Hovering Information : A paradigm for sharing location-bound information

Dimitri Konstantas and Alfredo Villalba

Abstract: Geo-referenced information is today coupled, stored and accessed not to the location it refers to, but on the server it is stored on. The next step in the (re)evolution of information storage and dissemination will be to couple and store the information in the location to which it refers to. In this paper, we lay the foundations and research questions of a new paradigm for sharing information which we term Hovering Information (HoverInfo). Hovering allows for decoupling information from its host and promotes coupling of this information with a specific geographical location. In this regard, hovering information stays "attached" to a specific geographical area. Information hovers from one mobile device to another, in a quest to remain within a specific vicinity and avail itself to users currently present or entering its anchoring geographical location..

1. Introduction

ICT users tend to share information (YouTube, GoogleEarth, wikipedia, blog etc), create networks for socializing (Skype, LinkedIn, etc), and communicate in order to help each other in resolving problems (Open software, SETI@home et al.). On the other hand, the interest for geo-referenced information is constantly increasing and users start exchanging casually geo-referenced information. These tendencies will increase in the next few years with the wide introduction and adoption of powerful wireless mobile devices, such as smart phones and PDAs (and even wireless-enabled photo cameras) and the need of users to create and access richer geo-referenced information. We can safely assume that future daily-life objects and people will be equipped with mobile devices that will have large memory capacities and computing power, and will be inter-connected via high-capacity wireless networks and provide geo-localization with high-accuracy. As a result, mobile users would also become able to exchange information ad hoc (possibly via ad-hoc connections that will be established and disconnected) as they move around and come within range of other mobile users or daily life objects. Each person and object will be a node capable of generating, inserting, accessing, storing, processing or disseminating new types of active information. However, this information will no longer be stored in large fixed servers, as is the case today, but will be available on mobile nodes or daily-life objects, circulating and exchanged between the different users and objects. Considering the storage capacities available in mobile devices today, more information will be stored in mobile devices around the world than in static servers, eventually creating a massively parallel and distributed information storage environment. Each user of mobile devices will carry with him a large amount of information becoming a potential mobile information server. However, based solely on existing approaches and models, this information will be inevitably confined by the mobile device itself; that is, the source will not associate information with its context but rather it will prescribe a number of irrelevant limitations.

Instead, given the forthcoming capabilities of mobile devices, the “information” should be able to detach itself from the physical media constrains (to which it is linked today) and associate itself with space and time. That is, information will become an active and somewhat autonomous entity, independent of the ephemeral hardware storage support; it will hover from one mobile storage device to another in a quest to stay alive and within some specific location in space or even define its migration plan moving independently from one location to another. We call this type of active information, able to hover from one mobile hosting device to another, in a quest to stay alive and within a specific location, *Hovering Information*, and the location to which it is “assigned” the anchoring location.

The concept of hovering information provides a new paradigm for the dissemination, organization and access of information, integrating concepts from other research domains, ranging from sensor networks, to p2p, ad-hoc and autonomous networking, under a consistent model. The Hovering Information concept extends past networking concepts, from communication infrastructures to clustered massively parallel, self-regulated storing infrastructures, with the locus being the main information property and its relation (anchoring) and “obligation” to stay within a specific geographical location.

The Hovering Information concept provides a realization of Stewart Brand’s “Information wants to be free” dream, freeing it from its ties with physical media, providing the means to have the right information in the right place.

2. Related work

The hovering information concept integrates research and technologies from different areas in mobile and wireless communications, and namely location based Services (LBS), Mobile Ad-hoc Networks (MANETs), peer-to-peer (P2P) systems and autonomic networking. Our work will build upon the knowledge developed in the past, making use of the results obtained and extending them in the creation of the hovering information concept.

