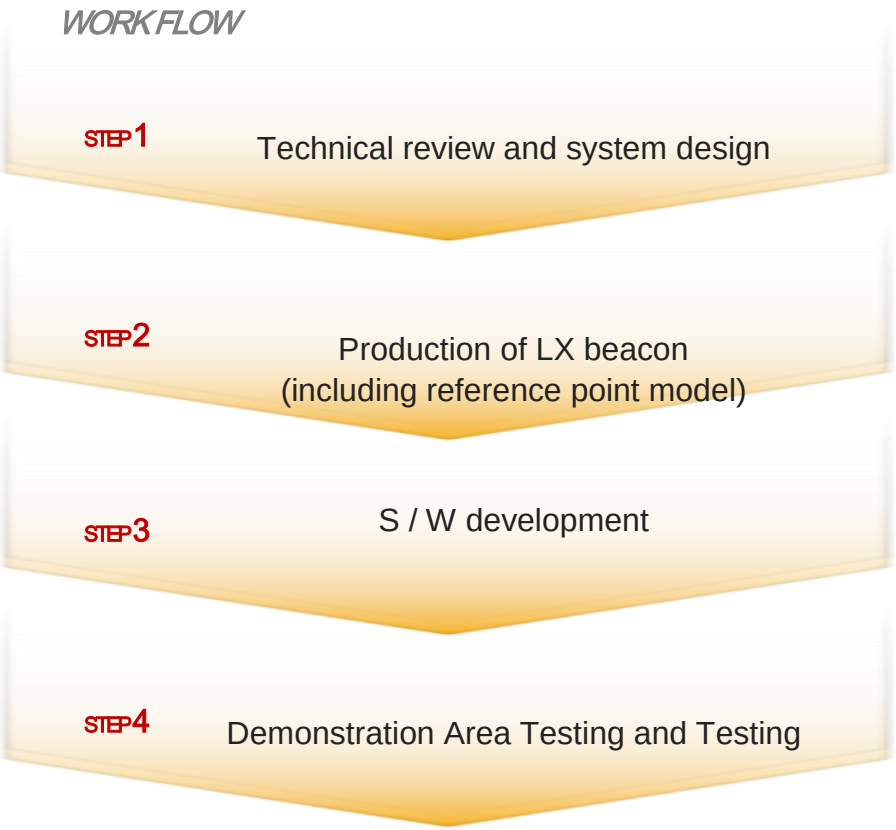


Figure5 : Work Flow Chart

2.4.2. Beacon control point production

• It is divided into for a paved road and for a non-paved. Each control point is made of Lego type so that LXcon can be attached and detached.

• The center '+' mark of the control point body is positioned so that the observation value is not changed during installation, and the module shape attached can support the center of the control point in alphabet C shape.

• LXcon maintenance is easy because it is possible to remove the cover after installation.

In our work, beacon control points were divided into paved-road and non-paved road point. And we have built the BLE module which is installed from Bluetooth 4.0. First, the beacon control point for paved-road was constructed by fixing nail to the center of BODY, and BLE module was installed in 100mm diameter BODY. Module and cover can be removed.

