Distributed Location-Aware Hovering Information Systems

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ABSTRACT

The rapid developments in the amount of mobile devices and in the mobile technology, as well as the surge of positioning technology in the mobile devices, have created a user base and demand for location-aware mobile applications.

The authors of Hovering information, AD LOC, and Abiding geocast have presented systems, which main idea is to bind information to geographical locations in ad hoc mobile networks. We will call these kind of systems as Distributed Location-Aware Hovering Information (DLAHI) systems.

DLAHI systems are decentralised, distributed, scalable, and generally lightweight. They are also human-driven meaning, that by default anyone should be able to create, share, and access information.

Categories and Subject Descriptors

C.2.2 [**Computer-Communication-Networks**]: Network Protocols

General Terms

Design, Measurement

1. INTRODUCTION

In recent years, user-generated content has grown drastically and sites like YouTube and Twitter are hugely popular nowadays. Furthermore, the modern mobile devices are equipped with operating systems, such as Symbian, Windows, Linux, and their derivations, that are open for third-party software development. Thus, we see that in future, a larger part of the content, be that blog entries, information, or entertainment, is created by users and shared in an ad hoc manner. In addition, the research of [1] indicated that users would like to see location-based information.

A part of our research are Distributed Location-Aware Hovering Information (DLAHI) systems. By nature, DLAHI systems are decentralised, distributed, scalable, and generally lightweight. They are also human-driven meaning, that by default anyone should be able to create, share, and access information. We see that, the DLAHI systems could be used in the future as a distribution platform for, most likely, location-based user-generated content. We consider a system to be a DHALI system if it obeys the concept of Hovering information presented recently by the authors of [3]. The main idea of Hovering information is to bind information to geographical locations in ad hoc mobile networks. In other words, a certain piece of information is considered only relevant to a specific location.

The center of the location is called an anchor location and the surrounding area is an anchor area. Using the available geographic information a piece of hovering information hovers from host to host in order to stay in the specified anchor area. In order to hover, a piece of hovering information uses local information, for example direction, position, and the power and storage capabilities of adjacent nodes.

A piece of hovering information is defined as a tuple h, h=(id, a, r, n, data, policies, size) where: id is the identifier for the piece of hovering information, a is the anchor location (coordinate) and r is the radius of the anchor area. Variable n is the mobile node where the piece of hovering information h is currently located. Data, policies, and size variables define the actual data carried by h, hovering policies that are associated with h, that is, the policies of how and when the piece of hovering information should hover, and the size of the tuple h in bytes.

A mobile node n is defined as, n = (id, loc, speed, dir, $\mathrm{r_{comm}}$) where id is the mobile node identifier, loc is a geographic coordinate location (a pair of latitude and longitude coordinates), speed is the speed in meters per second, dir is a relative geographic coordinate location vector representing the direction of the node's most recent moments and $\mathrm{r_{comm}}$ is the maximum communication range in metres.

The anchor area A_H of a piece of hovering information h is a region A, $\mathrm{A_H}$ = A(a(h), r(h)) where a(h) is the anchor location (the centre point) and r(h) is the radius of the area.

Information propagation, in any form, is probably the most likely form of use for DLAHI systems, especially in emergency situations. Furthermore, the DLAHI systems could be used when implementing applications in the context of virtual traffic signs, advertising, and live resulting system for sporting events. It is also possible to use a DLAHI system as an Internet cache. However, the uncontrolled and open nature will lead to issues concerning security and trust and the DLAHI concept relies heavily on the willingess of users to cooperate and share.

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2. SIMULATIONS & SELECTED RESULTS

The purpose of the simulations is to measure how feasible the concept of DLAHI systems is and to examine what kind of roles different parameters, such as mobility, communication range of the device, and density of nodes, have on the overall system availability. We use availability of a single message as our yardstick, which is reflected on our Research Questions. The simulations are conducted with the ONE simulator [2]. The following lists our Research Questions and the related observations made from the results of the simulations.

How does mobility affect availability?

- Mobility increases availability considerably, although at the same time more nodes are needed to obtain the highest availability levels and full mobility is better than full stability for availability.

- Mixing stationary and mobile nodes can increase availability and does so in most cases and as the number of nodes (density) grows the difference between mobility percentage levels, expect 0, decreases.

How does range affect availability?

- An increase of range results in higher availability and the higher the density, the more effective is an increase of range.

How does ratio between relevant area radius and range affect availability?

- In stationary setting, environments with different relevant area radii, but the same value for range, start to behave similarly after a convergence point related to density.

- Environments with the same ratio for relevant area radius and range behave similarly.

How does density affect availability?

- The higher the density, the more effective is an increase of range.

- In given environment, we can approximate the number of nodes and availability by using preceding data and a formula.

How does time affect availability?

- Areas with smaller relevant area radii obtain higher availability-levels faster, but areas with greater relevant area radii maintain availability-levels better.

- Availability can change drastically over time.

Other observations

- Environment with larger relevant areas have lesser of lost messages.

- The time that it takes for a node to receive the message is not linearly with the distance from the relevant location.

3. CONCLUSION AND FUTURE WORK

One of the most essential aspects of this research is to study the feasibility of the DLAHI systems. In this section we will give our current verdict.

Firstly, there are definitely a potential user base and hardware readiness. The study done by Kaasinen [1] revealed that users are willing, eager, and even to some extent demanding to create content. The vast success and popularity of P2P-applications in general also indicate that users are willing to share content as well. These are important findings as the two aspects are cornerstones of DLAHI systems.

The results of the simulation are encouraging or, put in other words, nothing from the results indicates that the concept of DLAHI systems would not work. The results show that good availability-levels are achieved with reasonable parameters. That environments with both stationary and mobile nodes yield the best availability-levels is an important and convenient piece of knowledge as it matches with most real-life scenarios.

So far it would seem that the future does look bright for DLAHI systems. However, in order to obtain mainstream recognition there is a definite need for a killer-app or an area of use where the DLAHI concept would really excel, to set it apart from the competition.

Research-wise the next logical step for us would be to scrutinise the already discussed questions more closely using other yardsticks than single message availability or look at the other dependability requirements, such as information survivability, security, and accessibility. In addition, movement models and routing protocols are aspects that are essential for the overall system performance and thus highly important research fields, which go together with creating more realistic simulation environments.

Thus far, we have not answered why would one choose a small relevant area over a bigger one. The simplest explanation comes with the territory of DLAHI systems. That is, the use of a small, or more accurately, a sufficient relevant area size will naturally tie the information to the right location. However, obtaining such sufficient size for the relevant area will in its turn be problematic as well.

An interesting take on this is to see the relevant area size as a measurement for the esteem of the information. That could mean that information which creator has a good reputation would receive bigger relevant area size, though implementing such mechanism could be tricky in fully open and uncontrolled systems. Commercial solutions could offer relevant area sizes that are determined by pricing. In future we would like to be able to give a more detailed answer and discuss more about the differences between fixed and dynamic relevant areas.

4. REFERENCES

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