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Security Services Based on Mobile Phone Networks: Cases in Japan[1]

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Abstract

A new approach to location-based services (LBS) using geographical positioning technologies in mobile telephony has recently been developed. In Japan, security services using mobile phone geographical location technologies were launched around 2001, and they have expanded in recent years. In this paper, we will overview security services based on mobile phone networks and discuss the geographical features of these services.

The primary reason for the recent expansion of location-based security services (LBSS) in Japan is the ardent desire for the security of children and the elderly, and Japanese national policies have facilitated this expansion. Although there are many kinds of LBSS providers, the major ones are mobile phone companies and security service companies. Mobile phones companies use mobile phone handsets for location positioning, and security service companies mainly use portable transmitters. Security service companies usually include emergency dispatch services as well.

LBSS using mobile phone networks have some spatially related difficulties at various geographical scales. First, positioning services that rely on GPS positioning do not operate well under poor conditions, such as in crowded buildings and underground. On the other hand, the accuracy of the Multiple Base-stations method using PHS networks is inadequate for rural areas. Second, security service companies can establish emergency response dispatch services at a reasonable cost using the existing network of emergency depots located throughout most of Japan. Although the price paid for emergency response dispatch services is far greater than

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that for ordinary location-search services, the dispatch services are unprofitable because of the low frequency of emergency service requests.

The LBSS utilizing mobile phone networks are basically constructed in virtual cyberspaces. A location-search service cannot provide actual security, because this service performs no action in real space. In contrast, a dispatch service provided by a security service company contains actions in real space as well as in cyberspace. The emergency response by local volunteers, a new concept in the field of dispatch services, is more geographical, or more deeply built in the locality, than the security company's services. Thus the LBSS based on mobile phone networks suggest new interactions between virtual spaces and real geographical spaces.

Key words

Mobile phone Security service LBS GPS

1. Introduction

A mobile phone provides real time communication, anytime, anywhere. However, the geographical location of a mobile phone cannot be easily identified relative to a fixed-line telephone. A new technological approach to location-based services (LBS) has been recently developed that uses geographical positioning technologies in mobile telephony. D'Roza and Bilchev (2003) highlighted the possibilities of these kinds of services, while Schiller and Voisard (2004) and Gartner et al. (2007) have discussed the available positioning technologies and the technical conditions for service applications, respectively.

One application of location data is to use mobile phone network systems to acquire real-time positions of people in urban areas to analyze the spatiotemporal characteristics of their movements for planning and public administration purposes. Ahas and Mark (2005) pilot-tested such a system in Tallinn, Estonia, and Ahas et al. (2007a) analyzed the movements of tourists over the whole of Estonia. Ratti et al. (2006; 2007) analyzed location data from projects in Milan, Italy, and Graz, Austria, respectively. Several experiments on guidance services for public transport passengers and tourists in urban areas were carried out in Hong Kong (Pun-Cheng et al., 2007), Vienna, Austria (Wiesenhofer et al., 2007) and Seoul (Kang et al., 2007). However, few commercial services have been reported. The "Find Friend" service

provided by AT&T in the United States is one of the few examples in practice (Strassman and Collier, 2004).

In Japan, where there is a wide variety of mobile information services, many services have been developed using geographical positioning data (Arai, 2006; 2007). The earliest LBS provided commercially in Japan was a location-search service designed for the security of children and the elderly, which was based on the base-station location data of the Personal Handyphone System (PHS). Following the wide diffusion of cellular phones and the decline of the PHS, interest in this type of LBSS waned, partially because of the relatively low accuracy of mobile phone positioning. However, when global positioning systems (GPS) for mobile phones became commercially available, various personal services utilizing high-accuracy positioning data were developed. A pedestrian navigation service, "EZ*naviwalk*" by KDDI, is the most advanced example in this field (Arikawa and Noaki, 2007; Raper, 2007; Morita, 2007).

In this paper, we will overview security services based on mobile phone networks and discuss the geographical features of these services. A brief history of the development of geographical positioning technologies and security services based on geographical location in mobile telephony is presented in the following section. The features of location-based security services (LBSS) are outlined in the sections 3 and 4. Some spatial issues of LBSS are examined in section 5. Finally, an interesting geographical implication of LBSS with respect to interactions between cyber- and geographical spaces is discussed.