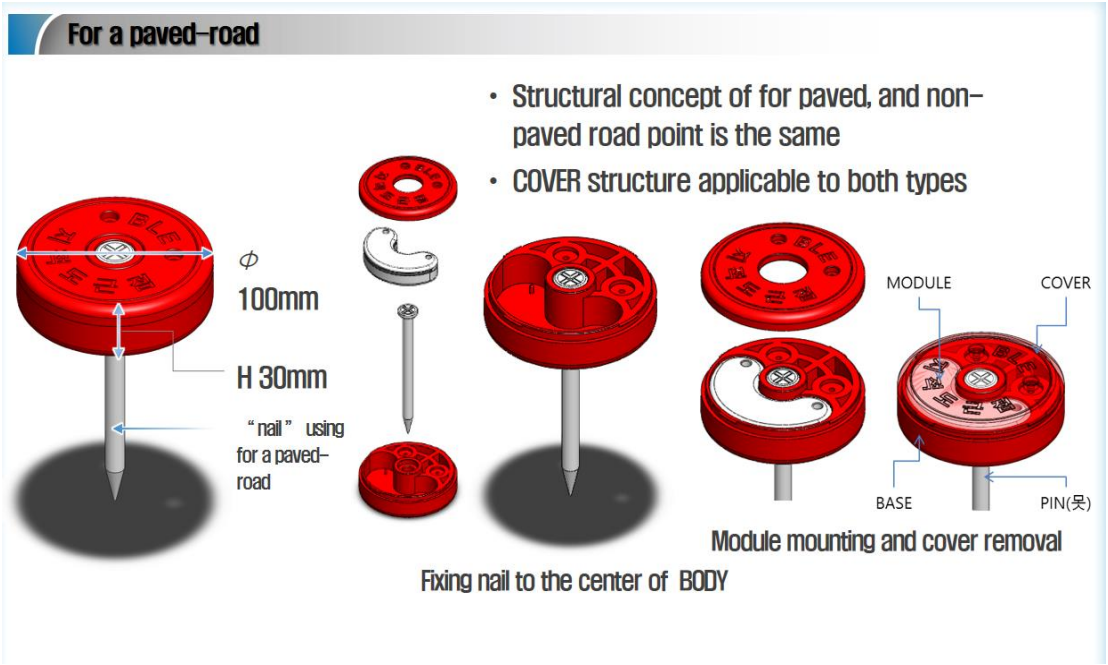


Figure6 : Point for a paved-road

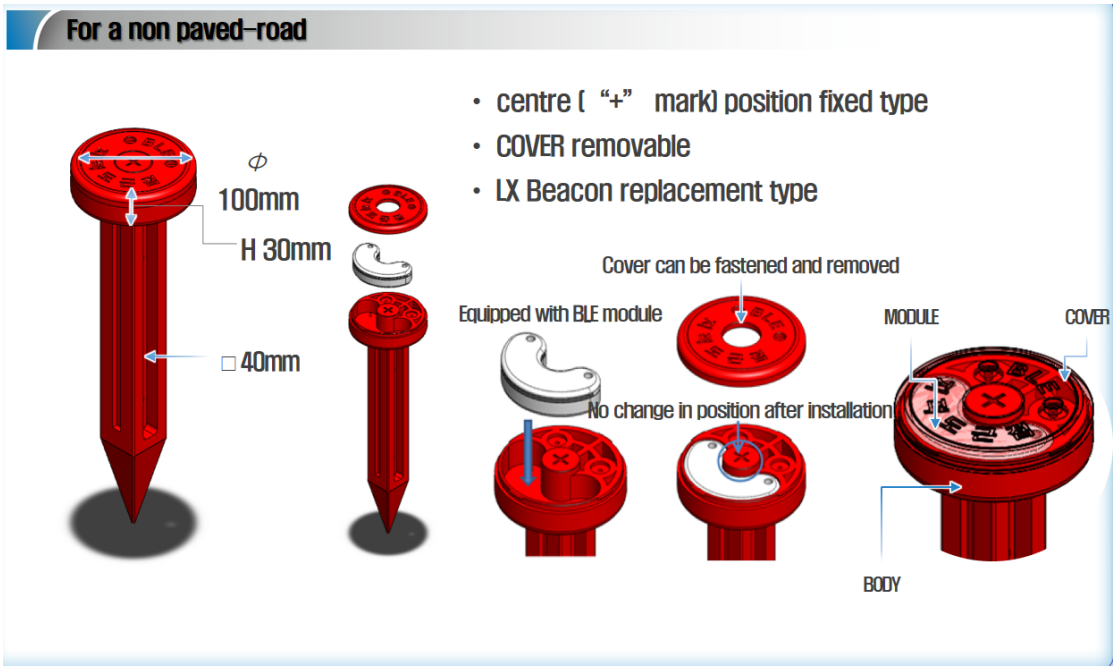


Figure7 : Point for a non paved-road

The point for non-paved road is shown in the following figure. The center + mark is fixed, the lid can be fastened and removed, and the BLE module is replaceable.

