GRChat: A Contact-based Messaging Application for the Evaluation of Information Diffusion

Enrique Hernández-Orallo, David Fernández-Delegido, Andrés Tomás, Jorge Herrera-Tapia, Juan-Carlos Cano, Carlos T. Calafate, Pietro Manzoni
Departamento de Informática de Sistemas y Computadores. Universitat Politècnica de València. Spain.
emails: ehernandez@disca.upv.es, daferde1@fiv.upv.es, antodo@upv.es, jorherta@doctor.upv.es, {jucano, calafate, pmanzoni}@disca.upv.es

***Abstract*—Contact-based messaging applications establish a short-range communication directly between mobile devices, storing the messages in the devices in order to achieve a full dissemination of such messages. When a contact occurs, the mobile devices interchange their stored messages, following a epidemic diffusion. No messages are sent or stored in servers. In order to evaluate the diffusion of messages among mobile devices based on opportunistic contacts, we developed GRChat, an Android application that uses Bluetooth as near-by communication protocol. We present some results about the efficiency of peer-to-peer message diffusion depending on message size and devices distance.**

Keywords–Opportunistic networks; Contact-based Messaging; Performance Evaluation; Epidemic diffusion

I. INTRODUCTION

Routing protocols for opportunistic communication environments enable the storing, carrying, and forwarding of information between mobile devices [1]. Based on this technology, Mobile Social Networking in Proximity (MSNP) [2], is defined as a wireless peer-to-peer network of opportunistically connected nodes that use proximity as the social relationship. This condition allows the establishment of local communication channels that can be used for applications, such as information sharing, advertisement, disaster and rescue operations, gaming, etc. For example, FireChat (developed by Open Garden) is a successful contact-based messaging application.

Contact-based messaging applications work as follows (see figure 1): Each mobile device is a node with an application that notifies and present to the user any received messages for the subscribed groups. The application is also cooperative: it must store all messages and performs the diffusion of such messages to other nearby nodes. Each node has a limited buffer where it can store the messages obtained from other nodes. When two nodes establish a pair-wise connection, they exchange all messages they have in their buffers, and check whether some of the newly received messages are suitable for notification to the user. Message spreading is based on epidemic diffusion, a concept similar to the spreading of infectious diseases, when an infected node (the one that has a message) contacts another node to infect it (transmit the message). Epidemic routing obtains the minimum delivery delay at the expense of increased local buffer usage and transmission count.

To evaluate the performance of contact-based messaging applications we have developed our own app: the *GRChat*. GRChat is an Android app that can establish connection between two or more phones and transmit data and images using bluetooth. With this app, we can evaluate several aspects that can affect the message diffusion performance, such as local buffer management, message interchange protocol, message time-to-live, power consumption, etc. Several sample screenshots of the GRChat app are shown in figure 2. It has two operating modes: normal and benchmarking. In normal mode, it works like a messaging app where the user can watch previous messages/images and write new ones. When the user pushes the send button, GRChat connects to any near-by devices in order to send this new message, as shown in figure 2a (and just in case, it also can receive new messages). When a device gets a new message it also tries to connect to other devices in order to complete the diffusion of the message. The results of sending and receiving several messages are shown in figure 2b. When no messages are sent, the application is periodically searching for near-by devices in order to automatically interchange messages. The benchmarking mode (see screenshot in figure 2c) is for evaluating the setup and transmission times. In this mode, one of the devices iteratively sends a number of messages or images with a predetermined size for measuring the delivery times of a bunch of messages.

The experience shows that contact-based messaging applications seem to be operative in open places with a moderate-high density of persons (greater than 0.05 people per m^2). Furthermore, analytical and simulation models show that information diffusion have a strong dependence on contact patterns, but also on message size [3] [4]. One of the key issues for performance evaluation is determining the contact setup time between two devices and the practical transmission bandwidth. These values will clearly depend on several factors such as the distance between mobile devices and network congestion. Thus, in this paper we focus our experiments in message interchange performance for obtaining contact and message delivery times depending on devices distance.

On the following section we detail the experiments and results for obtaining the delivery time, ending the paper with the conclusions section.

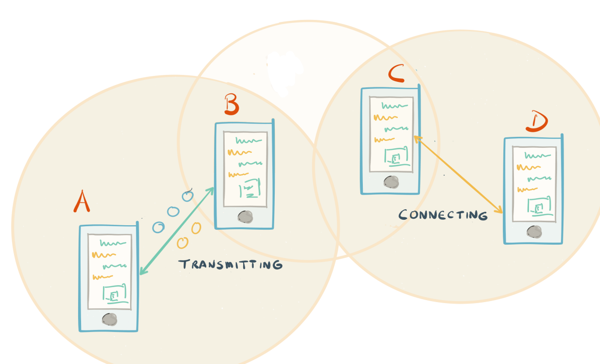

Figure 1. Opportunistic diffusion of messages.