2. The development of positioning technologies and security services based on geographical location in mobile telephony

2.1 Geographical positioning methods in mobile telephony

There are three types of data acquisition techniques for geographical location, as shown in Table 1 (Adams et al., 2003; Arai, 2006). The Cell-ID method is the simplest but least accurate way to measure the location of a mobile phone. Positioning accuracy is several hundred meters to 1 km for cellular phones, and 100 m to 200 m for the PHS in urban areas where base stations are densely allocated. The Multiple Base-stations method, based on signal timing differences between base stations and the target mobile phone (e.g., Enhanced Observed Time Difference "E-TOD" method), provides more accurate positioning than the

Cell-ID method. The accuracy of positioning is around 100 m in suitable conditions. The GPS-positioning method uses the signals transmitted from GPS satellites to provide much higher accuracy. In mobile telephony, Assisted GPS (A-GPS) positioning techniques use the data and computation capabilities of telephony networks to improve accuracy. With A-GPS techniques, the accuracy of positioning is in the order of 10 m. The GPS-positioning method has a weakness, however, because no positioning data are acquired in areas with poor cellular signal conditions, such as crowded buildings or underground. Most mobile phones with GPS devices change the positioning method automatically to the Cell-ID method or to the Multiple Base-stations method when GPS positioning fails. Naturally, this change leads to considerably reduced positioning accuracy.

Table 1 Geographical positioning methods in mobile telephony

Positioning method	*accuracy*
Cell-ID	100s m - 1 km (cellular phone) 100 m - 200 m (PHS)
Multiple base-stations	around 100 m
GPS positioning	order of 10 m

2.2 Launch of positioning services

The first commercial geographical positioning service in Japan was the "*Imadoco* (where are you?)" service, a PHS-based system provided by NTT in 1998. This service, which located users carrying PHS handsets via the Cell-ID method, was used primarily by those who wanted to be able to locate children and the elderly. Similar cellular phone-based search services could not be put into practice at that time due to the relatively low accuracy of positioning by the Cell-ID method.

Beginning in 2001, when integrated GPS devices became available in mobile phones, several Japanese mobile phone companies launched new positioning services in rapid succession. First, KDDI introduced a GPS-positioning system using a mobile phone network based on the "gpsOne" technology developed by Qualcomm. SECOM, the largest security service company in Japan, then introduced the "COCO-SECOM" service, the first LBSS using portable transmitter devices connected to the KDDI network. KDDI also developed

mobile phone handsets equipped with GPS devices and was able to use SECOM's service under the name "COCO-SECOM EZ".

NTT DoCoMo, the largest mobile phone company in Japan, followed KDDI with its own GPS-based positioning system called "DoCoMo Location Platform (DLP)". Several security service companies also used portable transmitters and the DLP system to provide LBSS. After NTT DoCoMo developed its mobile phone handsets with GPS devices in 2003, many mobile phone application service providers (ASP) introduced LBS using NTT DoCoMo's mobile phones.

2.3 Expansion of LBSS

In 2005, mobile phone-based LBSS began a new stage of dissemination. Two major mobile phone companies started security-oriented search services. First, KDDI started its own location-search service intended mainly for personal security called "*Anshin Navi*" (peace-of-mind navigation), which uses mobile phone handsets equipped with GPS devices. Then NTT DoCoMo introduced its Third Generation (3G) handsets with GPS devices. NTT DoCoMo also developed a new location-search–emergency-response mobile phone suitable for children, and paired it with its own search service called "*Imadoco* Search" (search where you are), similar to KDDI's *Anshin Navi* service. Toward the end of 2006, KDDI and SoftBank (which was previously Japan's division of Vodafone) followed NTT DoCoMo with their newly developed mobile phone handsets for use by children.

Changes in Japanese society may be partially responsible for the recent expansion of LBSS, including an increasing interest in the security of elderly people in Japan's rapidly aging population. A more prominent reason is the heightened security concerns for Japanese children following a string of vicious crimes against small children since 2004 (Figure 1). In response to these societal needs, mobile phone-based security services for children and the elderly were developed.

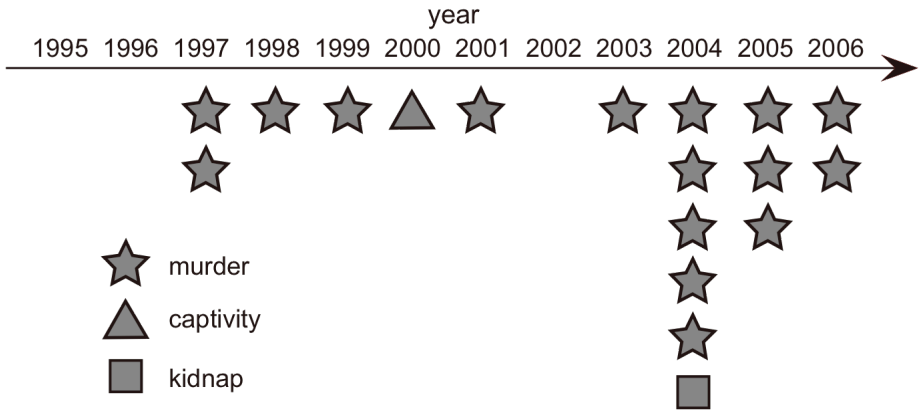

Figure 1 Number of vicious crimes against children in Japan, 1995-2006

2.4 Effects of national policies

The expansion of LBSS has also been facilitated by national policies to ensure the security of mobile phone users.