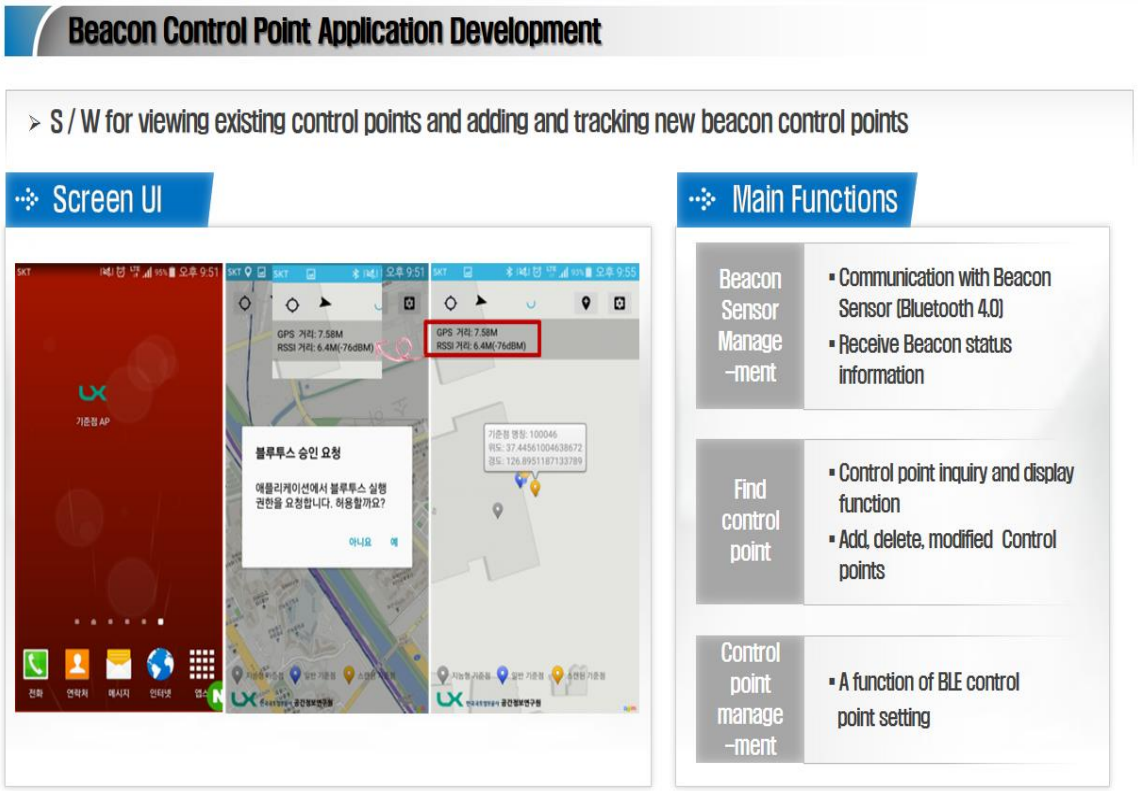


Figure8 : Beacon Control Point Application

2.4.3. Beacon control point service system development

• It can be divided into four software blocks: a control point display and inquiry function, a control point detail display function, a control point addition / correction / deletion management function, and a BLE control point setting function of requirements of a beacon control point management application.

• The beacon control point interworking interface is implemented through the Java web proxy module without directly querying the service DB.

2.4.4. Develop application for inquiry

• The beacon control point application for inquiry was developed based on Android 4.3 or higher and 8-inch tablet UI for inquire existing control points and managing and finding new beacon control points.

• The total communication specification according to service request and response is seven, and can be divided into application login, list request, detailed information request, information storage, detailed information storage, beacon information storage, and control point information deletion.

• If the registered beacon control point exists around the user, the intelligent control point is displayed in gray on the screen, orange when the intelligent control point is scanned, and blue in the normal type.