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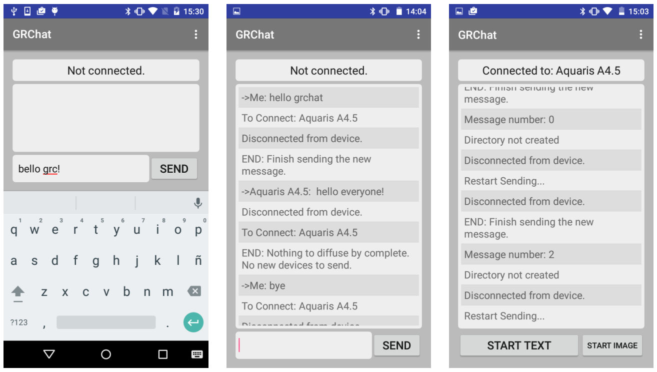

(a) (b) (c)

Figure 2. Several screenshots of the GRChat App.

II. Experimental results

The goal of the following experiments was to obtain the message delivery time (i.e. the time needed to transmit a message) depending on message size, evaluating the impact on the performance of the relative distance between the devices. The mobile devices used on the experiments were two BQ Aquarius M4.5 smartphones using Android Version Lollipop API 22 with the following hardware characteristics: ARMv7 988Mhz processor, 938MB of RAM, GPU ARM Mali-T720 and Bluetooth 4.0.

The experiments consisted on sending 500 messages from one device to another one. Every message sending comprises three steps: the device connection or pairing, the message transmission and finally the end of the connection, so the message delivery times reported include both connection and transmission times. Three message sizes were considered: a short text message (375 Bytes), a low-resolution picture or photo (109 KB), and a short video or high resolution picture (11 MB). Regarding the separation of the devices, three different distances are considered: near (10 cm), mid (5m) and far (10m). The cumulative distribution function plot (cdf) of the packet delivery time for the different message sizes are shown in figure 3, and a resume of the main statistics is on table I. We can see that, shorter messages have a high variability due mainly to the connection time, which have less impact on larger messages. The results for near and mid distance are very similar. When the distance is far (larger than the practical bluetooth range, that is 7m), the mean delivery time increases especially for shorter messages, due to connection and retransmission problems, affecting seriously the performance of the diffusion protocol. From these delivery times, we can estimate the connection time and the practical bandwidth: when the devices are close, the mean connection time is about 0.35s and the bandwidth is 1.8Mbps; when the devices are distant the connection time is increased to 5.8s and the bandwidth is reduced to 1.5Mbps.

III. Conclusions

This paper briefly describes the GRChat app and the experiments performed for obtaining the connection and message delivery times. In conclusion, as expected, these times are seriously affected when devices are distant. The obtained values are planned to be used in simulations and models as the one detailed in [3]. Also, as a future work, we plan to perform more experiments regarding buffer and message transmission strategies.

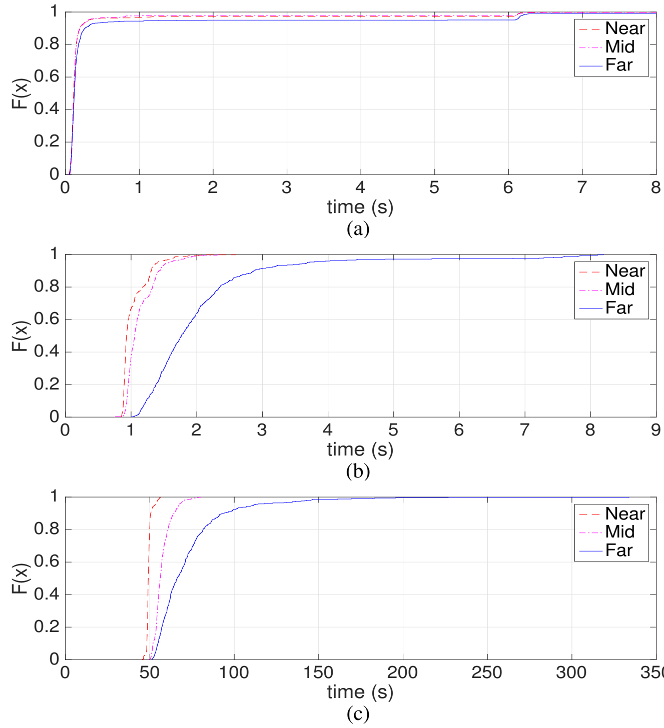

Figure 3. Cumulative distribution plots of the delivery times for different message sizes a) 375B; b) 109KB, c) 11MB

TABLE I. MESSAGE DELIVERY TIMES. ALL VALUES IN SECONDS.

	mean	min	max	Q1	Q3
375B					
Near (10cm)	0.30	0.04	12.42	0.09	0.14
Mid (5m)	0.26	0.06	9.35	0.10	0.14
Far (10m)	0.60	0.05	62.13	0.09	0.16
109KB					
Near (10cm)	1.03	0.85	2.56	0.90	1.07
Mid (5m)	1.13	0.76	2.33	0.97	1.13
Far (10m)	2.05	1.01	8.20	1.45	2.24
11MB					
Near (10cm)	49.37	45.43	56.75	48.66	49.71
Mid (5m)	57.35	49.62	80.17	54.10	59.60
Far (10m)	72.68	51.21	333.86	58.51	77.95

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