A related project is the Development of Geocasting Protocols for a Mobile Ad Hoc Network [1][2][3] of the School of Mines of Colorado. This project concerned the development and performance evaluation of protocols that offer geocast communication in an ad hoc network for communicated messages in disaster areas. The goal of a geocasting protocol is to deliver a packet to a set of nodes within a specified geographical area, i.e., the geocast region, using a mobile devices ad-hoc network.

Virtual Infrastructure [4][5][6] is a project from MIT CSAIL laboratory. It proposes several new approaches that allow existing distributed algorithms to be adapted for highly dynamic ad hoc mobile environments. These approaches take advantage of geographic information to implement high-level abstract objects that facilitate the design of algorithms for these environments. The mobile nodes interact with neighbouring nodes in order to implement in a reliable way different distributed algorithms and mechanism.

The MoSAIC [7][8][9] (Mobile System Availability Integrity and Confidentiality) project is studying new fault tolerance and security mechanisms for mobile wireless devices in ambient intelligence applications. It is focused on sparse self-organized networks, using mostly one-hop wireless communication. The first objective is to define an automatic data back-up and recovery service based on mutual cooperation between mobile devices with no prior trust relationships. Such a service aims to ensure continuous availability of critical data managed by mobile devices that are particularly prone to energy depletion, physical damage, loss or theft.

Reality Mining [10], a project from MIT Media Labs, defines the collection of machine-sensed environmental data pertaining to human social behaviour. This new paradigm of data mining makes possible the modeling of conversation context, proximity sensing, and spatio-termporal location throughout large communities of individuals. Mobile phones (and similarly innocuous devices) are used for data collection, opening social network analysis to new methods of empirical stochastic modeling. In this context, mobile devices set up mobile ad hoc network for exchanging information as people move around and interact.

PeopleNet [11] describes a wireless virtual social network which mimics the way people seek information via social networking. The information is classified and stored by its class, and a geographical area called bazaar, rather than a precise location, is associated to each type, where the mobiles devices will keep the information. PeopleNet uses the infrastructure to propagate queries of a given type to users in specific bazaar. Within each bazaar the query is further propagated between neighbouring nodes via peer-to-peer connectivity until it finds a matching query.

7DS [12] addresses the challenge of increasing data availability by providing a mechanism that enables wireless devices to share resources in a self-organizing manner without the need for an infrastructure. It exploits the host mobility and is capable of searching, relaying, disseminating and sharing information.

Autonomous gossiping (A/G) [13] is an epidemic algorithm for selective dissemination of information. A/G is a paradigm which suits well in a mobile ad-hoc networking (MANET) environment because it does not require any infrastructure or middleware like multicast tree and (un)subscription maintenance for publish/subscribe, but uses ecological and economic principles in a self-organizing manner in order to achieve any arbitrary selectivity (flexible casting).

Finally AD LOC [14] is based on similar ideas as Hovering Information, being a system for mobile users to collaboratively tie persistent virtual notes to physical locations without the need for any servers embedded in the environment or accessed via the Internet. All notes are proactively cached solely on the mobile devices of passing participants and served up to others in the vicinity via ad hoc wireless protocols like WiFi. However AD LOC simply studies some of the issues addressed by Hovering Information in the storage level and namely the effect of different caching strategies. It addresses neither the security issues, nor the integration with other concepts, and nor the global of view of the information as a part of a whole, as is the case with the Hovering Information.

3. Overview of the concept

The hovering information can be seen as an overlay on top of the P2P ad-hoc and autonomous networks, linking information to a location and detaching the information from its physical support.

Hovering information can be shaped as text, image, video, alarm indication or any combination of these. A hovering information piece is linked to an anchoring point, which is determined by its geographical coordinates (longitude-latitude, or offset point from fixed positions or by any other method). The hovering information anchored to a point covers (that is, can be logically be seen) a specific area around the anchoring point, that we call the anchoring area (or hot-spot of the hovering information). The anchoring area can be of any shape and can represent a volume. Any user present in the anchoring area should be able to receive/access the information, irrespectively of its actual storage or originating host (figure 1).

