

# Public Applications of SpaceTag and their Impacts

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**Abstract.** SpaceTag is an object that can be accessed only from limited locations and time period. SpaceTags are served and distributed from a central server which should be managed by a service provider. Users of the SpaceTag system can access SpaceTags with portable terminals equipped with location sensors and wireless communication device such as mobile phones. Users walk around in a city and find SpaceTags that can be only found at the location. SpaceTag is thus an inconvenient media, but suitable for gaming, advertising, city guide information, etc. A user can also put a SpaceTag at the location where (s)he is, which can be found by other people nearby. This feature also enables local public communication applications. In this paper, we will argue why this inconvenient but simple virtual platform can support various applications for a digital city. We will also argue social impacts of these applications.

## 1 Introduction

One of the authors visited Florence to present our paper on SpaceTag[6] in June. In the city, I found that many tourists were visiting the Uffizi Museum. Visitors should wait for one or two hours before entering the museum. They were mainly aiming at seeing Botticelli's famous paintings.

However, how many of the visitors are able to admire the real Botticelli's paintings? The paintings are printed on many art books published all over the world. They do not have to come to Florence if their aim is to see the paintings. Maybe most of them come to the museum to satisfy themselves by the fact that they see the real ones, or to tell their friends to say, "I saw the real ones," after returning from Florence.

The Internet and multimedia technologies are improving year by year, or month by month. In near future, a digital museum will probably become able to exhibit Botticelli's paintings with a very detailed image data. Nevertheless, people would still visit Florence to see the real ones. Florence's economy is everlasting.

Then, how is the case of digital art? Simply imagine that Botticelli had had a Macintosh and an Illustrator! Now his digital works would be copied

to everywhere through the Internet, because the copyright would have been expired hundreds years ago. Even if the works were still copyright-protected, the download fee would be lower than travel costs. Everyone in the world could saw the *real* ones at home, and Florence's economy would be poorer.

This is one of the problems of digital technologies that very few people point out. They make *only* computer and communication industries rich. One of my friends who is a member of a railway company complained me of digital museum's possible negative effects on the number of passengers.

People are interested in rare things, or things that are hard to get. WWW has made all digital data popular and easy to get. We don't want to deny the value of WWW, but we think that rare and hard-to-get information should also be digitally supported. Imagine a digital city where people can watch plenty of digital arts that can be enjoyed *only* in the city. The city would be rich!

Actually, location-restricted digital art exhibition is one of the possible applications of SpaceTag. The SpaceTag system is a platform to support digital data that can be accessed only from limited locations and in limited time period. Games, sightseeing information, local community communication, etc. are also SpaceTag's applications, as well.

In this paper we will describe the architecture, applications, advantages, and our prototype of SpaceTag system. Possible social problems will be discussed and solutions will be proposed.

## 2 The SpaceTag System

### 2.1 Concept

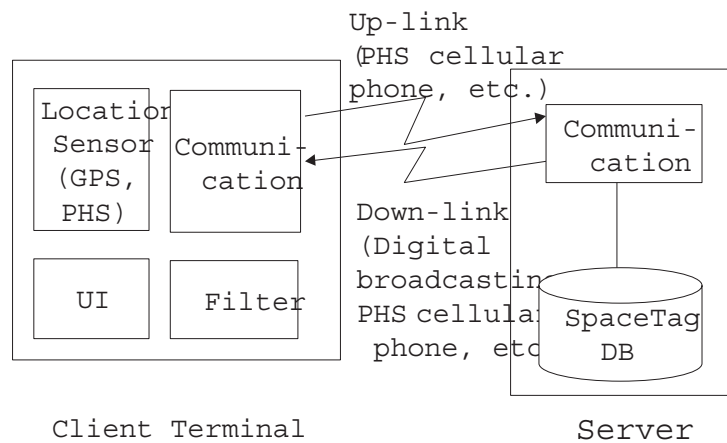
A SpaceTag is a virtual object that can be accessed *only* within limited area and limited time period. Restriction and inconvenience is the essential idea of SpaceTag. Of course, in some applications, it will be more convenient if SpaceTags can be accessed remotely. However, our policy is to give convenience by other media such as WWW, as SpaceTag can be interfaced with other media.

### 2.2 Architecture

Figure 1 shows the basic design of the SpaceTag system. It basically consists of a server and clients. A user has a handy client terminal.

