Institution: University of East London

Unit of Assessment: 11

Title of case study: Improving mobile service engineering in the Italian Telecommunication Industry

1. Summary of the impact Research on software and service engineering conducted at the University of East London has been successfully applied to the international telecom sector, within which it has contributed to the creation by Telecom Italia of a context-aware service platform and of mobile Value-Added Services based on that platform. The application of our work has had a positive impact on Telecom Italia's software development process, enabling an easier and faster integration of heterogeneous services necessary to provide mobile Value Added Services. The principal benefits have been to Telecom Italia's customers through the provision to them of improved telecom services, and to the company itself, which has been able to increase its customer base and profitability.

2. Underpinning research

In the telecommunications industry, Value Added Services (VAS) is a popular term for services above and beyond the standard core functions of voice calling and SMS messaging. They include advanced features such as Internet-based and geo-location services and social networking functions. Since the 1990s, research has focussed increasingly on service personalization, paving the way for the more widespread use, creation, and customization of mobile VAS. More recently, context-aware services have been used to realize VAS through automated implicit service personalization. This allows telecommunications providers to better meet their customers' needs by fully exploiting the user's 'context'; that is, by collating and using user-specific data such as geo-location, profile preferences, contacts, website history, and social network data. Context-aware services routinely analyze these sorts of user-specific data and behaviour in order to simplify and enhance user experience.

Mobile service providers have been able to capitalise on the increasingly ubiquitous presence in mobile devices such as smartphones of ever-greater processing power and sensing capabilities to deliver a more personalized and context-aware experience to end users, and to provide new types of mobile services. Their capacity to do so has proven important to their ability to maintain and increase their customer base and, thereby, to increase profitability. However, the real-time efficient collation and delivery of context information requires proper architecture facilitating the processing of heterogeneous user data to provide higher-level context information. Ideally, this architecture should allow the uniform representation of that information, such that new services (including those provided by third parties) can access it in a more uniform way, rather than requiring them to process different types of information and deal simultaneously with the different technical details of several heterogeneous devices. Dr Paolo Falcarin (Senior Lecturer at UEL since February 2010) has contributed to developments in this field via a collaboration between 2008 and 2013 with Telecom Italia. Since joining UEL in 2010, Falcarin's work on the following three projects has particularly underpinned the impacts described below.

The StarSCE project: Integration and Composition of telecom services
The main goal of this project was to improve the design of Telecom Italia's integrated IT and telecom services through the development of a visual editor in the form of an Eclipse plugin. Falcarin's principal contribution to the project was his development of the Eclipse visual editor, which allowed the company to visually represent VAS as workflow composing telecom systems and web services to be run in its JAIN-SLEE execution environment [4]. This visual editor relied on model-driven technologies such as the Eclipse Modelling Framework (EMF)

and the Graph Modelling Framework (GMF) to generate part of the source code out of the visual models. The novelty of this contribution was the extension of the JAIN-SLEE standard with a service description language used to represent the services composition. As is common in model-driven approaches, the code generated required subsequent extension by the service developers to obtain a working system.

Telecom Italia's Context–aware platform
The first Telecom Italia context-aware platform research prototype was set up in 2007 as the fundamental server-side infrastructure for all new personalised mobile services offered by the company. Data collated on this platform are used to provide context-aware services able to adapt automatically to users' preferences.

Research undertaken by Falcarin on mobile context-aware services contributed to the design of the architecture of this context-aware platform and the interfaces and interactions between its different components [2]. His work also supported the design and implementation of one of its core elements, the Context Broker, which gathers contextual data from heterogeneous Context Providers, elaborate sand aggregates that data, and sends it to the Context Consumers.

Mobile context-aware social apps
Telecom Italia's context-aware platform is also currently used in some commercial mobile applications provided by its mobile branch, Telecom Italia Mobile (TIM). These include a social application (TIM Social app; see sections 4 and 5, below) that periodically collects user data to be sent to the context-aware platform. That platform, and all related services, rely on the gLCB Broker client application deployed on all smartphones, which collects context data from all smartphone equipped sensors (WiFi, GPS, Bluetooth, and so on) and sends it to the remote context-aware platform. This constant use of sensors and network bandwidth considerably increases energy consumption and reduces battery life.