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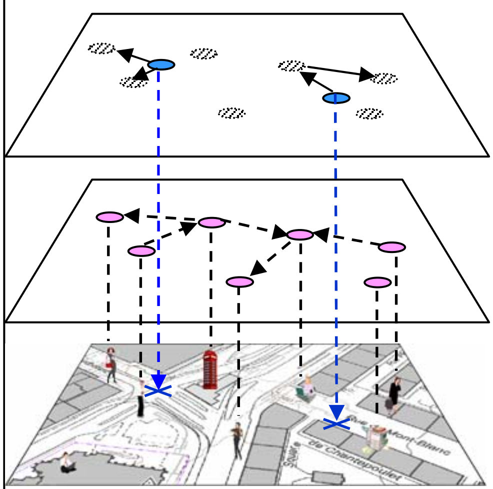

Figure 1. Overview of the hovering information concept

The hovering information can be applied and used in many situations similarly with the existing “points of interest” applications and services. However, the fact that the hovering information does not require a fixed infrastructure, as existing Location Based Service (LBS) do, opens a totally different dimension in the way location-based information is created, disseminated and managed. The hovering information concept provides a very promising paradigm of distributed, massively scalable, self-adaptable and auto-regulated information creation, management and dissemination, over heterogeneous networks and devices, offering many advantages, in relation to other traditional models of dissemination of mobile information.

First of all, with the hovering information, there is no central control and single point of failure. Hovering Information can operate at different granularity levels (from meters to kilometres), independently of each other. Hovering information is self-organized and controlled, allowing for information to exist and accessed as long as mobile users are present in an area and in a total absence of fixed infrastructure. Moreover, fallback solutions can be implemented to ensure that information survives if all mobile hosts leave a certain area, if this is desired (like for example allowing the information to move with a host hoping that it will be able to come back at a later time). .

A second advantage is that the hovering information allows far greater parallelism in accessing the information at a certain location, thus allowing faster access to the information in certain circumstances. For example, in an area where critical information is needed by large number of users, the Hovering Information can replicate itself and allow simultaneous and parallel access from many hosts.

A third advantage is that the Hovering Information does not require centralised services and powerful servers to exist and be deployed. Any user will be able to just load the hovering information application, create content and link it to a location. Hovering Information provides human-centric services along with a corresponding paradigm for storing information in space (graffiti and tags is a very familiar model for information dissemination since the dawn of human kind), allowing users to create their own spatial information.

A fourth advantage (or disadvantage) is that no-one can control, re-move or censor the information. Evidently, this could become a liability if appropriate solutions based on dynamic trust and adaptive security is not adopted.

Finally the use of hovering information can valorise the increasing but largely underused storage, processing capacity and resources of mobile devices. There are many millions of terabytes of storage capacity available in mobile devices that are hardly get any use. Hovering information can provide the means to make a good case for this storage capacity and utilize the available resources of mobile phones.

4. Some usage examples

Hovering information can be used in many cases for the dissemination of different types of information. The list of examples where the concept of Hovering Information can be used is very long. In the following, we present some selected cases to highlight the potential of hovering information to move beyond the constraints of existing models and services.

A first possible application relates with the dissemination and exchange of ephemeral information in popular events (where the density of the users will be high). For example in an open market or a concert clients or sales persons can put messages regarding quality of goods, special offers etc. As long as there are people present in the market the information will be available. When the market will close, and no-one will be present, the information will be neither needed nor be valid for the next day. It will thus disappear in a natural way.

Another scenario for applying hovering information is after a disaster, where it is very probable the communications' infrastructure will be damaged and out of operation for the first few hours. As a result, the persons on that location will require urgently information, but no fixed infrastructure will be available. However, it will be also very likely that many stand-alone mobile or fixed devices (e.g. sensors attached to objects or mobile phones, RFIDs) 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 urgent 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 (which will be continuously moving). 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, directions to safe places etc.

