Towards Hovering Information

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Position Paper

1 Introduction

The recent progress in mobile networks, mobile ad hoc networks, sensor networks, RFIDs and other related technologies have already given a step towards this vision. Thanks to mobile wireless networks, it is today possible for two or more persons to communicate and exchange multimedia messages using just their mobile phone or PDA from almost anywhere on the globe. Combined with localization systems in mobile devices, like GPS and Galileo, sensors and RFIDs, sophisticated location based and context-aware services are becoming available to mobile users.
In the future, we can safely assume that daily life objects and people will be equipped with a mobile device having large memory capacity, computing power and connected to a wireless highly speed network. Eventually the world will become a fully interconnected network where each person and object will be a node capable of creating, inserting, accessing, stocking, processing or diffusing information. Information will no longer be stored in large fixed servers, but it will be available everywhere in the environment. Eventually information will detach itself from the physical media and will have the ability of staying attached to a location (in space and time) hovering from one storage device to another, or even moving from one place to another, as possibly specified by its creator, or defined by the information itself. This type of information that we call "*hovering information*", will not be linked to any storage device and will have an existence of its own, linked to a location (rather than a hardware device) that we call the *anchoring location*. In this position paper, we describe some scenarios where the concept of the hovering information can be used and present some of the related research issues.

2 Sample scenarios

The applications of hovering information are limited only by our imagination. Nevertheless, in order to demonstrate the basic concepts and ideas we describe two representative scenarios that will clarify the nature and behavior of the hovering information and its potential usage.

2.1 Disaster areas

It is very probable that after a natural disaster (e.g. earthquake, tsunami, etc.) the communications' infrastructure will be damaged and out of operation. As a result in the

emergency situation where the persons on location will require urgently information, nothing will be available. However it will be also very probable that many stand-alone mobile or fixed devices (e.g. RFIDs attached to objects) will be still operational and capable of establishing an ad-hoc communication network. It is exactly in this case where hovering information can provide the required means for the dissemination of needed information. Since people will be continuously moving from one location to another, trying to help someone or finding a missing person, or even marking dangerous areas, information will need to be linked to locations instead of devices (that will be moving continuously). The concept of hovering information can provide the means to fulfill this specific need, and allow people to store and access information based on a location rather than a device.

Disaster survivors can for example post information regarding places that need to be searched, names of missing people, etc, while rescue workers can mark dangerous areas, provide rescue instructions and directions, etc. In addition, new information can be diffused and stored on the disaster area giving instructions, for example, for reanimation and first aid of rescued persons, or even of basic survival methods, taking into consideration related context information that will come from locally installed (and still functioning) sensors indication, for example temperature and humidity, or even distribution of people or active devices and their location in the disaster area.

People will try to leave as soon as possible the disaster area. However the information they created will find its way (as hovering information) to stay in place by migrating from one available device to another. In this way people will be able to access and enrich the information without the need of fixed networked servers. As the situation in the disaster area improves, new information will appear, while the older one will disappear or migrate wherever it might be needed.

2.2 Tagged world

In the previous example the hovering information can be described as being ephemeral: it is bound to disappear after some time. However we can also imagine persistent hovering information. During the last few years several location based services have been proposed allowing users to place virtual tags[1] at different places in space (called in the literature “air graffiti”, “space tags” etc). All these services require a centralized server where the information (along with its space coordinates) is stored. The concept of the hovering information however offers and alternative way to link information in space, without the need of a central server. The advantages of using the hovering information concept instead of a centralized solution for the creation virtual tags, are many. First of all there is no central control. This is a major advantage from the point of view of service robustness, since no central control means no single point of failure.

A second advantage is that the hovering information allows far greater parallelism in accessing the information at a certain location, thus allowing eventually faster access to the information. A third advantage (which of course can become disadvantage) is that no-one can control, remove or censor the information. Hovering information provides full user empowerment for the distribution of information. Finally the use of

[1] A paper by Michel Deriaz in this report describes the basic issues and an implementation of virtual tags.

hovering information can valorize the increasing and under-used storage and processing capacity of mobile devices. There are many tera-bytes of storage capacity available in mobile devices that are heavily under-used. Hovering information can provide the means to make a good use of this storage capacity.

