An Android Application for Opportunistic Alert Diffusion in Disaster Scenario

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***Abstract*—Opportunistic communications present a promising solution as a disaster network recovery in emergency situations such as hurricanes, earthquakes and floods where infrastructure might be damaged. We have proposed COPE, a cooperative opportunistic alert diffusion scheme useful for trapped survivors during disaster scenarios to report their position and ease their rescue operation. It targets to maintain mobile devices alive as long as possible for a maximum network coverage until reaching proximate rescuers. Unlike existing opportunistic-based disaster recovery solutions, COPE deals with mobile devices that come with an assortment of networks and aims to perform a systematic network interface selection. Furthermore, it considers mobile devices with various energy levels and allows low-energy nodes to hold their charge for longer time with the support of high-energy nodes. This work presents a proof-of-concept implementation of COPE for Android smartphones. Our demo contribution exploits smartphones equipped with two short-range communication technologies (i.e. Bluetooth and Wi-Fi) and takes the various energy levels into account. As rescue operation might take long time and in order to preserve the battery power, smartphones form cliques with neighboring nodes based on the low-energy network interface Bluetooth. Afterwards, smartphones, belonging to the same clique, cooperate alternately to perform an alert diffusion based on the Wi-Fi network interface.**

I. Introduction

During disaster scenarios such as hurricanes, earthquakes and floods, communication is mostly needed for rescue operations of trapped survivors. However, network infrastructure might be damaged and thus no longer available making mobile communication devices such as smartphones, tablets and mobile phones affording practically no help. Opportunistic communication has been investigated as a promising solution to partially overcome this problem [1], [2].

Several opportunistic-based disaster recovery approaches have been proposed [3–5]. However, part of the picture is still missing two important features. On the one hand, these works did not consider mobile devices that come with multi-network assortment. However, mobile devices might have multiple network technologies (e.g. WiFi-Direct, WiFi ad-hoc, bluetooth) and the choice is left to the user who has no idea what is the best or might be in physical or psychological distress preventing him/her from making this choice [6]. On the other hand, considering devices with various initial power levels has not been taken into account making low-energy nodes batteries drain quickly.

This work addresses the opportunistic-based alert diffusion useful for trapped survivors during disaster scenarios. Users exploit their daily mobile devices such as smartphones to communicate with rescuers using short-range communications to report their position, to make their rescue operation quicker and more efficient in a transparent way. We have proposed COPE, an opportunistic alert diffusion scheme for disaster scenario that exploits the multiple network technologies available in mobile devices and takes various battery levels into account. COPE targets to rapidly reach proximity rescuers while maintaining devices alive for longer time. We have firstly investigated COPE performance through extensive simulations that will be presented at the main conference PIMRC'17 conference [7]. Note that COPE is technology agnostic and works with as many communication technologies as available. Moreover, COPE can also be suitable for a mobile network composed of nodes having each a single communication interface that can be managed by different transmission powers leading consequently to different transmission ranges/energy consumption. COPE dynamically copes with all kinds of devices and interfaces, making decision only on link characteristics.

Our demo contribution is a proof-of-concept implementation of COPE for Android smartphones equipped with Bluetooth and Wi-Fi communication technologies. These latter are distinguished according to their transmission ranges and power consumption. To preserve the battery power, smartphones form cliques based on low transmission range interface (Bluetooth) in which they cooperate alternately for high transmission range interface (Wi-Fi) communications. Moreover, with the support of high-energy nodes, various battery levels are taken into account to maintain low-energy nodes alive longer and so the network coverage.

In Section II, we detail the proof-of-concept implementation. In Section III, we sketch how our software tool will be presented at the conference using several smartphones.

IEEE PIMRC 2017 Demo Presentation

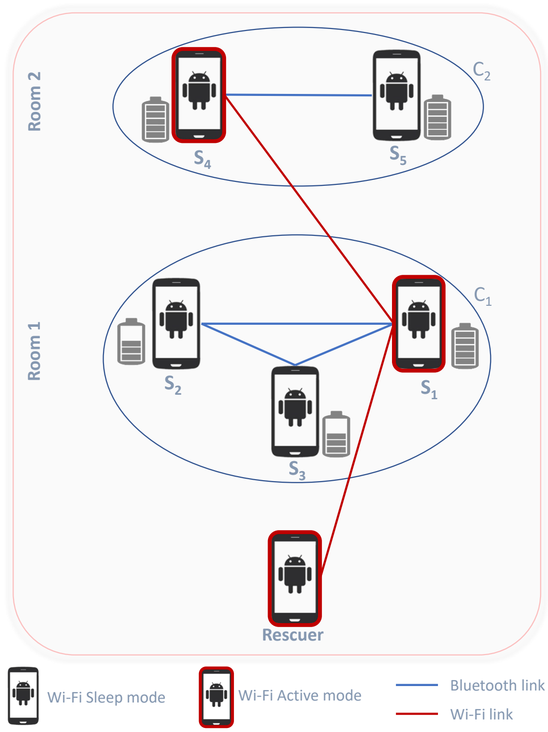

Fig. 1. Testing scenario

II. Android application for opportunistic alert diffusion

Figure 1 illustrates the experimentation environment that we propose to set up for the demo. It involves 6 Android smartphones equipped each with two short range communication technologies: Bluetooth and Wi-Fi. These latter are distinguished according to their communication power consumptions and to their transmission ranges. Indeed, Bluetooth consumes less energy while it offers a lower transmission range than Wi-Fi technology. Smartphones are distinguished to low and high-energy nodes by referring to a power threshold. For instance, on Figure 1, S_1 is a high-energy node compared to S_2 and S_3.

