ERCIM *Alain Bensoussan* Fellowship
Scientific Report

Fellow: Alessandra Toninelli
Hosting Institute: INRIA Paris Rocquencout
Duration: 12 months

September 17, 2010

1 Scientific Activity

1.1 Background

Sociality characterizes an individual's life: every person plays a role within a social community. Social ties, such as friendship, common interests, and shared professional activities, bind individuals together. This web of social bindings is referred to as a *social network*. Technology advances in wireless networks and the increasing diffusion of portable devices offer a unique chance to improve social applications, i.e., applications that support human social interactions. Complex *mobile social ecosystems* (MSE) of the future provide a rich platform for collaboration among individuals for achieving both professional and personal goals. In mobile social ecosystems, the heterogeneity of software platforms on constituent nodes, combined with their intrinsic distributed nature and heterogeneity of representation of data and context raises the need for middleware platforms to support the development of *mobile social applications* (MSAs). Middleware would be responsible for collecting, maintaining and processing social data, as well as allowing access to those data via flexible interfaces, thus enabling different applications to exploit information provided by the mobile social ecosystem.

1.2 Research Challenges

The design and development of a middleware support platform for mobile social applications (or a *MSE management middleware*), however, is challenging and must address a number of issues. Middleware for such applications is expected to include support mechanisms and tools, including location and proximity tracking systems, expressive representation models of physical place and user characteristics, and algorithms to extract social networks. Moreover, mobile social computing requires shared models and interoperable vocabularies to represent mobile social ecosystems. Finally, it is crucial to provide support for privacy

and access control of social data whose personal nature make them sensitive information. All these features should be implemented in a fully distributed architecture, to cope with the dynamic characteristics of mobile environments and with user's privacy needs that would prefer to avoid a centralized management of their social data. Current solutions only address a subset of these issues, and generally tend to embed into the application the handling of location tracking, social network extraction and management, thus significantly increasing design complexity and development costs. In addition, current social network models only represent friendship relations, while users' social interactions might take place in several ways, including sharing or tagging content, communicating via email/phone calls/SMS, or moving around the same places.

1.3 Achieved Results

1.3.1 Research Achievements

Developing middleware for mobile social ecosystems is an extremely interesting and challenging research domain. Towards that end, in close collaboration with researchers from the ARLES team, I made the following contributions. Firstly, I provided an expressive and extensible model of these social ecosystems, represented using Semantic Web technologies[1]. This allows to perform automated reasoning to infer new social information from given data, and it also enables data interoperability by assigning a clear semantics to data that can be exchanged between different applications. This model has been used in a novel middleware, called *Yarta*. The Yarta middleware architecture supports the development of mobile social applications by managing MSE data and providing them to application developers via a set of powerful application programming interfaces. Yarta also includes a policy-based access control framework I designed, which manages access to social data based on social relationships between users, social activities, and contextual information (e.g., location). The policy model being extensible, it can be applied to specify any data model required by new applications developed on top of Yarta. In addition, its semantic representation supports inference over policies and data, thus enabling policy reuse and facilitating policy specification over social data.

To support a prototype application that demonstrates the usefulness and feasibility of our work, we have implemented several components of the Yarta middleware, which will be soon available for download at GForge under the LGPL License[2]. The middleware prototype is written in Java2 SE and has been deployed on a laptop, and on smart phones running Android. To provide discovery and messaging abilities, the prototype exploits the iBICOOP middleware, which was developed by the ARLES team in previous research work on data sharing and replication in pervasive networks[3].

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[1] http://www.w3.org/standards/semanticweb/data
[2] https://gforge.inria.fr/projects/yarta/.
[3] A. Bennaceur, P. Singh, P.G. Raverdy, and V. Issarny. The ibicoop middleware: Enablers and services for emerging pervasive computing environments. In PerCom Workshops, pages

The Yarta data model was published in the proceedings of the IEEE Workshop on Middleware Engineering, held in conjunction with the IEEE Computer Software and Applications Conference (see section 2). We aim at a high quality journal submission providing more details about the Yarta middleware and experimental results based on the implemented prototype.

1.3.2 Other Activities

During my post-doc at ARLES, I have also been co-supervising a PhD student on topics related to the MSE management middleware. In addition, I have been supervising a MSc student working on access control policies for the Yarta middleware, and a summer intern working on data extraction from mobile phone and social networking applications. Finally, I have contributed to disseminate achieved results by visiting research groups at ETH Zurich and Trinity College Dublin and interacting with external visitors.