**Server** SpaceTags are stored in a database on a server machine, and they are broadcasted from the server to terminals (clients). A server is composed of a database subsystem and a communication subsystem. The server and the database are supposed to be managed by a service provider.

The database is required to manage SpaceTag objects. A SpaceTag is a digital object that has at least the following attributes: *ID*, *data type*, *effective zone*, *effective time period*, *access rights*, *channel*, etc.



**Fig. 1.** Configuration of the SpaceTag System

- ID is a serial number given by a server, which is not shown to users. Data types may be text, image, audio, program, VRML, URL, etc.
- Effective zone means the area within which a user can open the SpaceTag. It is defined by a pair of center location and radius.<sup>1</sup>
- Channel is like that of TV broadcasting. For example, tourist channel, communication channel, or gaming channel can be given. If a user selects a channel on the terminal, only SpaceTags that have the same channel attribute are shown.

Since the objects have uniform structure except the multimedia contents, the database can be implemented with standard relational or object-relational database products. Almost all queries are retrievals of SpaceTags that can be accessed from a particular position and time. This fact gives possibilities to tune the database performance for queries.

There are two cases in creating and modifying SpaceTags.

*By a service provider:* In cases of tourist information and advertisements, etc., information provider (city government or advertising agents) commissions the service provider to manage the SpaceTags. These SpaceTags can be modified or removed only by the service provider.

*By end-users:* A SpaceTag created by an end-user is transmitted to the server by the up-link communication and stored in the database as a SpaceTag with location attributes of the place where it was created. In this case the SpaceTag

<sup>1</sup> Correctly speaking, we have two kinds of zones. Another is the zone within which users can detect the existence of the SpaceTag but cannot open it.

can be removed by the creator or some specified people. Appropriate access right management should be applied.

It must be inhibited for users to access SpaceTags remotely. If it were allowed, remote access would become a popular behavior of end-users because remote access is simply convenient; the basic concept of SpaceTag might be crashed and some applications would become nonsense. If remote access is required, the service provider can select remotely accessible SpaceTags and copy them to WWW, or the company can create SpaceTags whose contents are URLs indicating the open data. The SpaceTag system and WWW can be linked and cooperate in this way.

It should also be inhibited for users to create SpaceTags remotely, in order to avoid SPAM-like SpaceTags. Only the service provider should be allowed to create them remotely.

**Communication** The SpaceTag system uses two way communication: up-link (client to server) and down-link (server to client).

For the up-link communication, we have adopted a popular digital cellular phone system. Required bandwidth is not so wide, because what are transmitted from clients to the server are some control commands, position data, and SpaceTags created at the client terminal.

For the down-link communication we currently have two options: public digital broadcasting and micro-cell type cellular phone (Japanese PHS (Personal Handyphone System)).

In case of adopting digital broadcasting, surface broadcasting is more appropriate than satellite broadcasting, because broadcasting area is smaller. For example, if a 10 Mbps bandwidth channel is reserved, about 60,000 SpaceTags of 1 KB short text can be broadcasted per minute. If large data like image is contained within a SpaceTag, it is possible to broadcast only indexing information to get the real contents from other network in an on-demand manner, e.g., from the Internet through http or other protocols.

If a micro-cell type cellular phone is adopted, the bandwidth is narrower. In case of Japanese PHS, 64 kbps can be reserved. However, each service area is small enough to reduce the number of SpaceTags to transmit in one area.

**Client Terminals** As shown in Figure 1, a client terminal has the following functions.

*Location sensor:* It senses the position of the terminal itself. We have currently two options for the sensor, GPS and PHS.

*Communication:* It implements the up-link and down-link communication functions. The manner of connection depends on its implementation. If digital broadcasting is adopted, it receives SpaceTags every time. If PHS is adopted, it should be connected continuously or periodically.

*Filter*: This function selects SpaceTags that should be shown to the user from all received SpaceTags and stores them. The filtering is based on location, time, channel, keyword, or other attribute values. Location, time, and channel-based filtering functions are mandatory; others are optional. If a wide-area broadcasting is adopted as the down-link communication, many SpaceTags might be filtered out by this function, because most of them are not within the neighborhood. Selected SpaceTags are cached on the terminal as long as it can be accessed.

Some optional functions can be appended. Content-based filtering is one of them. Another example is notification service, which is to notify the user when a particular specified SpaceTag is detected.

