Dependability Requirements for Hovering Information

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Abstract. Hovering information is a new concept denoting information that stays attached to a specific geographical location rather than to a specific host. As a result, when deployed over a mobile set of peers, hovering information than "hovers" from host to host in order to remain attached to its location. This paper describes the hovering information concept and its characteristics, and then highlights dependability requirements related to this type of information dissemination.

1 Introduction

The term "Hovering Information" has been recently introduced by Villalba and Konstantas [2]. It is a new concept of information dissemination over a highly mobile set of peers, where the information *itself* is responsible for its own survivability. If the host in which it is currently stored does no longer meet its requirements, the information "hops" towards another more suitable host.

An important aspect of the hovering information as defined by [2] is the notion of *anchor location*. Hovering information data are attached at some specific location, and the major requirement of the information is to find a suitable storage on a mobile device within range of its location. Whenever the mobile device leaves the area around the location of the information, then the information has to move to another device. Two scenarios highlight this notion:

- Virtual tags are inserted at specific locations on roads or motorways either by cars' drivers or traffic management staff. The purpose being to provide information to cars' drivers about road conditions, accidents, etc. In such a scenario, using the notion of hovering information, such tags will not be stored on a specific server and made available to users when they reach the zone of interest of the information. Instead the tags are locally stored in the cars and made available through wireless channels to nearby cars. Since data have a meaning for the specific location they have been attributed, data will have to "change" car as soon as the car they are currently stored in leaves the area of the anchor location. The data will then hop from one car to the next one.
- In an emergency scenario, virtual data present before a disaster may want to "survive" by using emergency crew or survivors devices. This data can also present useful information for emergency services. Additionally, disaster's survivors may want to indicate their position by placing the appropriate hovering information

attaching it to their own location. Emergency crew member can place hovering information to areas where survivors have been found or where there is a chance to find some survivors. In this case, the information will hop from one emergency/survivor device to another one.

2 Hovering Information Concept

Hovering information differs from traditional P2P or MANET storage in the sense that hovering information is the "active" element: the peers or the nodes of a MANET are not actively seeking ways of storing information, it is the information that actively seeks ways of storing/re-routing itself, according to its main criteria for storage, which is its defined *anchor location*.

We distinguish three distinct populations:

- the mobile P2P or MANET underlying infrastructure acting as a storage media;
- users (generally owners of the peer devices above) interested by the hovering information;
- the hovering information itself disseminated among the P2P/MANET structure.

These three populations, although linked together, are rather independent. Users place or retrieve information on which they have no later control. The information, once created, freely decides to split and/or store itself at the best storage location. The supporting storage media of peers simply move without taking into account any need of the hovering information that they are storing.

Hovering information made available to users can be viewed as a dependable service that is supported by a non-reliable set of peers. Indeed, hovering information cannot rely on cooperation, availability, or any other strong assumption from peers or users. Peers and users are just passing at some point in time close to the location place of the information. Peer nodes mobility, possible unavailability and unreliability are then the normal mode of operation.

3 Characteristics of Hovering Information

Two main characteristics of an Hovering Information service are *decentralised control* and *self-organising behaviour*.

Indeed, we distinguish the three following levels of hovering information data:

1. a single hovering information data, meaningful by itself for a user. For instance: "Here, car speed limit is 50km/h";
2. a single hovering information data split into different pieces in order to better store itself across different storage devices. Taken individually, each piece is not necessarily meaningful for a user;
3. several hovering information data that taken together provide some additional information. For instance: "A survivor is located here", "An emergency toolkit is on this site", "A doctor is arriving here".

As soon as some single hovering information data is created (1), it will individually and permanently seek a storage location. The different single hovering information data "work on their own" and try to locate themselves somewhere. There is no central control from within the users or from within the underlying peers, or any other management body that could possibly be related to the hovering information.

If a single hovering information data (as as whole) finds that it is not able to store itself on a single device (2), it will split itself into several pieces and find suitable storage. This is much similar to a school of fish trying to escape a predator by splitting the swarm in the presence of predators and reforming it whenever possible.

In the third case (3), from an observer point of view, the different single hovering information data all individually seek the best storage. Together, they display some self-organisation characteristics: for instance, depending on the constraints of storage provided by the available peers on the range, they will locate themselves where space is available, thus evenly loading the different devices.

When all the peers leave the area, two options occur: a. the information is no longer up-to-date, it may destroy itself; b. the information leaves with the last peer and seeks a way to come back using the underlying MANET infrastructure, as soon as some route is available to come back to its original location. This mostly depends on the application.

4 Dependability Requirements

The main constraint faced by hovering information is the high dynamicity of peers in the vicinity of its anchor location: appearance, disappearance, insufficient storage, insufficient power, etc. The goal of a single hovering information data, point (1) of Section 3, or the property that this data has to satisfy, is "to remain fully (all pieces) stored within range of its anchored location". Note that having all pieces stored at the anchored location does not imply they are all stored on the same device.

Survivability. This is the main dependability requirement of hovering information: it has to survive (keep a storage at the anchor location) independently of any change occurring to the underlying peers supporting its storage. It has to appropriately jump from one node to another, split itself among different nodes, possibly leave and come back later. Implied by the notion of survivability are the notions of *adaptation* and *stability*. If hovering information is able to survive, this means it has been able to overcome any perturbation incurred by the movement of the peers: stability of location including recovery of lost location; and adaptation to changing environmental conditions (moving/splitting/coming back). This aspect encompasses as well replication and redundancy.

Integrity. While survivability is linked to storage and possible loss of the information, integrity relates to genuine modification of data by users in order to update, modify, or remove it.

Availability. Once survivability and integrity requirements are met, the hovering information must be made available to the users in a meaningful way. This encompasses the notions of semantics and ontology, how a piece of information stored by

user A can be (correctly understood) by user B? How, for case (2) of Section 3, the different pieces of hovering information data are comprehensively gathered together for a single user?

Self- and Context-awareness. Hovering information must know its anchor location and its size. It must also know different parameters of the current device it is stored in, such as its location, its current power and storage capacity. It must also be able to sense in some way its environment: what are the other devices in the vicinicity to which it can move or split?

Security and Trust. Finally, from a user's point of view, what is the value of hovering information posted by other (potentially unknown) users, can she trust the information? Similarly, can a user/device trust some hovering information data that asks for some storage?

5 Engineering Issues

So far three levels of enginnering issues have been identified:

- Communication: physical capability to locate nearby hosts, to hop from one node to another and to know the position
- Storage: how/when/where to hop. This encompasses as well splitting into and aggregation of different pieces;
- Usage: presentation and meaning for users of single hovering information data pieces; gathering and meaningful aggregation of pieces (in case of splitting).

6 Conclusion

Hovering information is a recent concept that requires still further research work in order to be fully operational. However, this concept is closely linked with MANET [1], P2P systems [3], self-organising systems, aggregation of data, for which extensive research attention has been given these last years. Possible solutions devised for these domains may be applicable to hovering information as well. Future short-term works include: formal definition of the concept, and elaboration of survivability algorithms, including simulations.

References

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