2.4.1 Mandate for the provision of mobile phone location information in emergency calls

In 2004, the Japanese government required that mobile phone companies provide the location information of a mobile phone in an emergency call, such as a “110” call to police and a “119” call to a fire station. This mandate corresponds to “Enhanced 911” (E911) in the United States. The mandate calls for 50% of all handsets have high-accuracy location data provided by GPS positioning by April, 2009, and for 90% of all handsets to have this information by April, 2011. The government allows the use of low-accuracy positioning (e.g., the Cell-ID method) in the initial phase of the emergency call location system. However, the government also requires mobile phone companies to equip all their 3G mobile phones sold after April 2007 with GPS devices. At the time of the mandate, NTT DoCoMo had not implemented GPS positioning in its 3G network, in contrast to KDDI, which had already equipped almost all of its 3G handsets with GPS devices. In October 2006, NTT DoCoMo launched GPS-positioning services on its 3G network. The implementation of GPS-positioning services by the largest mobile phone company in Japan has stimulated the development of various LBSS.

2.4.2 Promoting the development of ICT-based security systems for children and the elderly

After the series of vicious crimes against children mentioned above, the Japanese government began promoting the development of new security systems for children and elderly people using "ubiquitous network" technologies. In 2006, the government published a report on the LBSS available for children using mobile phone and radio frequency identification (RFID) tag technologies. This report was published in part to encourage the development of new services by public, nonprofit and private organizations. A new report on similar services for the elderly was published at the beginning of 2007. At the same time, the government has subsidized selected field experiments on the development and operation of LBSS. This policy has drawn the public's attention to the concept of using mobile phones for LBSS, and a wide range of companies and organizations have become interested in LBSS businesses.

3. Features of security services by category of service provider

Various kinds of companies and organizations provide security services using geographical positioning technologies and mobile phone networks. These service providers are classified into four broad categories: mobile phone companies, security service companies, ASPs or mobile phones, and others. Although their services typically use mobile phone networks for geographical positioning, there are some differences across provider categories with respect to positioning devices and the additional services. Whereas mobile phone companies and ASPs use mobile phone handsets for location positioning, security service companies mainly use specially developed portable transmitters, allowing them to target vehicles, boats and various pieces of equipment, as well as cellular phone users. Some service providers include emergency dispatch service with location search and emergency call services.

The features of the services by the category of provider are summarized in the following subsections.

3.1 Mobile phone companies

All three major mobile phone companies operating cellular phone systems in Japan provide location services for security purposes, *Anshin Navi*, by KDDI, *Imadoco* Search, by NTT DoCoMo, and *Ichi Navi* (location navigation), by SoftBank.

The core of the security services provided by mobile phone companies is the geographical location search service, using GPS positioning. A subscriber to the service (e.g., a mother) can search the geographical location of a mobile phone holder (e.g., her child) using a PC or a mobile phone (Figure 2). Some modified services are generally added to the basic search service. For instance, a "scheduled search service" provides continual location searches at regular intervals during a specified time period. With an "area monitoring service", a subscriber can receive a warning e-mail when a mobile phone holder goes out of the geographical area designated by the subscriber.