It should be noted that the filtering function could be modified to show SpaceTags that may not be accessed. Currently we are supposing that this type of cheating does not occur. However, we should design more secure implementation against cheating. Developing one-chip SpaceTag terminal is an example of secure design.

*User Interface (UI)*: It provides the following functions:

- List up all the SpaceTags that can be accessed.
- Creation of new SpaceTags. Stylus pen interface, audio microphone, and digital camera (still, motion) are possible future interfaces to create SpaceTags. Currently any Windows files can be stuck as a SpaceTag, on our prototype system.
- Sticking newly created SpaceTags in the real space, and removing or copying SpaceTags from the space. If a SpaceTag is moved from the space to the terminal (cut operation), a control command is sent to the server and the server removes the SpaceTag from the database.
- Channel selection.

### 2.3 Prototype

We have prototyped the first version of the SpaceTag system. For the communication, we adopt PHS for both up-link and down-link. The server is located in our laboratory; Oracle 8 is adopted for the database. Terminals are implemented on usual notebook PCs running Windows, with a client software shown in Figure 2 and Figure 3.

In Figure 3, a user is shown as an icon at the center of the map image. SpaceTags are shown with icons around the user. The user can open a SpaceTag by double-clicking the icon, or a SpaceTag name shown in the list of SpaceTag in the upper-right sub-window. Some SpaceTags, which are not so close to the user, are shown with “?” icon. These SpaceTags are detected by the user, but cannot be opened. Other SpaceTags, which are far from the user, are not shown.

In the lower right sub-window, a list of channels is shown. The use can select a channel in this window to restrict categories of SpaceTags to be shown. In this example, “Hotel,” “Sightseeing,” “Restaurant,” “Advertisement,” and some other channels are used.



Fig. 2. A Client Prototype

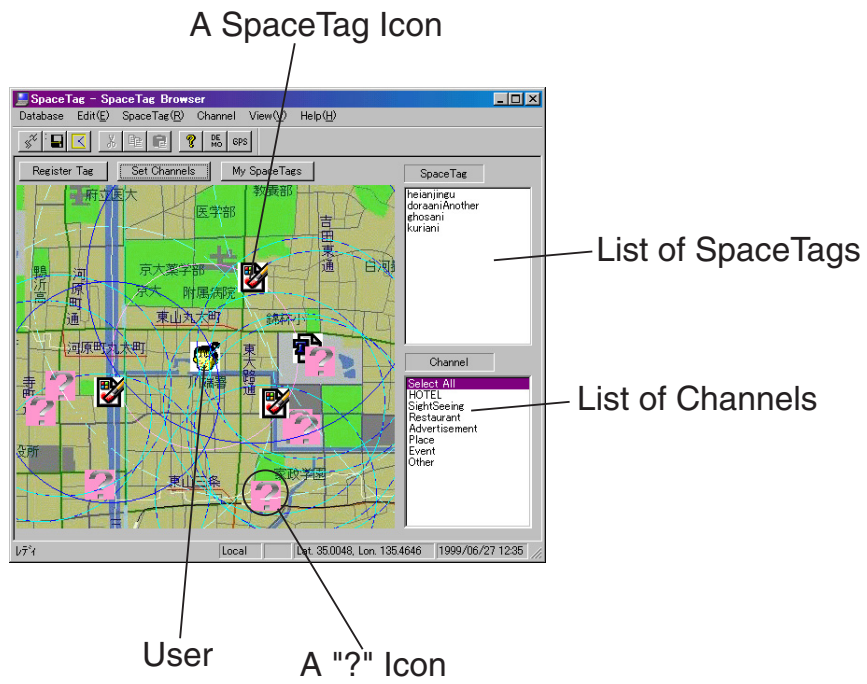


Fig. 3. User Interface of Our Prototype

If the user walks, the map and SpaceTag icons are shifted. SpaceTags getting closer will appear, or the icon will be changed from “?” to usual icons. SpaceTags getting farther will be changed to “?” icon, or disappear.

For the user to stick a SpaceTag, what the user should do is only select a Windows file and drag-and-drop it into the map area. It will be stuck at the place where the user is.

## 2.4 Future Perspective

In June, 1999, Epson Corporation started to sell “Locatio.” It is an integrated handy terminal that has GPS, LCD (3.9 inch), digital camera, and PHS. Its weight is 260 – 290 grams. Its market price is under 100,000 yen (without PHS). For location sensors, it can use GPS and PHS complementarily.