• Clicking on the orange control point (scanned beacon control point) displays the RSSI (Receive Signal Strength Indicator) while performing the scanning continuously.
The tag location recognition method using the RSSI value is one of the distance free methods with relatively high positioning accuracy.

• The system implementation for recognizing the beacon control point of mobile device apps has generated the beep sound for the nearest beacon control point.

• The distance is calculated according to the signal for the set geo-fencing event is processed. The constraint condition of the recognition distance is given as 10m, 5m, 3m and the orientation is indicated by scanning around the control point.

2.4.5. Burial and Testing in the Test Area

• In order to evaluate the performance of the cadastral control point survey system that reflects the implemented beacon, the selected test areas are centered on urban and rural complexes, compartmentalized districts or definite districts, Gyeonggi-do Bucheon-City, Sejong-City, and Gimje-City.

• The installation target for the test was the Cadastral Supplementary point, and the prototype was built with the help of the field staff in some areas of the site installation area.

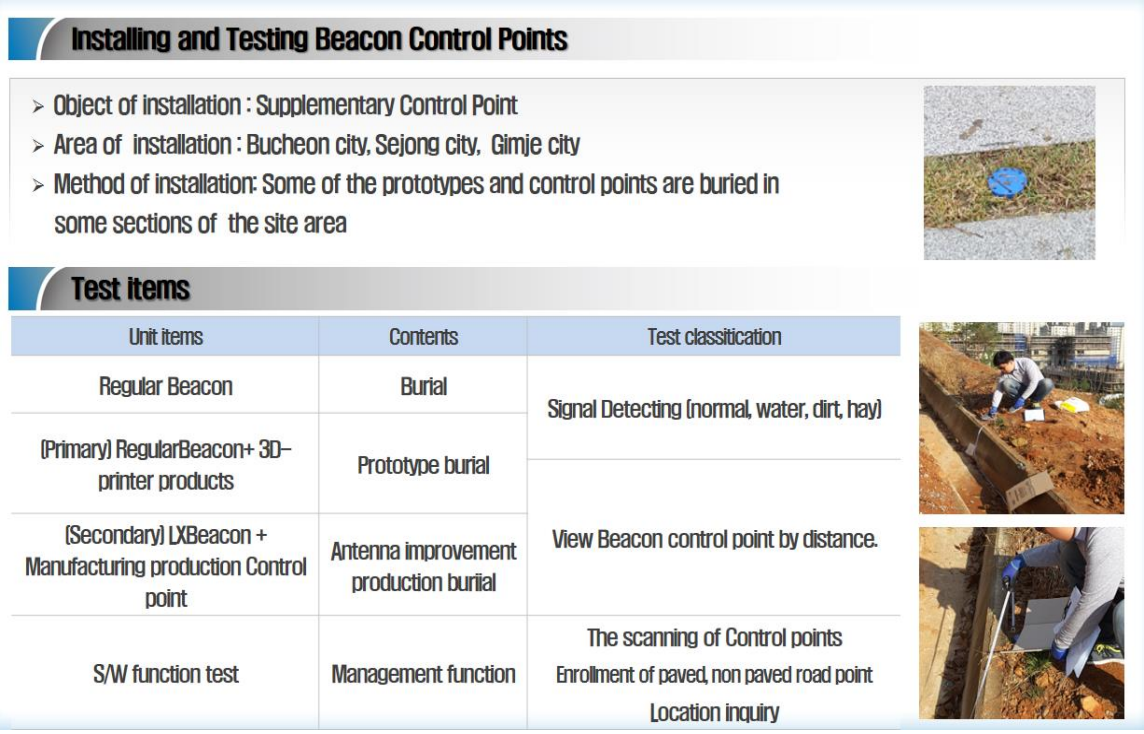


Figure9 : Installing and Testing Beacon Control Points

• The test object was tested by using four types of BLE modules and control point shape, embedded in parallel with the ground, and then tested in the form of forced interference through water, soil, and hay.

• When commercial beacons were embedded, the signal was detected only within 3m. Especially, the closer the control point to the ground, the shorter the signal distance. As a result, the prototype test confirmed that the PCD integrated antenna reduces the radiation efficiency during landfilling.