Between 2010 and 2012, Falcarin was involved in a parallel research strand with Telecom Italia to re-design the gLCB application to minimize power consumption in Android phones. In meeting this challenge, he contributed to the definition of seven user profiles for power consumption, and to experiments aimed at collecting power-consumption data for different sensor configurations. Each user profile was associated with a set of sensor configurations; the chosen user profile could change the ways in which the gLCB behaviour searches and publishes context data by managing the number of active sensors, the time validity of data collected by those sensors, and the time between subsequent updates sent to the remote context-aware platform [1] [5].

3. References to the research
Outputs 1, 2 and 3 best indicate the quality of the underpinning research.

1. L Ardito, M Torchiano, M Marengo, **P Falcarin**: gLCB: an Energy Efficient Context Broker, Sustainable Computing, Informatics and Systems, pp 18-26, v 3(1), Elsevier, 2013, on-line at http://www.sciencedirect.com/science/article/pii/S2210537912000522 DOI:10.1016/j.suscom.2012.10.005

2. **P. Falcarin**, M. Valla, J. Yu, C.A. Licciardi, C. Fra', L. Lamorte: "Context Data Management: an Architectural Framework for Context-Aware Services", Service Oriented Computing and Applications, v 7(2), pp 151-168, Springer, June 2013, DOI 10.1007/s11761-012-0115-1.

3. JF Mejia Bernal, L Ardito, **P Falcarin**, O Rodriguez Rocha, M Morisio, F Giovannelli, F Pistore: "Emergency Situations Supported by Context-Aware and Application Streaming", International Journal of Ad Hoc and Ubiquitous Computing (IJAHUC), v 13(2) Inderscience, 2013, DOI:10.1504/IJAHUC.2013.054176

4. **P. Falcarin**, C. Venezia, J. F. Mejia Bernal, "Broadening JAIN-SLEE with a Service Description Language and Asynchronous Web Services", In: Web Services Research

for Emerging Applications: Discoveries and Trends, IGI-Global, ISBN 978-1-61520-6841, 2010. http://www.igi-global.com/chapter/broadening-jain-slee-service-description/41533 , DOI: 10.4018/978-1-61520-684-1.ch019

5. J. F. Mejia Bernal, L. Ardito, M. Morisio, **P. Falcarin**, Towards an Efficient Context-Aware System: Problems and Suggestions to Reduce Energy Consumption in Mobile Devices, in IEEE International Conference on Mobile Business (ICMB-2010), Athens, Greece, June 2010. ISBN: 978-0-7695-4084-9 DOI>10.1109/ICMB-GMR.2010.34

4. Details of the impact

The impacts of the research outlined above have been primarily upon Telecom Italia and its customers. With 46,000 employees, a 64.6% share of Italy's fixed phone landline market (13.78m customers) and a 50% share of the country's broadband ADSL market (6.6m customers), Telecom Italia is Italy's leading Telecommunication company, as well as maintaining a significant presence in countries including Brazil, Turkey, and Argentina.

The research has particularly supported the company's definition of the architecture underpinning its context-aware platform, the development of which was completed in 2012. Based on open standards for communication protocols and data representation, this architecture has allowed Telecom Italia to deploy different mobile applications and services using its new context-aware platform. As such, the research has contributed since 2010 to the growth of the company's mobile Value-Added Services (VAS) offering [a]. Although it is impossible to quantify precisely the contribution of the UEL work to it, that growth and the associated commercial benefits to the company have been considerable. According to the Quarterly Telecommunications Report, in March 2013 TIM led the business segment of the Italian mobile phone market, with 7.52 million business customers (59.2% market share), and held a strong position in the private market (30.5%), with 24.34 million residential customers [c]. In particular, while Telecom Italia's outgoing voice services have been negatively affected by the economic climate and the competition, revenues from TIM Value-Added Services – underpinned by the context-aware platform using Falcarin's research - increased by 8.4% year-over-year in the second quarter of 2013 [f].

The research has also helped Telecom Italia and its subsidiaries to shape the design and implementation of the adaptable gLCB context broker (running on Android OS), which is responsible for gathering context data efficiently. Early prototypes of context-aware services consumed smartphone battery in just a few hours because of their intensive use of Bluetooth and GPS sensors and network connections (WiFi and 3G). Since 2011, the results of the power-consumption analysis research [1, 5] have informed the engineering phase of the TIM Social app by providing a set of guidelines to minimize power consumption on smartphones. The adaptable energy-consumption behaviour of the gLCB smartphone application – which responds to specific user-profiles - has improved Telecom Italia's service offering by extending mobile use of such services, making the company's services more user-friendly and giving them a competitive advantage in a difficult market. [e, h].