The time horizon is divided into time-slots τ. A time synchronization is required between nodes. Note this is already provided since mobile devices get the local time from the network providers with millisecond accuracy before disasters occur. As τ is at second level, no additional synchronization is required.

COPE proof-of-concept is composed mainly of two phases: (i) *bluetooth periodic discovery and clique formation* and (ii) *Wi-Fi based cooperation*.

(ii) *Bluetooth periodic exchange and clique formation*: Each node periodically exchanges a short message that comprises mainly its identifier (ID) and power-level using the low-range communication interface Bluetooth. When nodes discover their neighbors, they exchange their 2-hop neighbors allowing each node to know the cliques to which it belongs. For instance, on Fig. 1, nodes S_1, S_2 and S_3 belong to clique C_1 while nodes S_4 and S_5 belong to clique C_2. Then, a Wi-Fi based neighboring discovery and alert diffusion is performed alternately inside each clique.

(ii) *Wi-Fi based cooperation*: With the knowledge of neighboring IDs and energy levels, each node computes its wake-up schedule. This latter consists in determining the wake-up period and wake-up order during the time-slot τ. To maintain low-energy nodes alive longer, high-energy nodes have a wake-up period two times longer than low-energy nodes until making an energy balance. Thus, each node can determine its wake-up period based on the number of nodes inside the clique and to their energy level as shown in Fig. 2. For instance, S_1 has a wake-up period of $2\tau/4$ while it is equal to $\tau/4$ for S_2 and S_3 (see Fig. 2). This is done until making an energy balance between nodes inside the same clique. When nodes have similar energy level, for instance S_4 and S_5 in Fig. 2, they cooperate based on equal wake-up period ($\tau/2$). Each node determines its wake-up order based on its ID rank among those of other nodes inside the same clique. By way of illustration, S_1 and S_4 occupy the first period during the time-slot since they have the lowest ID in their corresponding cliques.

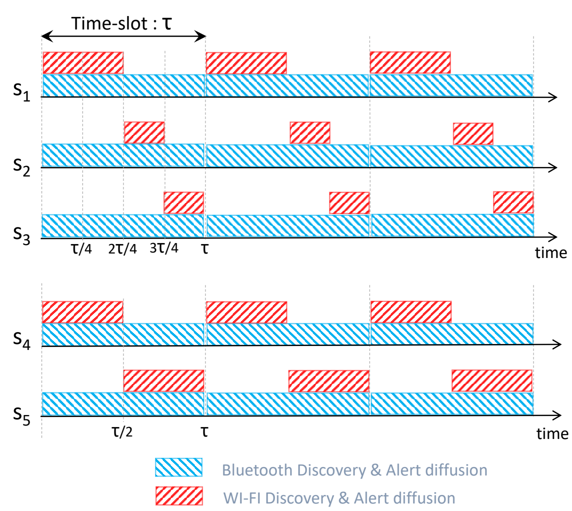

Fig. 2. Wake-up schedule

III. Demonstration setup

We demonstrate the proof-of-concept application of our opportunistic alert diffusion solution on several Android smartphones with a pre-installed user application. We initially start the application on several smartphones considered as survivors. We show on each smartphone, information about its discovered neighbors, the cliques to which it belongs and its wake-up schedule during time (i.e. how it switches between active and sleep mode for Wi-Fi alert diffusion). We demonstrate also how nodes update their cliques and their wake-up schedule by making a node joining/leaving the clique. Finally, we run a distant smartphone playing the role of rescuer and show the alert message received and contains GPS coordinates of survivors to ease and speed up the rescue operation.

ACKNOWLEDGMENT

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REFERENCES

[1] A. Fujihara and H. Miwa, "Disaster evacuation guidance using opportunistic communication: The potential for opportunity-based service," in *Big Data and Internet of Things: A Roadmap for Smart Environments*, 2014, pp. 425–446.

[2] H. Nishiyama, M. Ito, and N. Kato, "Relay-by-smartphone: realizing multihop device-to-device communications," *IEEE Communications Magazine*, vol. 52, no. 4, pp. 56–65, 2014.

[3] J. T. B. Fajardo, K. Yasumoto, N. Shibata, W. Sun, and M. Ito, "Disaster information collection with opportunistic communication and message aggregation," *Journal of information processing*, vol. 22, no. 2, pp. 106–117, 2014.

[4] A. MartíN-Campillo, J. Crowcroft, E. Yoneki, and R. Martí, "Evaluating opportunistic networks in disaster scenarios," *Journal of Network and Computer Applications*, vol. 36, no. 2, pp. 870–880, 2013.

[5] D. Reina, M. Askalani, S. Toral, F. Barrero, E. Asimakopoulou, and N. Bessis, "A survey on multihop ad hoc networks for disaster response scenarios," *Int. J. of Distributed Sensor Networks*, vol. 2015, p. 3, 2015.

[6] S. Deng, A. Sivaraman, and H. Balakrishnan, "All your network are belong to us: A transport framework for mobile network selection," in *Workshop on Mobile Computing Systems and Applications (HotMobile)*. ACM, 2014, p. 19.

[7] F. Mezghani and N. Mitton, "Opportunistic alert diffusion in disaster scenario - stay alive longer !" in *IEEE PIMRC 2017*.