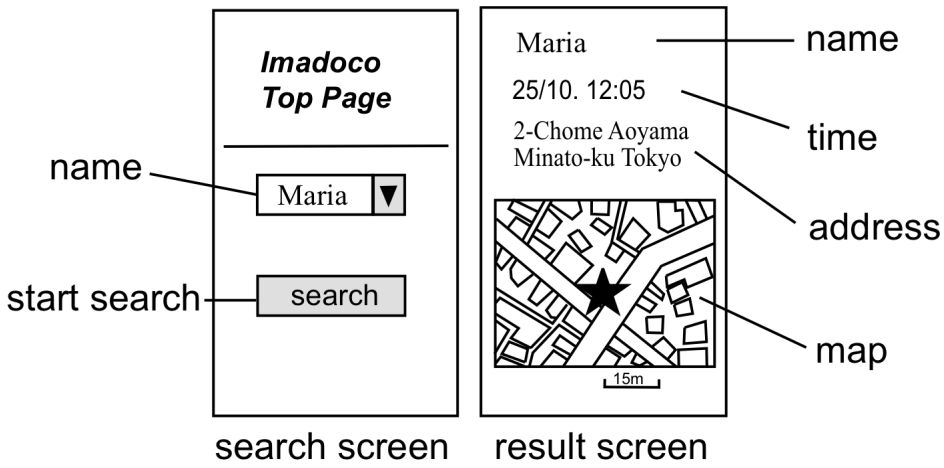

Figure 2 Schematic search screen of a location-search service (*Imadoco* Search)

Although these services are similar to the "Find Friend" service by AT&T in that they are based on geographical positioning techniques of mobile phones, Japanese companies' services are strongly oriented to the security of mobile phone holders. In particular, Japanese mobile phone companies emphasize security purposes for their "kid mobile phone (kid-phone)". The list of phone numbers that can be dialed from a kid-phone is limited to prevent overuse, and the handset has an emergency-call button. When a holder presses the button in case of emergency, a buzzer sounds and an emergency e-mail with a map indicating the location of the handset is sent to the subscriber, usually the holder's parent. Some models will automatically submit continual location-mails at a certain time interval if the power switch on the handset is turned off in an abnormal manner. With this function, a subscriber can trace the location of the holder even if a criminal tries to shut down the handset to prevent a location search.

The kid mobile phone has been a powerful force driving mobile phone companies to provide geographical positioning services. More than half of over 300,000 subscribers to NTT DoCoMo's *Imadoco* Search Service use kid mobile phones (NTT Docomo, 2007).

3.2 Security service companies

Apart from mobile phone companies, security service companies are the most common providers of LBSS. In fact, security service companies began LBSS earlier than mobile phone companies. As mentioned above, SECOM, the leading security service company in Japan, launched the "COCO-SECOM" service in 2001. This was the first commercial LBS for personal use in Japan, possibly in the world, because no mobile phone companies offered such a service at that time. Other major security service companies followed shortly after with their own services. *Sohgo* Security Service (ALSOK) began the "*Anshin* Mate" (peace-of-mind mate) service, using NTT's DLP network, in 2003. In that same year, Central Security Patrols (CSP) also launched their "Mobile Guard" service on the same network as ALSOK's.

Security service companies typically use portable transmitters equipped with both a small GPS unit and a mobile phone communication unit. With this device, a security service company can provide a geographical location-search service similar to that provided by mobile phone companies. A subscriber can locate the device by contacting the call center of the security service company. The transmitter also has an emergency-call button, which allows the holder to send location information to the operation center of the security service company. The operation center then notifies the subscriber by phone call or e-mail. Using similar transmitters, security service companies provide location-search services for automobiles and valuable property as well. These services are used to search for stolen automobiles, automated teller machines (ATM), construction equipment, and so on. To help prevent theft, a warning is transmitted when a parked automobile or an ATM is moved away from its original position.

A press release from SECOM reported that at the end of 2003, 45 percent of 188,000 subscriptions are for persons, 45 percent for automobiles, 5 percent for motor bicycles, 5 percent for other items, and a small number of the devices were used to locate pet animals. These figures suggest that one of the most popular uses of LBSS is the prevention of vehicle theft. SECOM reported that the average number of location searches per day was about 40,000, which is 0.2 searches per subscription per day (Secom, 2003).

A distinctive service provided by security service companies is the dispatch of emergency response personnel. The details of dispatch services will be discussed later.

3.3 Application service providers for mobile phones

ASPs also provide LBSS. They commonly use ordinary mobile phone handsets for simple location-search services. Their services have few distinctive features relative to mobile phone companies' services, except for several unique cases.

For example, one ASP operates location search and emergency response services for mountain climbers and pleasure boaters called "*Umiyama Zanmai"* (playing on the sea and in the mountains), using mobile phones with GPS devices. Some examples of the use of GPS positioning in sport include rally racing, orienteering, hot air ballooning, and the use of location-tracing systems in long-distance sailing races (Zentai and Guszlev, 2007). The equipment used in these systems, however, is too expensive for use in small pleasure boats. Mobile phones with GPS devices make it possible to provide a very reasonable service, even though the service area is limited to relatively narrow stretches of sea near the coast where radio waves from a mobile phone network can be reached. The service company developed original digital nautical charts and mountain maps for the *Umiyama Zanmai* service because the digital maps commonly used in ordinary location-search services are not sufficient for the navigation needs of climbers and pleasure boats. Rescue call services to police and coast guard are added on demand.