Of course there will be cases where a hovering information piece will not be available at its anchoring location (last person left the location etc). However, this does not invalidate the approach and concept, since the hovering information will be able to provide and disseminate far more information than it would have been possible without it.

As the situation in the disaster area improves, new information will appear, while the older one will disappear or migrate wherever it might be requested.

Furthermore, hovering information can also be used to indicate the perimeter of the disaster area, informing persons to avoid entering or determining a point onwards where special care is deemed necessary. The anchoring area of the hovering information can thus be of any arbitrary shape or volume.

A third example can come from the Vehicular Ad-hoc Networks (VANETs). Future cars will be equipped with mobile devices and sensors, and will be able to exchange information for improving driver safety. Cars moving on a highway will be able to anchor information that will be passed from one car to another, regarding local road conditions (slippery road, strong lateral wind, nearby accident etc). This way, drivers will be alerted of any dangers or problems that may lie on the road ahead, in effect establishing a mobile sensor network in which the locus of dissemination of different pieces of information remains constant, whereas the sensors that tied the data to that specific location have moved on.

Another example can be a situation where a person has lost an item that was later found by another passer-by. Assuming there is no way to identify the owner of the item, the only piece of information that might help establish a link between the person losing the item and the one finding it, is the location in which it was found. The owner is likely to retrace his steps, thus at some point passing near the location where the item was lost. A note left hovering by the person who found the item, and retained by the devices of other bystanders, could help the owner recover the lost item.

Hovering Information can also be used by the industry for commercialization of new mobile applications and services that require the existence of specialised sensor devices, which (sensors) are not widely adopted. That is, a user having bought the specialised sensors will leave the readings in a location as hovering information, and other users not equipped with the sensor will nevertheless be able to make use of the new service. This way the new services can be introduced to the market at a different speed than the sensor devices.

The above scenarios highlight the main features and capabilities of hovering information. Firstly, the information recorded is by nature location-dependent. Secondly, such information need only be disseminated to nodes that happen to be in the vicinity of where the information was anchored. Moreover, such information is transient and likely to become irrelevant with the passage of time. Therefore, if no users remain in the vicinity of the information, then the deletion of the information may not be problematic, as it is likely to have turned stale by the time the next user arrives in the area. Consequently, the more users are present in the anchoring location, the more important the information becomes. More users means more nodes, which translates to a higher retention rate for often sought-after and subsequently important information.

In the previous examples the hovering information is ephemeral, as it is expected to expire at some point. However we can also imagine persistent hovering information. One usage example can come from the existing LBS services, like virtual tags, points of interest etc. that allow users to place tags at different places in space ("air graffiti", "space tags" etc). Today these services provide persistent information dissemination but require a centralized server where the information (along with its space coordinates) is stored. The concept of the hovering information however offers an alternative way to link this type of information in space, without the need of a central server, based on the capabilities of the mobile users' devices.

5. Analysis of the Hovering Information concept

Although the Hovering Information is a simple and elegant concept, it requires coordinated research at different levels and domains. We distinguish three main layers of research for the development of the concept and the models, and namely the **communication layer**, the **storage layer** and the **usage layer**.

At the **communication layer** the research issues relate to the recognition by the hovering information of the nearby hosts, the capabilities and potential for hovering from one host to another, the localization information and its accuracy etc. At this layer we build on research results coming from ad-hoc, p2p and autonomous networking, towards the understanding of the constraints and requirements for the communication between hovering information hosts. The main difference being that it is not the hosts that will define the policy of the communication, but the information itself (the paradigm is thus somehow reversed). For this we need to define the required communication primitives that will be available to the higher layers.

At the **storage layer** we concentrate on issues related to the survivability of the hovering information *pieces*. Based on the primitives of the communication layer, a hovering information piece controls when, how and where will it hover from one host to another. For this part of research we start be evaluating models coming from different areas (like bio-models) and understand how a new model can be designed to suit the hovering information needs. At the storage level each hovering information piece is seen independently of any others.