2.4.6. Result

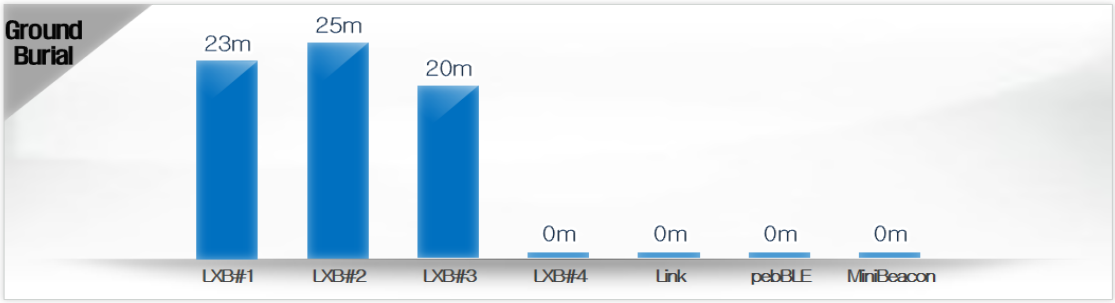
• Three LXcons with improved antennas and four other commercial beacons were assumed to have interference conditions.

• In a normal buried condition, it has been confirmed that the improved LXcon with an antenna greatly improves reception strength.

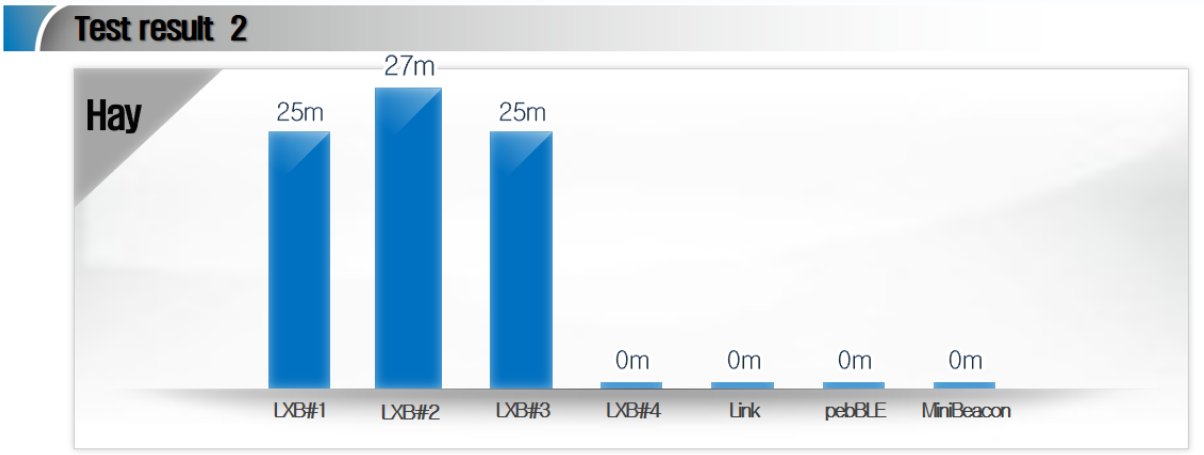
• In the pile of hay, there was no significant difference between the normal product and the control group, but in the case of water, the signal intensity was reduced by half (average 10m) in addition to the refraction phenomenon.

• If the beacon control point is buried in a farmland or forest area where the communication is difficult to cover, such as dirt, leaves, or areas where there is a high possibility of being covered with an interference material such as snow or ice, it may be effective.

• The prototype product and system implemented through the research have clearly detected the function within the minimum distance of 5m from the control point and perform better than the existing beacon.