3.4 The others

Some companies provide emergency dispatch services similar to those provided by security service companies, although in a unique way. For example, "e-CAB" is a service marketed to the elderly that dispatches a taxi to respond to emergency calls from mobile phone handsets equipped with a GPS device.

In addition, several new security services using PHS, which was used for the first LBS in Japan, are available. A toy manufacturing company developed inexpensive mobile phone handsets for children using PHS communication units and launched a similar security service to major mobile phone companies. Portable transmitters equipped with PHS units (but no voice capabilities) have also been developed for security services. The accuracy of PHS-based Cell-ID positioning is greater than cellular phone networks, but less than that attained with

GPS positioning. A transmitter with a PHS unit has some advantages compared to a device with a cellular phone unit, including its small size, lighter weight, longer battery life and lower price. As discussed below, a company is carrying out a field experiment on a new security service for younger schoolchildren utilizing these advantages of PHS devices.

4. Outline of the usage of LBSS

Detailed information on the users of mobile phone-based security services is not readily available. Let us here outline service usage based on press releases and materials collected from interviews with persons in charge of the security services of selected companies.

4.1 Total number of service subscribers

The popularity of LBSS cannot be accurately estimated, because service providers do not disclose subscription data. NTT DoCoMo suggests that the *Imadoco* Search service has more than 300,000 subscribers. Although there is no firm evidence on the number of subscribers to KDDI's service, we suppose the number to be near to NTT DoCoMo's. Support for this estimation can be found in the fact that KDDI has two-thirds the number of 3G handsets as NTT DoCoMo, but a far higher percentage of their handsets are equipped with GPS devices. SECOM, the largest security service company, announced the number of subscribers to COCO-SECOM was around 190,000 in 2003 (SECOM, 2003). A person in the pertinent division of SECOM suggested that the number has grown to nearly 500,000.

Taking these figures into consideration, we estimate roughly that the number of LBSS subscribers using mobile phone networks in Japan exceeds one million. These services are steadily infiltrating Japanese society, even though they are not universally popular among the Japanese.

4.2 Geographical features of service use

Mobile phone-based LBSS are available almost everywhere in Japan, because all mobile phone companies and the major security service companies operate throughout the country, except in remote mountain or island regions. The following description of the geographical features of LBSS usage is based on the results of interviews with the persons of selected mobile phone companies and security service companies from March to May of 2007.

For mobile phone companies, the geographical distribution of subscribers to their security services corresponds roughly to the distribution of the general population of mobile phone users. There are no significant differences in subscription rates between, for instance, large cities and provincial areas, or between city centers and suburbs.

For security service companies, however, the service users are heavily concentrated in large metropolitan areas, especially in the Tokyo Metropolitan Area. Although the reason for this heavy concentration is not clear, the fact that ordinary security services are also more popular in metropolitan than in provincial areas may be important. In large metropolitan areas, security services for ordinary families are more dominant than in provincial areas. In addition, a number of institutions in the suburbs of large metropolitan areas, such as schools, childcare centers and elderly care centers, subscribe to security services to facilitate searches for lost children or the elderly. In contrast, subscription rates for property-related security services (e.g., protecting an ATM) are significantly higher in provincial areas.

A company operating a new service for children in a large metropolitan area points out that parents in low-income districts tend to be sensitive to the price of security services. There may be some differences in the attitudes toward personal security services corresponding to the income disparity among districts.

5. Spatial dimensions of LBSS

LBSS using mobile phone networks have encountered some space-related difficulties at various geographical scales. Here, we discuss two significant issues.

5.1 Positioning method and accuracy

The accuracy of location positioning is more important for security services than for other location-based services. For example, accuracy levels less than 20 m to 30 m are needed to find a lost child. Although the GPS-positioning method can be highly accurate, it fails in crowded buildings, underground, or anywhere else radio waves from satellites cannot be received. Although a standard positioning service using a mobile phone network switches automatically to the Cell-ID positioning method when GPS positioning fails, there is a significant reduction in accuracy. An empirical study in Estonia found that the average positioning accuracy based on the Multiple Base-stations method using cellular phones is around 400 m for urban areas and 2600 m for rural areas (Ahas et al., 2007b). This suggests

that there is a serious risk of disruption of emergency response services when GPS positioning fails. Actually, both mobile phone and security companies emphasize that the largest number of claims from subscribers regarding LBSS relate to the inaccuracy of location-search services.