Since its memory and disk space is not enough, currently it cannot be used for a SpaceTag client. However, this product suggests that we will be able to start SpaceTag service in very near future, with very handy terminals.

## 3 Expected Service of SpaceTag System

The SpaceTag system is intrinsically inefficient because accessibility is limited. Its application is mainly in the entertainment field, rather than the business field. In this section we give some applications we are expecting. Especially, the first three applications can be provided as public services of digital cities.

*Public Information Service:* Location-dependent public information can be presented by SpaceTags. Examples are sightseeing information that describes and illustrates famous sightseeing points, public announcement to warn people against pickpockets, to show (temporal) traffic regulation, to show the place of an events, etc.

City residents and visitors who have SpaceTag-aware terminals can find such SpaceTags. If channels are separated, visitors find only those they need, like sightseeing information and traffic regulation announcements, while city residents find other SpaceTags (like a SpaceTag that navigates people to a local tax office) as well.

*Multimedia Attraction:* With SpaceTags, we can implement attractions and entertainment scenes at festivals or events, like fireworks. Digital art exhibition, mentioned in section 1 belongs to this category. If a city offers many multimedia attractions by SpaceTags, many people will visit there to enjoy them.

*Local Area Communication:* A SpaceTag-powered city gives people opportunities to have communication between them. A SpaceTag put by a person is shown to unspecified people nearby. This means that a SpaceTag can be used for instant communication with people around the user. For example, SpaceTags like bills to ask for help to search a lost child, to offer a ticket exchange at event sites, to look for partners to enjoy themselves, and to exchange information about police speed-traps between car drivers are examples of such requirements.

*Real World Adventure Game:* SpaceTags can be used for items in adventure games like secret keys, hints for puzzles, instructions, etc. Players carrying terminals walk around a town, getting and putting SpaceTags according to a game scenario. This type of game is better for our health than existing game machines, and realizes multi-player games naturally.

*Advertising Event:* People must move to access attractive SpaceTags. It causes some economic impacts. For example, suppose that a supermarket chain store announces that some SpaceTags will appear at some of the chain stores on a particular day and people who get the SpaceTag will win a prize. This campaign will gather many customers at all chain stores.

*Moving Advertisement:* A SpaceTag can be shown as a moving object, by periodically changing its location parameter. Using a moving SpaceTag for advertisement, we can provide a moving advertisement. It is only displayed to small number of people, but sometimes more effective than common advertisement like banners on Web pages. It is because it gives strong impression and sometimes causes rumors about the time and place to watch it. Moving advertisement is very easily implemented by periodically changing the location attribute.

## 4 Advantages of SpaceTag System

### 4.1 Overlaid Virtual System

In Figure 4, we categorize location-aware information systems.


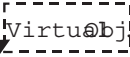


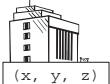
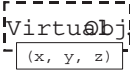
Category	Real World	Provided Service
Augmented Reality		
Ubiquitous Computing		
Overlaid Virtual		

Fig. 4. Location-aware Information Systems

The first category is *augmented reality*. This concept was originally invented in contrast to *virtual reality*. While virtual reality systems just create realistic 3D

computer graphics and give interactive interfaces to the graphical objects, augmented reality is intended to give strong relationship between virtual objects and real objects. Virtual objects are used to give information about real objects. Examples of typical augmented reality systems are NaviCam[4], UbiquitousLinks[2], and Augment-able Reality[5]. In their cases, special tags are attached to real objects. The systems detect these tags and retrieve related information.

The second category is *ubiquitous computing*<sup>2</sup>. In this category, small electronic devices are attached to real objects. The device is enabled to communicate with other devices in a wireless manner like radio waves or infrared. This type of device is also attached to portable computers or human users. They detect each other, sense surrounding situations, and give appropriate services according to the situation. Examples of this category include Cyberguide[1] and Active Badge[7].

The third category, *overlaid virtual* include the SpaceTag system and Touring Machine[3]<sup>3</sup>. In this architecture virtual objects have location attributes and shown at the location.

Overlaid virtual systems may be regarded as a subcategory of augmented reality, because virtual objects can give information of real objects. However, overlaid virtual systems can also be used without real objects, and its implementation is quite different from augmented reality systems. Hence we have given a new category.

An overlaid virtual model can also be illustrated as Figure 5. We assume multiple virtual worlds, which have same geometry with the real world. Objects in virtual worlds are mapped on the real world according to their positions. People in the real world can see these virtual objects with a SpaceTag-aware device.