At the **usage layer** the hovering information pieces are seen as a whole. In this layer a hovering information piece will be a part of a "community" of hovering information pieces serving the mobile users. In the usage layer issues related to the capabilities of the nodes, the multiplicity and complementarities of hovering information pieces will be studied. Questions related to the meta-information carried by the hovering information pieces, the need or not of classification of hovering information, the methods to identify available information at different hosts in the anchoring location with minimal overhead as well as considerations of the local host preferences (like power and capacity considerations), will be some of the research issues in this layer.

In addition to the above "horizontal" layers, a vertical layer covering the issues of security, privacy and trust needs to be addressed. As hovering information is an active entity, we will have to provide guarantees for the protection of the hosts, the information itself and its users, as well as offer the means for trust development between users, hosts and information. A new model of trust able to dynamically adapt in the ever changing configuration of the hosts and hovering information needs to be developed. These issues and models that we will develop, have implications to all three layers.

6. Research Issues

The development of the hovering information concept requires the clarification and study of many issues and problems, which are new in the area of wireless information management. In order to demonstrate the complexity of the issues related to the abstract concept, let us take a simple example. We assume that we have a small number of roaming mobile users with a simple sensor measuring the temperature of the air and making it available to other users, as hovering information pieces, linked to the location where the temperature was sampled. Other users will be able to be informed of the temperature at a location, even if they do not posses the required sensor. A temperature at a location will change over the time and different temperature-capable mobile users will pass-by a specific location during the day. The questions that arise are many; when more than one measurements of the temperature are available at the location, which is one is valid? Time stamps can solve this problem, but then what happens to the old measurements? Can a new measurement delete an old one? And what about keeping the need to keep track of the temperature changes during the day? How a mobile user entering the anchoring area can "read" the latest defined temperature, without having to receive all measurements from time immemorial and choose the latest? How the oldest reading will decide that they are no longer valid and decide to die-away? How can they know that there is a new reading available and that no-one is interested in the historical data or that other copies exist in the area? How can a user receiving the temperature indicating hovering information can trust the reading as coming from a reliable source?

All the above questions raise important research issues regarding models and methods for self-organization and collaboration of information. These issues require the integration of research effort from different domains and research communities. In the rest of this section we describe the most important issues that require research for the realisation of the Hovering Information concept.

6.1 Persistency, reliability and information life cycle

The first issue concerns the persistency and reliability of the hovering information. Hovering information stored at a location might disappear if all nodes leave the location. When the last node will leave the anchoring location vicinity (lonely host problem), the hovering information will disappear or will move away with the last node and will no longer be accessible at the specific location. Both information disappearance and moving away have advantages and disadvantages. The information disappearing can be a "natural" way to clean up the system, while moving away, can be useful for preserving the information which at a later time will be re-connect to its anchoring location. This can be achieved if we allow the hovering information to crawl to its destination, moving from node to node. This in fact can be an element that will be able to distinguish different types of hovering information pieces, allowing some information to stay alive and come back to its anchoring location and others, not so evolved, to simply die away. Appropriate mechanisms to ensure survivability of information and life cycle control should thus be provided.

6.2 Information consistency

A second issue concerns the consistency of the information. Can the hovering information be modified by its hosts? If yes, how can we guarantee consistency? One important question however to reply is whether the notion of consistency is applicable, and under what conditions or cases, in the hovering information concept? Being localized in time and space makes a piece of information unique and immutable. When a person writes graffiti on a wall, it makes no sense to provide a version number. However, anyone passing from this location can write on top of the graffiti, modifying it or even completely erasing it. The hovering information will thus need to define which paradigm is more appropriate to follow and under which conditions. Versioning and information update might thus be useful in certain cases, while being meaningless in other cases.