Recently, a positioning service employing the Multiple Base-stations method that simultaneously connects more than 10 PHS base stations was developed. This service achieves a high positioning accuracy, close to that of the GPS-positioning method, with the advantage that accurate positioning is available almost everywhere in urban areas, even in crowded buildings and subways. On the other hand, the accuracy of the PHS positioning service falls off greatly in small provincial cities and rural areas (where PHS base stations are not densely located), so much so that it cannot be used for emergency response services. Therefore LBSS for climbers or pleasure boats, as described above, cannot be based on PHS positioning. As we can see, there is no generally applicable method for accurate positioning, and that the choice of positioning method depends upon the purpose of the location services and urbanization and geographical conditions of the area to be served (Table 2).

Table 2 Positioning method and accuracy in LBSS

positioning method	***condition***			
	open -sky	crowded buildings	under-ground	rural
GPS positioning	high	low	not available	high
PHS based multiple base-stations	medium	medium	medium	low

One question relating to positioning methods remains: Should service providers develop their own transmitters or use ordinary mobile phone handsets? In the latter case, the service price can be kept relatively low, because there is no expense associated with developing transmitters. The basic charge for location-search services provided by mobile phone companies is 200 to 300 yen (1.25 to 1.9 Euros) for one month. This is considerably lower than the average of 1000 yen (6.25 Euros) charged by security service companies using their own transmitters. On the other hand, a portable transmitter has the advantages of being smaller, lighter and easier to handle than typical mobile phone handsets, and thus they may be

more suitable for small children and the elderly. In addition, a transmitter can be used when parents are hesitant to give their children mobile phones, or when schools prohibit their use (Table 3).

Table 3 Type of device and service price

	basic charge	***advantage***
mobile phone handset	200-300 yen (1.25-1.9 euro) /month	•multipurposes
portable transmitter	around 1000 yen (6.25 euro) /month	•smaller size •lighter •easier to handle •less reluctant to give children mobile devices

5.2 Spatiality of dispatch services

The dispatch of emergency response personnel in the case of emergency is an important feature of the services provided by security service companies. Based on press releases and interviews, we estimate that it takes between 30 minutes and one hour from a dispatch request to the completion of the response. Indeed, many companies only guarantee a dispatch service within one hour of contact in their service contracts. Given the average traffic conditions in Japan, dispatch service depots can cover no more than a 20 km radius. Therefore, a dense network of service depots is needed to operate a dispatch service in a wide area. However, major security service companies have already constructed nationwide networks of emergency depots to operate ordinary security services (Figure 3). Security service companies can establish dispatch services at a reasonable cost utilizing these networks.

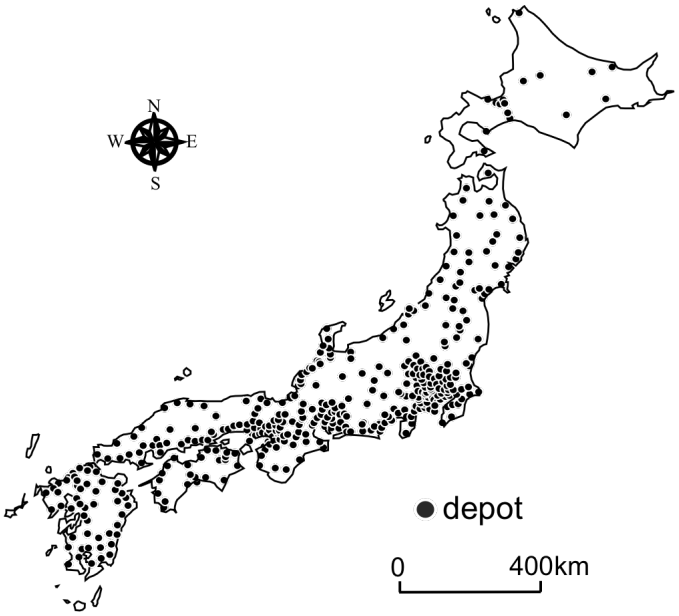

Figure 3 Distribution of the emergency depots of SECOM

SECOM announced in a press release there were 1,800 emergency dispatches to serve children or the elderly, looking for vehicles, and so on, in the first two and a half years of its service (SECOM, 2003). The value of the total sales of the dispatch service can be estimated around 7 million yen (44,000 Euros) per year. These numbers suggest that a dispatch service must be unprofitable as an independent business.