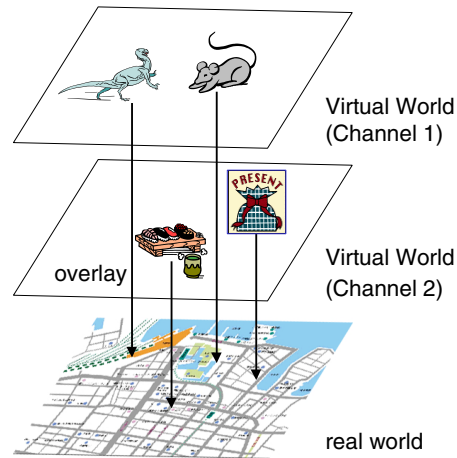
The most important benefit of this architecture is that it is free from real object management. In case of the first two categories, small tags or devices must be attached to real objects. This fact causes the following four harmful costs proportional to the number of objects. Hence we do not think they are realistic implementation for public and open use.

1. Hardware costs of devices or tags.
2. Labor costs to attach them to real objects.
3. Management costs of real objects. Without management, devices or tags might be removed or exchanged by people who are not familiar with the system. Object ID management and maintenance are also included as the management cost.
4. Negotiation costs. Before attaching devices or tags, the system administrator should negotiate with the owner of the object.

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<sup>2</sup> It may not be the correct definition of ubiquitous computing, but here we use this name to refer to this type of architecture since many ubiquitous computing systems take this architecture.

<sup>3</sup> In [3], they categorize Touring Machine as an augmented reality system, but we re-categorize it because it can be used without real objects.



**Fig. 5.** Overlaid Virtual Model

There is another implementation of augmented reality systems. It recognizes real objects by pattern recognition techniques instead of detecting tags. In this case, real world object management is still necessary. System administrators should collect information about shape, color, and material of real objects.

One of the drawbacks of overlaid virtual system is that it cannot give augmented information to moving objects. However, our standpoint is that lower cost is more important than this drawback.

The difference between the overlaid virtual systems and virtual reality systems is that overlaid virtual systems are not intended to represent 3D virtual graphics realistically, for now. This fact strongly affects the system cost and portability.

Then, what is the difference between the SpaceTag system and Touring Machine? Touring Machine can be regarded as a research prototype to investigate the possibilities of user interfaces for overlaid virtual worlds. Its user interface is a heavy kind of thing including HMD, neglecting high cost and heavy weight. SpaceTag gives a basic architecture and application possibilities of overlaid virtual systems, supposing light-weight and low-cost devices. In future, Touring Machine's ideas of user interfaces will be able to be applied to the SpaceTag System, if device technologies improve them.

## 4.2 WWW's Complementary Media

As described in section 1, SpaceTag is the opposite of WWW in the sense that SpaceTag supports locally accessible information while WWW supports globally accessible information. However, these two can be connected and used as complementary media to each other.

If a SpaceTag's data is a URL, a person who discovered it can access to the indicated WWW page, which is also a globally accessible data for people who have already known the URL. On the other hand, we can give a WWW page that announces what kind of SpaceTag can be seen when and where, to attract more and more people.

### 4.3 Economical Effect

As described in section 1, SpaceTag has a potential power to lead people to go out and move. This has a positive economical effect on transportation companies, shops, restaurants, etc.

The supermarket chain store's campaign and the moving advertisement mentioned in section 3 are examples of SpaceTags used as a marketing tool.

### 4.4 Easy to Popularize

Imagine a city office selling portable terminals to visitors and residents to distribute city information. Few people would purchase them because application is limited. With the SpaceTag system, there are various applications. Games and other attractions are included. It is a very important point to make the system attractive and to sell SpaceTag-aware portable terminals as many people as possible.

Moreover, as stated above, SpaceTag will have positive economical effect to many kinds of industries. This means we can expect that various industries will help the popularization activities.

With all reasons described in this section, we believe that SpaceTag is the only solution as a popular, low-cost location-aware information system.

## 5 Social Impact

The SpaceTag system would impact on people's life and social systems. In this section, we will describe such problems and propose their solutions.

### 5.1 Abuse

A possible problem of SpaceTag is its abuse. Users can put slanders and slurs as SpaceTags. SPAM-like advertisements can also be placed as SpaceTags.

To avoid them, a membership system can be considered. Below is an example of membership system.