The Telecom Italia context–aware platform architecture is composed of different context providers, each one providing context information for different types of users'. Since it relies on open standards, it enables easier and faster integration of the heterogeneous data services necessary to provide a uniform standard interface to represent context data and to query context data providers. These sorts of open interface ease the adoption of this platform by third-parties and it has, indeed, been indeed in subsequent projects [d]. The knowledge of such systems acquired in this collaboration allowed Telecom Italia to successfully bid for further funding from Ministero Istruzione Universita' e Ricerca (MIUR), the Italian Ministry of Education, Universities and Research [I]. This supported a further project in 2012 to adapt their context-aware platform to collect more precise user location data. Falcarin contributed to the design of a context-aware emergency management system for the project, which was specifically intended to improve the accuracy of fire rescue services' navigation [3].

The JAIN-SLEE Service Creation Environment tool co-developed by Falcarin through **the StarSCE project** [4] provided benefit to Telecom Italia in the first instance by facilitating the company's faster service creation and composition of integrated services based on the JAIN-SLEE platform [e]. This service creation environment was later successfully engineered by Telecom Italia, in partnership with Italtel [g], another leading player in the development and integration of fixed and mobile networks. Further benefit accrued to Telecom Italia when it sold the tool to Italtel It has since allowed Italtel software developers to exploit model-driven engineering technologies to automatically generate part of the source code – and thereby reduced the development time required - for their implementation of commercial video-communication services on ADSL networks. This has allowed Italtel to improve the automation and efficiency of its developing of those commercial video-communication services [g] and thereby improve its customer service.

Telecom Italia is currently using the context-aware platform as a server-side back-end for different commercial mobile value-added services, including **mobile context-aware apps** such as TIM Social app for iOS and Android [b] smartphones. Released in 2012, these apps allow users unique and integrated access to different social networks. The app, which relies heavily on the Telecom Italia context-aware platform, provides a map that can be used to find shops, clubs and restaurants partnered with TIM. Its main functions are: collecting Facebook posts, tweets, and information about places where friends have been; visualizing on a map the nearest shops and restaurants; and helping to organise dinners with friends, with discounts and offers available for subscribers. Tim Social App has been installed on more than 5000 devices so far. User review posts suggest particular appreciation for features allowing the aggregating of content from different social networks (Facebook, Twitter, and Foursquare), geo-localized to the user [b].

5. Sources to corroborate the impact

[a] A factual statement about the use of the research by Telecom Italia, and about subsequent benefits to them, may be obtained from the Research director of Mobile Social Application at Telecom Italia Innovation.

[b] For the Tim Social app and user reviews of it (in Italian): see iTunes: https://itunes.apple.com/it/app/tim-social/id575116306?mt=8 and Google Play: https://play.google.com/store/apps/details?id=it.telecomitalia.timsocial&hl=en .

[c] For figures from the March 2013 Quarterly Telecommunications Report Autorità per le Garanzie nelle Comunicazioni, Quarterly Telecommunications Observatory: http://www.agcom.it/Default.aspx?DocID=11333

[d] EU FP7 project SOCIETIES: http://www.ict-societies.eu/

[e] For incorporation of the Service Creation Environment tool co-developed by Falcarin [4] see the JAIN Service Logic Execution Environment (JAIN-SLEE) standard specification: http://www.jcp.org/en/jsr/detail?id=22

[f] For Telecom Italia's increased revenue from TIM Value-Added Services – underpinned by the context-aware platform using Falcarin's research: http://www.telecomitalia.com/tit/en/about-us/general-archive.html - Presentation slides Telecom Italia 1H 2013 Results-Operations - Marco Patuano (slide 14).

[g] The successful engineering of the service creation environment in partnership with Italtel is described on the latter's webpages: http://www.italtel.it/en/

[h] A factual statement about the use of the research to minimize smart phone power consumption may be obtained from Falcarin's academic collaborator at Politecnico di Torino

[I] For Telecom Italia's successful bid for further funding from MIUR: http://www.istruzione.it/