OnMove: A Protocol for Content Distribution in Wireless Delay Tolerant Networks based on Social Information*

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ABSTRACT

We present OnMove, a protocol for content distribution in wireless delay tolerant networks for use by handheld devices. To improve content distribution, OnMove exploits social characteristics (social similarities and physical encounters) between individuals. We motivate the problem and describe a content sharing protocol based on a ranking algorithm that exploits the social and networking characteristics of individuals.

1. INTRODUCTION

In the last years, most of the handheld devices such as PDAs or mobile phones have been equipped with different wireless interfaces such as Bluetooth or WiFi. Furthermore, these devices have tremendously augmented their storage capacity. Both facts make possible a new communication paradigm: the *Delay Tolerant Content Distribution*, where individuals carrying these devices can obtain a given content at a certain time, store it and forward it to other individuals at a later time.

In this paper we envision a scenario for content distribution in wireless delay tolerant networks (DTNs) from a social perspective. For this we use the concept of *egocentric networks* [2] which describes the ties that a specific individual has in its immediate locality[1]. In wireless DTNs these egocentric networks are dynamic and change as the individuals move. Figure 1 graphically illustrates this notion.

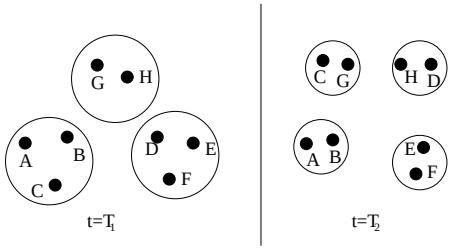

Figure 1: The egocentric network of individual A is formed by (A,B,C) at instant T_1. Eventually, C moves and the egocentric network of A becomes (A,B) at instant $T_2 > T_1$.

In our approach, every individual has two types of relationships with other individuals: relationships based on *physical encounters* (i.e., individuals are in the same locality) and on *social similarities* (i.e., same profession, hobbies, interests, etc). Each individual can collect the information about the pattern of physical encounters with other individuals [3], as well as the social similarities. This information will be helpful in the future to decide how to upload/download contents to/from a given individual.

We present OnMove, a novel protocol that exploits the social information (pattern of physical encounters and social similarities) for content distribution in wireless DTNs. The key point of this system is the selection of the individual to interact with (i.e., upload or download content). For this purpose we design a simple ranking algorithm that allows to select the "best" individual based on some parameters described in the next section.

2. ONMOVE DESCRIPTION

OnMove individuals consider the following parameters to create a ranking of the known individuals:

Social Similarity (SS): Each of the OnMove individuals has a social profile and exchanges it with other

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[1]In wireless DTNs, a locality is formed by the individual and all other individuals in its range of coverage.

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individuals. This social profile contains social details (such as profession, interests, hobbies) about the individual. It must be highlighted that in order to identify individuals across different sessions, OnMove individuals possess a User-ID that can be a nickname, a large random number, etc.

Pattern of Meetings (PM): The pattern of encounters between two individuals is defined by the frequency and the duration of these encounters.

Connection Quality (CQ): Some features can be measured during encounters. We are mainly interested in the type of used technology (e.g., WiFi, Bluetooth), available bandwidth and the connection stability (absence of connection interruptions).

Content Accuracy (CA): This shows how well aligned are the previously downloaded contents to the individual's social profile. Thus, it allows each individual to identify those individuals that provide interesting contents.

Egocentric Betweenness: The egocentric betweenness B_i of an individual i is the number of pairs of neighbors of i that are not directly connected to each other. Individuals with high value of egocentric betweenness have a lot of influence in the network as a lot of other individuals depend on them to make connections with other people [1].

Average Egocentric Betweenness: Since wireless DTNs are dynamic environments, we use the *average egocentric betweenness* $\overline{B_i}$ to denote the average value of egocentric betweenness of an individual along the time. This is expressed in (1). In a nutshell, $\overline{B_i}$ defines the ability of i to disseminate contents.

$$\overline{B}_i = \frac{1}{T}\sum_{t=1}^{T} B_i(t) \quad (1)$$

We will use a ranking metric for each individual which will be a weighted average of the above parameters. The weights (assigned on a scale between 0 and 1) for each parameter will be related to its importance for the specific application scenario (see also Sect. 3). It must be noted that the ranking of the individuals depends on the dynamic parameters B and $\overline{B}$ (individuals exchange them in real time). Thus, the rank of an individual should be also a dynamic parameter.

Finally, we explain the content exchange process in a given locality. Each individual sends a content query to the highest ranked individual in the locality having an interesting content to the individual. This query could be accepted or rejected by that individual. If it is accepted the individual starts the download process, otherwise the individual selects another individual and repeats the process. On the other hand, individuals in the locality may receive several content queries from different individuals. Then, the individual selects among the individuals, the one with the highest position in the ranking and accepts his query while rejecting the other queries.

3. APPLICATION SCENARIOS

OnMove can be applied in different scenarios. In this section we briefly describe two realistic cases: *advertisement platform* and *file sharing on the road*.

In the *advertisement platform* the final objective is to achieve the maximum dissemination of the advertised object (e.g. photo, video). Thus, the OnMove ranking algorithm must be configured giving higher weights to B and $\overline{B}$ parameters. However, the advertisement must be delivered to those individuals interested in it. Thus, the social similarity is also an important parameter in this case. On the other hand, the previous pattern of meetings is not very relevant.

In the *file sharing on the road scenario*, the individuals retrieve small contents (news, small videos, etc) to be consumed on their daily trips from home to work, etc. In this case, individuals are selfish, i.e., they are interested in downloading contents satisfying their social profile. B and $\overline{B}$ become less relevant and thus, the ranking becomes more static. In this situation, the individuals could be interested in downloading contents that satisfy the social profile of their best ranked individuals.

4. CONCLUSION AND FUTURE WORK

This paper introduces OnMove, a novel protocol for content distribution in wireless DTNs populated by handheld devices. OnMove exploits social relationships among individuals in order to improve content distribution. The core algorithm running on OnMove individuals is a ranking mechanism. The ranking parameters vary depending on the application making OnMove an adaptive protocol. In the next steps, we will extensively investigate the configuration of the ranking algorithm mechanism in several application scenarios and optimize it. We also plan to analyze the social profiles available on the current systems such as FaceBook and how to export them to wireless DTNs. Finally, we will investigate the creation of overlay networks for content distribution in wireless DTNs.

5. REFERENCES

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