An alternative approach to operating emergency support services can be seen in businesses outside the security services field. An experimental field project called SKIP (Save Kids Project) is being conducted by the Yomiuri Agency, a major advertising company. A miniature transmitter used for the security of children in a primary school was developed for this project. Parents can have their child's location information during trips to and from school automatically delivered to them. The transmitter is equipped with an emergency button to notify the school and the parents by e-mail in case of an emergency. The message is sent as well to local residents who have volunteered to respond to emergency calls from the children. The volunteers are asked to watch the place specified in the emergency message and to call police if there is any criminal activity (Figure 4). The operating company claims that it is difficult for local volunteers to deal with actual crimes. However, an immediate response by volunteers, even if it only amounts to standing witness at street corners where incidents have been reported, may help to prevent crimes.

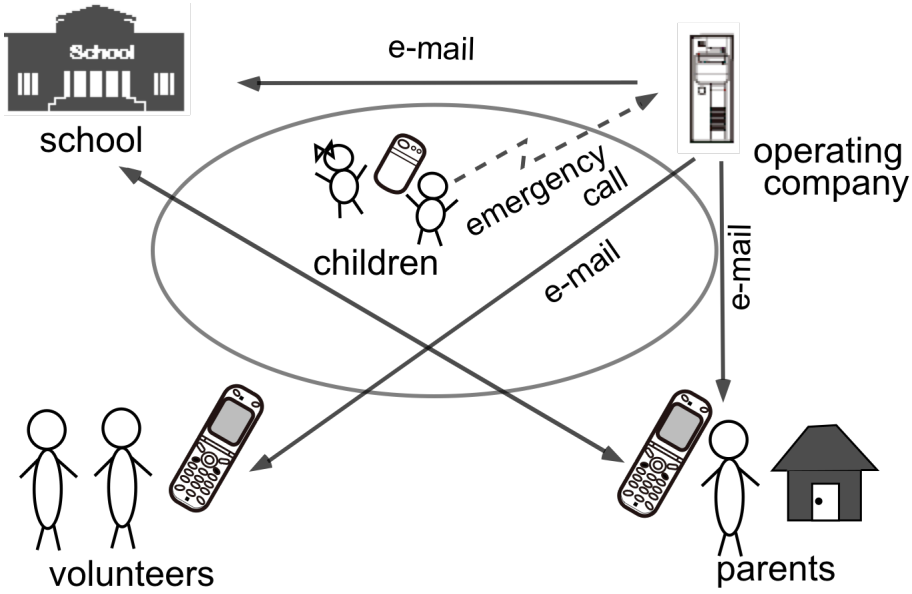

Figure 4 The structure of the SKIP security service

6. New interactions between cyberspaces and geographical spaces: concluding remarks

LBS based on mobile phone networks have developed rapidly in the past decade. In Japan, security services using mobile phone geographical location technologies were launched around 2001, and have been expanded in recent years. The primary reason for the recent expansion of LBSS is the ardent desire for the security of children and the elderly people in a society where crimes against children are mounting and the population is rapidly aging. The government's mandate that mobile phone companies provide location information in emergency calls and its policies promoting the development of ICT-based security systems for children and the elderly have facilitated the dissemination of LBSS in Japan.

The major providers of LBSS that use mobile phone networks are mobile phone companies and security service companies. Although the precise number of subscribers to LBSS using mobile phone networks cannot be known, the total number is estimated to be over one million. While the geographical distribution of subscribers is also unclear, there is no evidence of a significant concentration in large metropolitan areas for the LBS services provided by mobile phone companies. For security service companies, however, some regional differences in subscriber distribution may exist between large metropolitan areas and rural areas.

LBSS using mobile phone networks have some spatially related difficulties. First, although positioning services that use a combination of the GPS-positioning and the Cell-ID methods

can provide sufficient accuracy for the security services, the accuracy is drastically reduced under poor signal conditions, such as crowded buildings and underground. Although the Multiple Base-stations method using PHS networks performs better than the GPS-positioning method in highly urbanized areas, it is not accurate enough in rural areas for emergency services.

Second, security service companies can establish emergency dispatch services at a reasonable expense using the existing network of emergency depots found throughout most of Japan. Although the price paid for emergency response dispatch services is far higher than that for ordinary location-search services, dispatch services are unprofitable because of the low frequency of emergency service requests.

The mobile phone is a ubiquitous, advanced information device, and networks of mobile phones may create cyberspaces. LBSS that use mobile phone networks, as discussed here, are constructed in virtual cyberspaces. Although a location-search service handles geographical location information, it consists of information and transactions that exist in cyberspace.