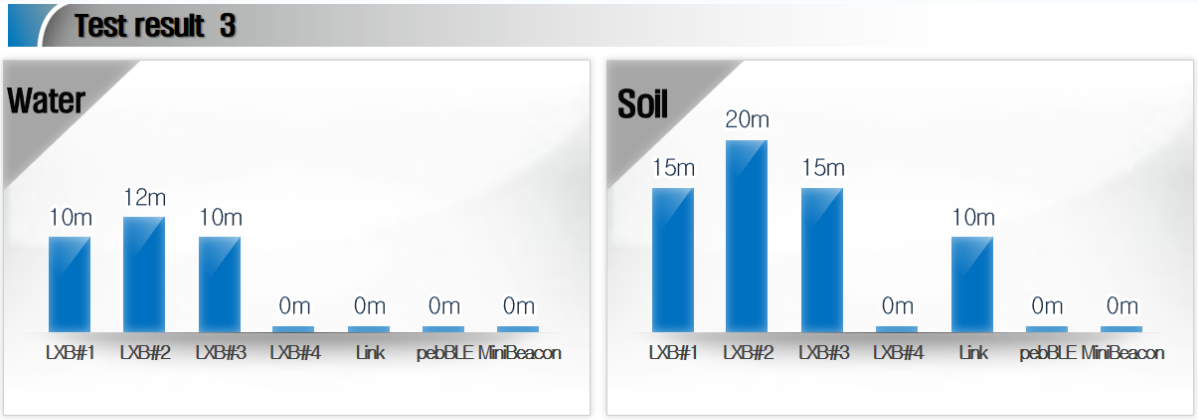


Ground Burial	OUI	EC:83:6C	EC:83:6C	EC:83:6C	EC:83:6C	84:dd:e0	D0:39:72	F8:27:93
	Company	LX	LX	LX	LX	NA	TI	Apple
	DUT	LXB#1	LXB#2	LXB#3	LXB#4	Link	pebBLE	MiniBeacon
	Mac Add.	00:0A:04	00:0A:09	00:0A:2B	0:09:16	B6:07:FC	A3:D8:D2	0C:9F:52
0m	RSSI	-67	-64	-56	-74	-69	-92	-67
	Distance	2.51	1.8	0.71	5.27	3.12	4.93	2.51
5m	RSSI	-77	-82	-85				
	Distance	7.12	11.49	15.13				
10m	RSSI	-89	-89	-93				
	Distance	21.52	21.52	30.16				
15m	RSSI	-91	-90	-93				
	Distance	25.52	23.44	30.16				
20m	RSSI	-93	-92	-95				
	Distance	30.16	27.75	35.51				
23m	RSSI	-90	-88					
	Distance	23.44	19.73					
25m	RSSI		-92					
	Distance		27.75					



Hay	OUI	EC:83:6C	EC:83:6C	EC:83:6C	EC:83:6C	84:dd:e0	D0:39:72	F8-27-93
	Company	LX	LX	LX	LX	N.A	T.I	Apple
	DUT	LXB#1	LXB#2	LXB#3	LXB#4	Link	pebBLE	MiniBeacon
	Mac Add.	00:0A:04	00:0A:09	00:0A:2B	0:09:16	B6:07:FC	A3:D8:D2	0C:9F:52
0m	RSSI	-67	-60	-75	-83	-82		-69
	Distance	2.51	1.14	5.83	12.61	11.49		3.12
10m	RSSI	-86	-82	-85				
	Distance	16.55	11.49	15.13				
20m	RSSI	-91	-90	-91				
	Distance	25.52	23.44	25.52				
23m	RSSI	-94	-93	-92				
	Distance	32.74	30.16	27.75				
25m	RSSI	-94	-94	-94				
	Distance	32.74	32.74	32.74				
27m	RSSI		-91					
	Distance		25.52					