3 Issues

The implementation of the hovering information concept has many implications ranging from social and cultural issues, to technical problems and design questions. In the rest of this position paper we will describe only some of the research questions and technical issues, related to the implementation of the concept. Social and cultural issues will be studied in a future work.

3.1 Persistency and Reliability

The persistency and reliability of hovering information is one of the most important problems to solve due to the mobile nature of the storage nodes and the absence of a fixed infrastructure. Hovering information stored at a location might disappear if all nodes present leave the location at some time. In this case, there will no node left in the location or near by. When the last node will leave the anchoring location vicinity, the hovering information will disappear or will go away with the last node and will no longer be accessible at the specific location.

If there are no nodes available, then no-one is interested in accessing the hovering information in this location. And when a node will arrive in the anchoring location vicinity, it will come following a certain path where, at some point was in contact with other nodes. This means some solutions might be possible. The study of mobility patterns and replication algorithms could give us some ideas about the trajectories of storage nodes and so how to design replication algorithms in order to guaranty the persistency of the hovering information and its migration to its anchoring location.

3.2 Consistency

The consistency of hovering information presents some problems since the information that was posted by a person, will be replicated or migrated, in order to ensure robustness, reliability, and persistency. As a result if the owner of the information wishes to update the information, it might be impossible to access all nodes where the hovering information is stored and update it. However we have to note that hovering information is like the knowledge exchange by humans. That is, every human has *his* version about some specific knowledge, which might or might not be the same as another person. For instance, someone can tell us this restaurant is very good, but when we visited we discovered that the cook had changed and the food quality has dropped. In most cases we will not be able to inform our friend about the quality change of the restaurant and will thus have two entities (ourselves and our friend) distribution contradictory information. The human race had managed to live long, and even take ad-

vantage, in spite the presence of this type of contradictory information! Thus we can imagine the existence of inconsistent hovering information may be in fact an advantage. That it might be useful to have many opinions about a subject and being able to choose what is the more convenient for us.

Behavior and social phenomena of human knowledge may give us some starting points for studying this problem.

3.3 Distribution

The distribution of hovering information represents an interesting and may be a very important issue. Hovering information does not really needs to be anchored in a specific location, but it can move freely from one place to another. This *nomadic* hovering information will move from one place to another, as defined by its creator or by the information itself, for example, depending where the information is needed.. We can even imagine hovering information migration, when many persons (nodes) request to access this information at a specific location. For example, we might observe the migration of football related information to Germany, during the world cup, taking place in Germany, where thousands of fans are requesting related information.

3.4 Security

The nature of hovering information is dynamic and user defined. These two factors are an advantage and at the same time a source of security challenges. Any person or any autonomous device will be capable of creating and inserting information about some subject and this information will be anchored at a location or distributed around the world. Since there is no central control and no predefined communication channels, we will need to develop new security mechanisms that will allow us to protect nodes from malicious information, chase and erase information that should not be there, provide some means to define trust in the information etc. This latest, that is trust, is one of the most interesting points to work on, due to its direct relation with the nature of hovering information. For instance, how can one trust some information saying that there is a souvenir shop near a place (which is not true) and this information has been posted by a thief for attracting victims to his location.
We can of course imagine a kind of trust chain mechanism as a solution, meaning that only some authorized entities, will be capable of publishing this type information, but this would be in contradiction of the main idea of the hovering information. Other solutions might be to include some type of certificates in the information (as described in another paper in this report), but this would require a central control point.

4 Conclusions

One assumption we made in describing the hovering information concept and examples, is the existence of powerful mobile devices (with lots of memory, processing power and high bandwidth wireless communications) carried by people or attached to

objects. Today however, mobile networks have a limited bandwidth, routing protocols over mobile ad hoc networks are not yet sufficiently performing, sensor networks and RFIDs have a limited range communications, memory and computing power. This posses more problems and restrictions to the study and the design of a platform supporting the hovering information concept, but we are confident that in the near future the evolution of the technology will allows to implement the system in its full scale and capabilities.

Our next steps will be to refine the concept of the hovering information, defining the conceptual and technical challenges and providing some type of solutions. We will then proceed to a design and the development of prototype for the study of related issues. We expect to have some first results in the study of the concepts within a year.