1.4 Current and Future Work

Early results coming from developing experience with the Yarta middleware have been encouraging. The addressed topic being novel, only few research efforts exist at the state of the art. Therefore, my stay at INRIA has been extended, funded by a one year post-doctoral contract. This will facilitate team work on both prototype development and publication production, thus leading the ARLES team at the forefront in research about mobile social applications. To assess the contribution of our work and make it available to both researchers and developers, we are actively developing and testing the prototype, while enriching its features. We are planning to submit in the short term an article to a top conference in the area of mobile computing, and to later submit a comprehensive report of our experience with the Yarta middleware to a high quality journal or magazine. Furthermore, a potential outcome of my recent research visits is the collaboration with research groups at European level working on closely relate topics. Since I am currently responsible for setting up these initial collaborations, a longer stay at INRIA will allow me to let these relations develop to reach the stage of more stable connections. In addition, my presence will be beneficial for the PhD student I am currently co-supervising as it would ensure continuity in his work and constant knowledge transfer.

On a longer term perspective, I am planning to go back to Italy, where I am applying for research positions, both in academia and industry. The fruitful experience at INRIA has helped me in the development of a personal career plan and original research experience. In addition to acquiring significant knowledge and professional skills, I have significantly extended my professional network, mostly within Europe. These aspects are crucial towards the achievement of a personal and professional maturity as senior researcher. Given my positive experience at ARLES, we are planning to actively maintain our research col-

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16. IEEE Computer Society, 2009.

laboration, possibly under the framework of some cooperation program, such as the French-Italian program Galileo[4], or a joint research project.

2 Publications during the Fellowship

- A. Toninelli, A. Pathak, A. Seyedi, R. S. Cardoso, and V. Issarny. Middleware support for mse management. In Proceedings of the 2nd IEEE International Workshop on Midd leware Engineering, with COMPSAC 2010, 2010.

3 Attended Seminars and Conferences

- ACM/IFIP/USENIX 10th International Middleware Conference, Urbana Champaign, Illinois, USA. November 30 - December 4, 2009

- Paris Networking, Seminar on *Scaling Online Social Networks*, Paris Research Lab, Thomson Technicolor, February 17, 2010.

- Seminar *Reseaux Sociaux sur le Web*, Musée Arts et Metiers, Paris, January 28, 2010.

- Mobile Monday Media, La Cantine, Paris, November 16, 2009.

- INRIA-Bell Labs Workshop II *Fundamentals of Communication and Networking*, INRIA Rocquencourt, October 22-23, 2009.

4 Research Exchange Program

During my fellowship[5] I established professional relationships with research groups, whose research interest are closely related to mine.

1. ETH Zurich, Switzerland
   31 May - 4 June, 2010
   Systems Group, headed by Prof. Gustavo Alonso

   During my visit at ETH Zurich, I presented work done at INRIA to develop the Yarta middleware for managing mobile social ecosystems. In particular, I gave a talk to all members of the team and I directly interacted with many of them to collect feedback about my work, exchange ideas, and discuss our vision on common research interests. Based on this experience, Prof. Alonso and his team members expressed interest in the forthcoming release of the Yarta middleware. This visit was relevant to disseminate the results of my research activity within ARLES.

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[4]http://www.universita-italo-francese.org/appel+a+projets-fr-24-programme+galilee.html

[5]12 months scheme

2. Trinity College Dublin, Ireland
   14 - 18 June, 2010
   Distributed Systems Group, headed by Prof. Vinny Cahill

   During my visit at TCD, I presented work done at INRIA to develop the Yarta middleware for managing mobile social ecosystems. I gave a talk to all members of the team and I directly interacted with many of them to collect feedback about my work, exchange ideas, and discuss our vision on common research interests. In particular, I initiated a possible collaboration based on the exploitation of the Yarta middleware for smart city applications, which are of interest for the DSG team headed by Prof. Cahill. To support this collaboration, we are currently planning to apply for the 2011 call of the France-Ireland partnership program Ulysses (Partenariat Hubert Curien)[6] with a common research project.

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[6]http://www.egide.asso.fr/jahia/Jahia/site/egide/lang/fr/ulysses