Figure10 : Test Results



water	OUI	EC:83:6C	EC:83:6C	EC:83:6C	EC:83:6C	84:dd:e0	D0:39:72	F8-27-93
	Company	LX	LX	LX	LX	N.A	T.I	Apple
	DUT	LXB#1	LXB#2	LXB#3	LXB#4	Link	pebBLE	MiniBeacon
	Mac Add.	00:0A:04	00:0A:09	00:0A:2B	0:09:16	B6:07:FC	A3:D8:D2	0C:9F:52
0m	RSSI	-82	-78	-80	-94	-90		-89
	Distance	11.49	7.85	9.52	32.74	23.44		21.52
10m	RSSI	-94	-91	-95				
	Distance	32.74	25.52	35.51				
12m	RSSI		-94					
	Distance		32.74					

soil	OUI	EC:83:6C	EC:83:6C	EC:83:6C	EC:83:6C	84:dd:e0	D0:39:72	F8-27-93
	Company	LX	LX	LX	LX	N.A	T.I	Apple
	DUT	LXB#1	LXB#2	LXB#3	LXB#4	Link	pebBLE	MiniBeacon
	Mac Add.	00:0A:04	00:0A:09	00:0A:2B	0:09:16	B6:07:FC	A3:D8:D2	0C:9F:52
0m	RSSI	-64	-66	-63	-86	-71		-69
	Distance	1.8	2.25	1.6	16.55	3.86		3.12
10m	RSSI	-90	-81	-88		-92		
	Distance	23.44	10.47	19.73		27.75		
15m	RSSI	-92	-87	-94				
	Distance	27.75	18.08	32.74				
20m	RSSI		-90					
	Distance		23.44					

Figure11 : Test Results

2.5. Benefits of Beacon Control Points

In cadastral surveying, the advantage of a beacon control point is that it can be easily found through a Beep sound for a control point within a certain distance of the mobile app. Therefore, it is effective to find a control point in a forest or an area where there is a high possibility of covering with soil, leaves, heavy snow or ice.
It is also possible to systematically manage digitized cadastral control points due to computerized surveys. And if you use beacon technology, you can solve the problem of manpower because you can reduce the number of current 2-person investigation to 1 person. And research results show that it can shorten the investigation time and is excellent for budget reduction. Therefore, it will be able to overcome the problem that can not be investigated periodically every year.

2.5 What to do next

LX Corporation is trying to apply Lora WAN (Long Range Wide Area Network) to the boundary point mark.
The world's first IoT hybrid network (low-power wireless Internet service network), Lora network, should be used to establish a more stable, inexpensive and large-scale device access system. Applying the Lora network to the IoT technology of boundary point markers and cadastral control point will enable aggressive management of land development and boundary management. Furthermore, if the acceleration sensor and gyro sensor are installed at the boundary point and the control point to check the displacement value and detect the damage, a big data management system such as temperature and earthquake will be provided.