Persons and properties protected by such security services do, however, exist in the real world. The "safety" of these entities cannot be ensured without some action in real geographical spaces. A location-search service, as such, cannot provide security, because the service performs no action in real space. Despite this limitation, the security services provided by mobile phone companies attract a large number of users. The reason for this may be that people want not so much safety as the peace of mind obtained by knowing that someone can be located at any time. A location-search service can provide that peace of mind (Figure 5). The recent string of vicious crimes against children in Japan has created a vague sense of anxiety among the Japanese. With this sense of anxiety has grown the desire for peace of mind. The security services discussed here have expanded in correspondence to this growing desire. The fact that the subscription rates have risen regardless of where the crimes occurred supports the notion of a broadly felt sense of anxiety.

In contrast to location-search services, a dispatch service provided by a security service company contains actions in real space as well as in cyberspace. A dispatch service is expected to ensure real safety. Actually, present dispatch services are not an effective response to a crime, partially due to the insufficient reliability of positioning accuracy and partially due to the high cost of operation. The minimal use of dispatch services relative to the number of subscribers reflects the limitations of present dispatch services.

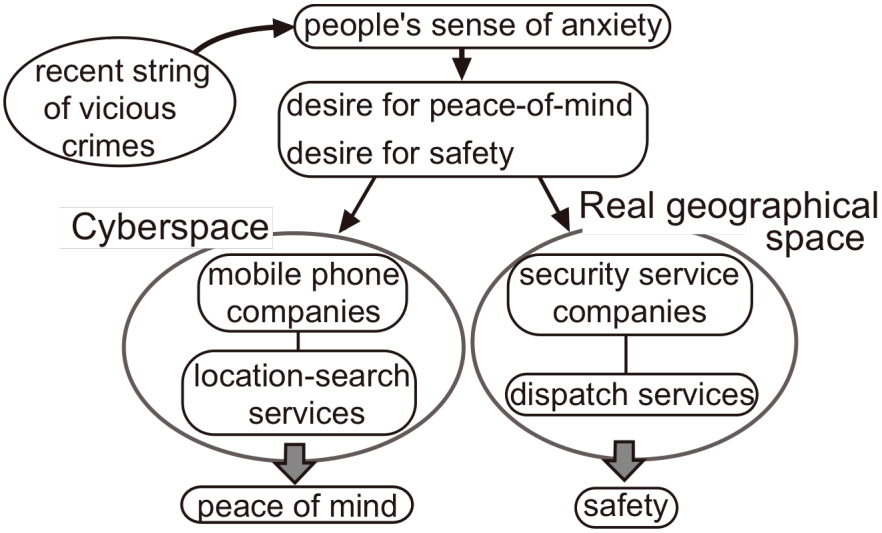

Figure 5 Interaction between cyberspace and real geographical space in LBSS

An experimental project using local volunteers for emergency responses suggests a new concept in the field of dispatch services. The local volunteers, who are not trained to respond to crimes, are not expected to directly confront criminals. The project hopes to prevent crime through the watchful eyes of local residents. The emergency response by local volunteers is a kind of action in real space, but is more geographical, more deeply knit into the locality than the security company's services, because of the social networks of the local residents (Figure 6).

Thus LBSS based on mobile phone networks hold the promise of new interactions between cyberspaces and real geographical spaces.

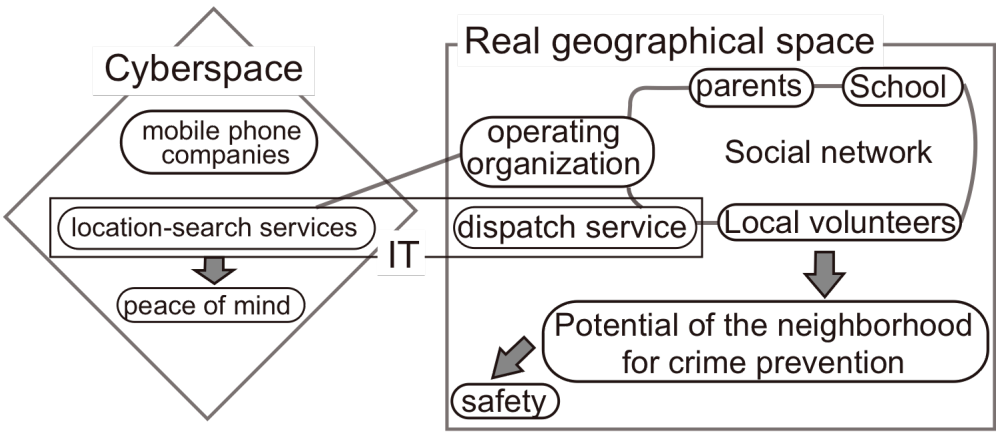

Figure 6 Concept of dispatch services in the SKIP security service

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