**An institutional member** can put SpaceTags everywhere. Examples are national and local governments, advertisement companies.

**An individual member** can put SpaceTags only where the member exists, but can delete SpaceTags that (s)he has put wherever (s)he is.

**A non-member** cannot put any SpaceTag. (S)he can read them if the SpaceTag is on a free channel.

It should be inhibited for individual members to create SpaceTags remotely, in order to avoid SPAM-like SpaceTags. Only institutional members should be allowed to create and distribute them remotely.

The SpaceTag service provider can suspend the membership of an individual member if (s)he has put slurs or other troublesome SpaceTags.

Even if a slur SpaceTag is placed, it can be seen only limited number of people. To put more SpaceTags, the malicious user must move about. Nevertheless, the SpaceTags can be easily removed by the service provider. This means that SpaceTag is a less attractive media than the Internet or physical posters, for malicious users who want to SPAM.

There is some subtle usage of SpaceTags. The communication about speed-traps mentioned in section 3 is an example. Such communication between unspecified car drivers interferes with police's business, but free communication between people should be protected. As well as communication on the Internet, communication with SpaceTag should be discussed further from various viewpoints.

The membership system is also beneficial from the viewpoint of the service provider's business. For example, the service provider can propose membership ranks. Highly ranked members who pay high membership fee would be able to access and put more SpaceTags than usual members.

## 5.2 Right to Attach Tags

As described in 4.1, one of the advantages of SpaceTag is that augmented information can be attached on a physical object without negotiation with the owner of the object. However, this may cause another kind of troubles. Can the owner request for the SpaceTag service provider to remove the SpaceTag?

For example, assume a case that a SpaceTag advertising a steak restaurant is placed at a building whose owner is a vegetarian. This case will happen if the building is at the center of the area where the restaurant's owner wants to advertise. The building's owner does not suffer any damage, but (s)he just want to remove the SpaceTag from his/her place, because (s)he simply do not like it. However, the SpaceTag is not physically attached to the building. To solve this kind of problems, a new law system to deal with SpaceTag is expected in future.

## 5.3 Communication or Broadcast?

Does the SpaceTag system belong to the category of communication or broadcast? If it belongs to communication, the privacy of communication should be protected by law. If it belongs to broadcast, the broadcasting company, the service provider in this case, should guarantee the quality of contents.

It seems that the SpaceTag system is a kind of broadcast since unspecified people can view the contents. On the other hand, it seems to be a kind of communication, because it is similar to ham radio.

As well known, Web pages have a same kind of problem. A Web page is authored by individuals, distributed by a service provider through the Internet. However, the provider does not guarantee the quality of the contents, at least prior to distribution.

A SpaceTag is very similar to a poster on a bulletin board, but posters are neither communication nor broadcast, from the viewpoint of law. It seems very strange. Hence we expect a new law system, again.

#### **5.4 Location Sensor Infrastructure**

Our prototype uses GPS as the location sensor. PHS can also be a candidate of location sensor. However, both have disadvantages. GPS cannot be used underground or in buildings. PHS provides only rough data. Both are weak in providing the Z-axis location data. It is difficult to know on which floor in a building a user is.

We propose that a digital city should provide a universal location identifying system for SpaceTag and other location-aware information systems. It is low cost. It can be implemented only by installing cheap beacons at places where above problems occur. What a beacon should do is only to radiate a constant location data around it.

## **6 Conclusion and Future Work**

In this paper, we have described the function and architecture of the SpaceTag system, presented its possible application services, and discussed its impacts on our life and social systems.

We are now developing a next version of the SpaceTag system. A SpaceTag will be more object-oriented, in the sense that it will have methods to process events and that it will be able to send messages to other SpaceTags and users. Examples of events are receiving messages from other SpaceTags or users, timer events, and location events.

Adopting these features, we will be able to provide new kinds of applications. For example, a SpaceTag can be made look like a pet. We call it "SpacePet." A SpacePet moves about a city, communicate with other pets and other users, and returns to the owner and reports what it has experienced. Different from other virtual worlds, SpacePet may meet other users who do not know much about the SpacePet system. A SpacePet also may find other SpaceTags that are related to the real society. Hence SpacePets and SpaceTags will be bridges between virtual and real world.

We believe that SpaceTag's overlaid virtual architecture is a promising candidate of digital city's location-aware information service, due to its low cost and easiness of popularization. We welcome proposals from companies or city governments to implement the SpaceTag system in a large scale.

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