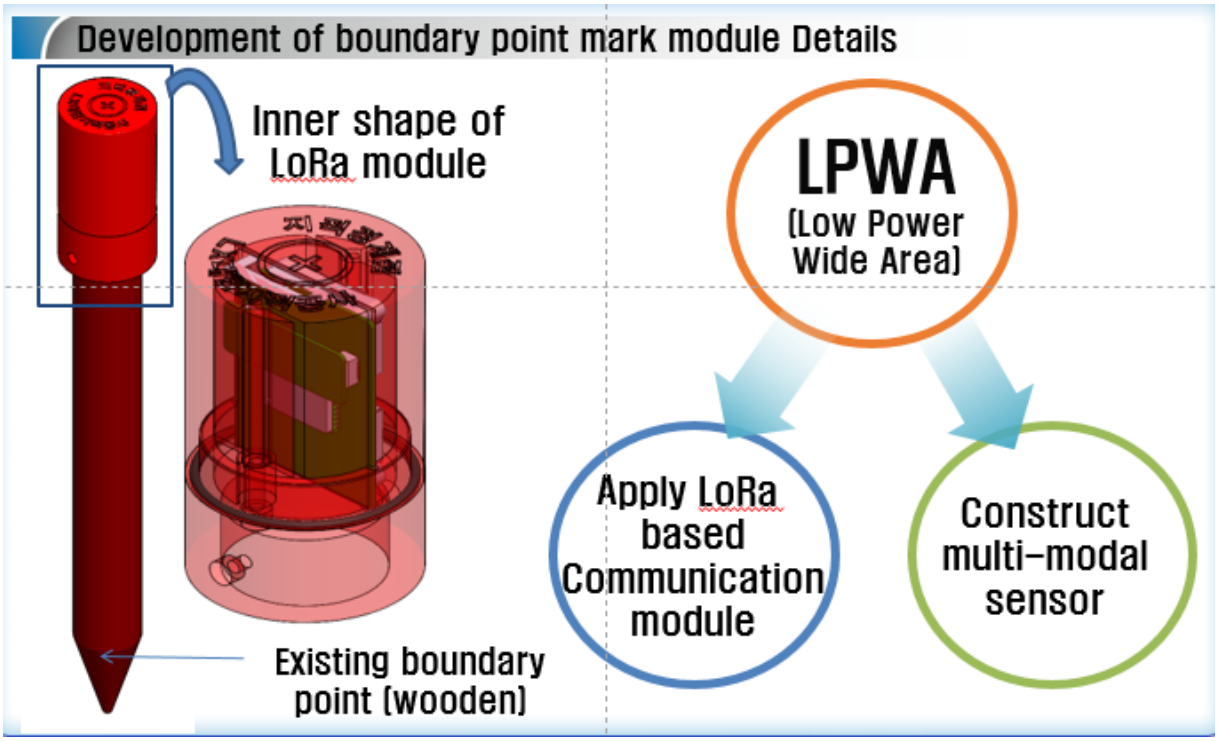


Figure12 : Development of boundary point mark with LoRa module

3. CONCLUSION

So far, we have studied the outline of cadastral survey, the problem of current control point, and the beacon control point as a solution method.

• Developed a prototype system by designing a private beacon and designing the LX beacon platform model accordingly, and solving the problem that the signal distance is significantly reduced when the beacon is buried in the ground.

• LXcon improves battery performance compared to commercial beacons in service in Korea. It is developed as a special type for buried control point and supports strength and waterproof function enough to withstand depositing and can also be used for general purpose.

• In order to verify the feasibility of the technology through the development of the LXcon platform prototype, the test area was selected and tested, and it was confirmed that it could help find the control point difficult to see.

• We will provide other types of beacon services using LXcon as we have secured a technological basis to quickly provide new public services using LXcon.

• Examining the cadastral control points using beacon technology can reduce the manpower required for the current cadastral control point investigation and reduce the time required for field investigators to find cadastral control points.

• Management of cadastral control points can also be computerized. If AP equipment is upgraded and a system of constant power supply is provided, it is expected that remote monitoring of the control point of the country will be possible.
• In order for the research method that uses the beacon control point to be put to practical use, it is necessary to analyze the results by carrying out an empirical test on more control points in the future, and to propose a systematic and specific improvement plan such as related laws, regulations and fees.

• Due to the nature of prototypes rather than mass-produced products, it is difficult to carry out tests on various field conditions. Therefore, it is necessary to verify the reliability of the pilot project and to conduct research to smoothly process a large amount of IoT communication data.

• Research should be done to find alternative batteries (eg Flexible Battery) and to reduce the size. In the case of apps, research on how to optimize distance calculation according to RSSI is needed.

• On the beacon control point side, due to the difficulty of commercialization due to the cost of additional production, it is necessary to find a specialized beacon service model that can protect the property rights of the public with LXcon as public goods.

This will bring innovation in surveying and will be the cornerstone of digitized surveying in the future world.

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BIOGRAPHICAL NOTES

JungKyu Lee
Education background: Feb,2011, Bachelor degree, Geoinformatics engineering, Inha University.
Current position: Assistant Manager, H.Q of Daejeon Chungnam-do, Korea Land And Geospatial Informatix Corporation.
Main task : Creation of railway protection zone using continuous cadastral map

CONTACTS

Asst Manager, JungKyu Lee
Business office of Geo-informatics, Korea Land and Geospatial Informatix Corporation,
12Munjeong-ro 48beon-gil, Seo-gu, Daejeon, Republic of Korea
Tel. + 82 42 479 2186
Fax + 82 42 479 2168
Email: tochi123@lx.or.kr