6.3 Security and Trust

A third issue, but very important issue, is the question of security and trust, applied to both the information and the host of the information. How can we guarantee that a hovering information piece has not been tampered or modified by a malicious host? How can we make sure that the information was posted by a specific person and how can accountability be established? What type of information can we accept to host? Can the host screen and reject to host information based on its own policies and requirements and what are the consequences for the over paradigm? The hovering information will act as a worm that will move from one device to another. How can hosts distinguish the real information from real worms, seeking to damage them?

Mobile and wireless networks including ad hoc, sensor and 4G/heterogeneous networks are used in a number of environments that handle sensitive information. Due to this, there are many considerations that should be investigated and are related with protecting sensitive information travelling between nodes (which can be for example mobile sensor nodes or a base station) from being disclosed to unauthorized third parties. This means that security and trust should be studied and included in the hovering information design, rather than added up on security functionality at the application level. The hovering information should thus provide mechanisms and tools ensuring integrity, consistency, and privacy, as needed by the applications.

6.4 Robust and adaptive self-organization

A fourth issue is how the hovering information can provide a robust and adaptive self-organisation, in view of the high level mobility of its underlying systems and the wireless communication environment. Since the underlying characteristic of Hovering Information is the mobility of nodes, the fundamental question is how two of the primary tasks of such environments, that is to disseminate information in time with the required accuracy to the interested user and the ability to self-organise, are impacted by the mobility of nodes, and in which way the mobility can improve the performance and robustness of the hovering information paradigm, enabling new applications.

It has been shown [15] that mobility may increase the communication capacity in ad-hoc networks. In this context, we should investigate if this attribute can also be exploited in "Hovering Information" paradigm or is not true in our context..

The issues and targets for optimization, reliability and robustness are dependent on which nodes are moving and whether the movement is random, predictable, or even controllable. In the context of mobility/environment modelling issues, we should study the movement patterns of users and the mapping to location anchoring by addressing what is a minimal population concentration to support hovering information as well as what is the significance of the localization precision in relation to population density.

6.5 Information representation

The target of the hovering information paradigm is to allow mobile users to store and access information that is linked to a specific location. Thus one can be tended to compare the paradigm with a distributed database. However the physical independency aspect of the hovering information makes the approach of formalization and representation used in database systems loose all of its meaning.

In fact, data base approaches are devoted to apply a formal method in order to optimise and guarantee the integrity of storage. Hovering information is more focused on the "comprehension" of the transmitted data and on its personalization. For example, information with a general destination should eventually be accessible, readable and storable by all users situated on the same location. Information, sent to one ore more users and for one or more locations, should be represented differently. For this, new methods of design and representation of data should be investigated.

6.6 Scalability of the concept and models

The notion of scalability is in general connected to the number of instances (like users, devices, software, data etc), defining how the basic concept will behave when large numbers of instances occur. In the case of Hovering Information we will have to first define how the scalability notion should be interpreted. We can see scalability as the number of hosts present at a specific anchoring location, or as the number of parallel intercommunicating hosts at different anchoring locations. We can also see it from the point of view of the number of information pieces present at the same anchoring point/area. Or we can see it from the point of view of the anchoring area size covered by a hovering information piece (we can have hovering information pieces with a small anchoring area and hovering information pieces covering the whole Earth). The behaviour of the hovering information and how these cases can be handled must be studied in detail, in order to define the real notion of scalability of the concept.

7. Current state and directions

Our research has started with the definition of the hovering information concept and the design of one or more models, taking into considerations different options and assumptions. For example, the frequency of announcing the existence of a hovering information piece to other hosts in the area and the method of transmitting the information can be done using different methods: broadcast at regular intervals, triggered by location change or even only when the information hovers from a host to another. In parallel we are developing simulation tools in for the study of movement patterns, where we can study in-vitro the different models and identify inconsistencies, problems, and unforeseen issues. Based on the results of the simulations we will revise the model and if needed notions of the concept. This iteration will repeated until we come-up with one or more consistent models for the hovering information.

