Scientific Report

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I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

According to a recent survey [1], rate of growth in the number of subscribers of mobile broadband services has become 168.62% in the year 2013 compared to the year 2010, which is about 5 times more than the growth in number of subscribers of fixed broadband services. Nowadays, a typical university campus or a health care institution or even a social gathering is equipped with hundreds of smart mobile devices that are being used by the participants [2]. These devices not only enable their users to perform a variety of tasks involving data transfers using traditional cell-phone network infrastructure, but also it can gather a variety of information about the users which may found to be private, for example, a list of important friends, movement trajectory, social interest, etc. using the sensors present in the respective devices. One of the most important impact of such a huge penetration of mobile devices is that it has driven the proposal of a new networking paradigm called opportunistic networking [6]. In this paradigm, the users in the network can communicate among themselves using their devices, for example, with the help of Bluetooth [3]. A considerable amount of research interest has been devoted to the design of efficient protocols for end-to-end communication in opportunistic networks (OppNets), which have utilized users past contact patterns [8], introduced passive agents for message relay [10], utilized collective movement patterns [11], and so on. A common assumption in all these protocols is that every agent in the network can always offer services voluntarily in the sense that it is always ready to receive and send messages for others including it. Such an assumption may not be always true in reality.

Relatively, a limited amount of research interest [5, 9] has been devoted to relax these assumptions in the design of forwarding protocols in OppNets. In these studies, communication between a pair of agents can occur depending on the degree of similarity between the agents, where the similarity is expressed in terms of the similarity of interests on a common set of subjects. While the similarity among the agents can be expressed in many different ways [7], a recent study in [4] has shown that location-based similarity measure can be used to provide location based services efficiently.

The research activities carried out in this project can be categorized into three parts.
- A. Design efficient protocols for routing – in this part, we have analyzed the scalability of a set of existing routing protocols, and proposed a new protocol for efficient routing in OppNets.
- B. Analyze the similarity of mobility traces of humans – in this part, we have considered large scale synthetic as well real mobility traces to unify the properties of human mobility in order to precisely define a specialized similarity measure among them.
- C. Develop applications for android based mobile devices leveraging secure communication frameworks – in this part, we have analyzed the feasibility of developing the applications for device to device direct communications securely to be used for localized services.

Ongoing research work:

As a continuation of this project, we are working on the third part of the project
- A. Developing a generalized framework for localized and secure communication - the aim in this part is to deploy a communication network in a localized area for secure interaction among the participating agents.

References

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II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Two research papers have been communicated which are listed below.

A. Gianpiero Costantino, Rajib Maiti, Fabio Martinelli, Paolo Santi, "Impact of Mobility on Secure Mobility-cast forwarding in Opportunistic Networks", under revision in the journal of IEEE transaction on secure and dependable systems.

Abstract: In this paper, we introduce the notion of mobility-cast in opportunistic networks, according to which a message sent by a user S is delivered to users with a mobility pattern similar to that of S – collectively named place-friends. Motivation for delivering a message to placefriends stems from the fact that current social acquaintances are likely to be place-friends. Most importantly, it has been recently found that a large fraction of new social contacts come from place-friends. After introducing mobility-cast, we present a privacy-preserving mobile-cast protocol based on secure two-party computation. The effectiveness of the protocol in delivering messages to place-friends is demonstrated by means of analysis and extensive simulations based on a realistic mobility model. In the last part of the paper, we present two alternative implementations of mobility-cast on the Android platform, and test their computational performance on a number of different smart- phones. Overall, the results presented in this paper show that privacy-preserving mobility-cast can be effectively implemented with current mobile phone technology.

B. Gianpiero Costantino, **Rajib Ranjan Maiti**, Fabio Martinelli, Paolo Santi, "LoSeRO: A Locality Sensitive Routing Protocol in Opportunistic Networks", submitted in the 12th IEEE International Conference on Mobile Ad hoc and Sensor Systems (MASS), Dallas, USA, Oct 19-22, 2015.

Abstract: User trajectories can be used to extrapolate personal information such as interests and movement patterns. Extrapolating this information is especially important in the context of opportunistic networks, which take advantage of human mobility and their interactions to deliver messages to relevant users. In this paper, we propose a Geo-casting routing protocol called LoSeRO for opportunistic networks, which uses knowledge of the locations most frequently visited by a user to route messages. LoSeRO forwards messages (in a multicasting way) to all users who have a mobility profile that intersects the packet's destination zone. In particular, users' mobility profile is defined based on pre-defined zones, and LoSeRO generates a mobility vector, called MobyZone, populated by the most n-frequented zones. Thus, if the destination zone of the packet belongs to the MobyZone of a user, then the user is chosen as valid candidate for receiving the packet. Efficiency of our protocol has been evaluated using different metrics, such us coverage, precision and success rate, and compared to that of state-of-the-art geo-casting protocols. Simulations show that LoSeRO reaches the best compromise among the mentioned evaluation metrics. Moreover, results highlight that the performance of our protocol improves as the number of network users increases.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

I have attended ERCIM 25th Anniversary and Fall meetings at CNR Research Area, Pisa, during 23-24 October 2014 along with fourth ERCIM ABCDE Fellowship Seminar in the same location.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

I have visited the following institutes through my Research Exchange Program:

I)   Decisions, Networks and Analytics laboratory (DNA Lab) at Swedish Institute of Computer Science (SICS), Stockholm, Sweden.
Scientific Contact: Dr. Daniel Gillblad

During this visit, I had short meetings with a group of eminent researchers in DNA Lab in the field of my research interest as well as in the related fields. Interestingly, this visit has given an opportunity to get familiar with some important research fields, such as data analytics on human movement and information centric networking, which can be well integrated with my research interests.

II)   Self-Organizing Future Ubiquitous Networks (FUN) research team of INRIA at Lille, France.
Scientific Contact: Dr. Nathalie Mitton

This research visit has given an astounding experience of interacting with a wireless sensor network laboratory that is equipped with self-organizing and mobile robots having RFIDs and actuators. In fact, laboratory coordinator, Dr. Mitton, has given me an opportunity to access the laboratory for my own research purpose. Consequently, I am planning to orient my research in order to get advantage of such a state-of-the-art laboratory setup.

III) MAESTRO project team of INRIA at Sophia Antipolis, France
Scientific Contact: Dr. Giovanni Neglia

I have visited this research group with an aim of interacting with researchers working in the area of performance evaluation and optimization in wireless networks. Though I have
planned this visit for a limited period of time, I was able to interact with the researchers in MAESTRO team who are expert in designing innovative mathematical as well as software tools for performance evaluation of communication networks, in particular, communication protocols, network architectures, and network services.

In general, through the visits I had broadened my scientific network with new valuable scientific contacts.