We will base our study on existing data available in the research community, like the FORTH mobile data repository which models for the access, roaming patterns, traffic workload of APs and clients at campus-wide wireless infrastructures, and the MIT data, providing different traces from large-scale academic campus-wide deployments of IEEE802.11. With this data we will study the relations between mobile users and distances from fixed location areas. What we will try to identify are issues like the effect of the density of mobile users for different sizes of anchoring locations, the relations between the presences of users within the anchoring location, the influence of the node capabilities etc.

Based on the results of this study we will then develop a first set of algorithms with aim to keep the information within the anchoring location. The first generation of algorithms will, inevitably, be based on several simplification assumptions (for example, low network latency, large bandwidth and storage capacity, few security requirements, no power consumption limitations, unlimited resources, no malicious users etc) but will operate in a distributed fashion. The algorithms will be tested and fine-tuned in the simulations, under different conditions, population densities etc. and their utility in query processing user requests will be ascertained. We expect this will give us a first view of the behaviour of the hovering information and the relations with the mobile users' movement patterns as well as how different connectivity options affect the dissemination of hovering info. In our results we will define basic measurable properties of the hosts and hovering information, including, for example:

- The movement vector(s) of the hosts, indicating their movement capacity, movement potential etc. A host moving very fast will have high movement vector, while a host being temporarily immobile will have a low movement vector but possibly linked with a high movement potential vector.
- The dissemination and absorption capacity of the hosts, indicating the capabilities of the host to send out and receive hovering information. A host with low memory capacity will have a low message absorption capacity, but might have a high dissemination capacity, if it can support a high bandwidth network
- The hovering information parameters, like size of the information, importance and life time (if the information will need to disappear after some time) etc.

The next step will be to start removing certain assumptions, to gradually approach the reality. We will introduce latency times, limited bandwidth and differentiation of the capabilities of the nodes. We will adapt the algorithms and study the consequences of each new element in the viability of the hovering information.

Once we have a clear understanding of the consequences of the different elements (like population density in the anchoring location, speed of movement of the mobile nodes, capability differences, localization accuracy etc) we will study and adapt/extend the previously developed algorithms and develop as needed new algorithms incorporating advanced strategies and options that will provide a more "intelligent" behaviour of the hovering information. With this new set of algorithms we will address problems such as replication of information, "expiration time", security issues etc and different types of feasible solutions will be investigated. These new concepts and mechanisms will be tested in simulations.

To be noted that due to the fact that the existing mobile network simulators are not all of the same quality [16][17], we will make use of more than one simulator, so that we can validate the results and eliminate bogus behaviour of the simulators.

Following the simulation studies and the development of sophisticated algorithms supporting the hovering information concepts, we will seek to validate the results with field studies. This validation with life tests is very important in the definition of the concept and models of the hovering information, since it will allows us, from one side, to validate theoretical models and from the other side to provide a first experience of the functionality and capabilities of the concept. For this we will port the developed algorithms into commercial mobile devices such as phones and PDAs and proceed to field studies using volunteers. With the collected experimental data to we will revise the models and the simulation assumptions, engaging in an iteration phase allowing us to improve the concepts and refine the hovering information paradigm and propose research areas and possible usage applications. The reason for opting for field studies is that for current traffic modeling tools, the application mixture and traffic models are quite simplistic. One of the problems is that complex mobility and topology models are rich subfields of their own expertise. Existing simulation tools cannot fully capture and represent this richness and complexity of human traffic and behaviour. A field test however can provide us with the required inside, help us comprehend the related issues and even allow us to adapt the simulation models and simulation tools to better represent the real world.

To be noted that in all our research we are based on a few fundamental assumptions and namely that mobile devices have the capability to communicate wirelessly between them and they are location aware (either using GPS or any other method allowing them to know their location in space).

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