Future Generation Computer Systems 34 (2014) 94–96

Contents lists available at ScienceDirect

Future Generation Computer Systems

journal homepage: www.elsevier.com/locate/fgcs

Editorial

Distributed solutions for ubiquitous computing and ambient intelligence

This special issue of the Future Generation Computer Systems (FGCS) journal is devoted to papers selected from the 6th International Conference on Ubiquitous Computing and Ambient Intelligence (UCAmI 2012) and the 4th International Workshop on Ambient Assisted Living (IWAAL 2012), held in Vitoria-Gasteiz, Spain, on 3–5 December 2012. On the one hand, UCAmI focuses on the ubiquitous computing and ambient intelligence research, which represent a new generation of user-centred computing solutions, aiming to find new ways to obtain a better integration of Information and Communication Technology (ICT) in everyday life devices and activities. On the other hand, IWAAL focuses on Ambient Assisted Living (AAL), an important application domain of ambient intelligence that aims to contribute with ICT research applied to enabling assistive living environments.

Advances in computing and wireless communication have allowed the development of novel distributed computing methods, middleware and applications that support ubiquitous and ambient intelligence systems. With this in mind, this special issue of Future Generation Computer Systems has aimed to explore the recent state-of-the-art developments in theory and application of distributed solutions to support the design, implementation and evaluation of these system types. Conceptual and theoretical frameworks, empirical research and case studies on distributed solutions applied to ambient intelligence and ubiquitous systems are presented.

Concretely, the revised versions of the papers selected for this special issue cover topics such as the distributed systems and artificial intelligence support to enable personalization and adaptation of ubiquitous systems, the rising importance of cloud computing as a key component of ubiquitous systems and the still prevalent need of mixing mobile devices, wireless embedded sensors and coordination middleware to carry on giving place to smarter environments.

A first important issue addressed by some of the selected papers has been personalization and adaptation of ubiquitous system using context information. The increasing use of context-aware technologies has sparked the growth of assistive applications, resulting in a need to enable adaptation to reflect changes in the user behaviours. The paper entitled "*Ontological User Modelling and Semantic Rule-Based Reasoning for Personalisation of Help-on-Demand Services in Pervasive Environments*" by Kerry-Louise Skillen et al. [1] deals with the limited support of user personalisation in existing context-aware applications. This proposal introduces a systematic approach to service personalisation for mobile users in pervasive environments. The approach uses semantic technologies for user modelling and reasoning techniques for personalisation. User behaviours and needs in pervasive environments are represented through ontological user models with special emphasis on ontological modelling of dynamic and adaptive user profiles. A rule-based personalisation mechanism was proposed. It exploits semantic Web rule mark-up language for rule design and also a combination of semantic and rule-based reasoning for personalisation. These proposals were tested through two case studies focused on providing personalised travel assistance to people using help-on-demand services.

On the other hand, self-adaptive applications autonomously adjust their behaviour and services according to the user current context without asking him. However, the user's situations, habits and intentions must be considered in these adaptations. The interaction design based on such adaptations can be irritating and distracting for the user if they do not match the current situation. The paper entitled "*The User in the Loop: Enabling User Participation for Self-Adaptive Applications*" by Christoph Evers et al. [2] provides a solution on how to integrate the user in the self-adaptation feedback loop. The user is able to influence the adaptation behaviour at run-time, by setting individual preferences. Consequently, a harmonization between full application autonomy and user control is achieved. Generic concepts to support user participation were included by the authors in an existing self-adaptation middleware, in order to provide it capabilities to respect the user's application focus and interaction behaviour. The suitability of this proposal was illustrated through a user study that involved a notification-based solution for user participation and 62 participants.

Some of the selected works have stressed the importance of cloud computing based solutions to enable ubiquitous systems in very diverse application domains, such as learning, e-health or environment protection. Particularly, situated learning solutions stress the importance of the context in which learning takes place. It has been therefore frequently associated with informal learning or learning outside the classroom. Cloud technologies can play an important role supporting this type of learning, since it requires ubiquitous computing support, connectivity and access to data across various scenarios, for instance on the field, in the classroom or at home. The paper entitled "*Using the Cloud to Develop Applications Supporting Geo-collaborative Situated Learning*" by Gustavo Zurita et al. [3] presents the situated learning theory and indicates how cloud computing can leverage the implementation of computer applications based on this theory. This proposal can also be used to perform informal learning recognition [4]. The article also proposes a Service Oriented Architecture (SOA) for integrating existing cloud services into new applications supporting these learning activities. Cloud services can easily orchestrated in a SOA using "glue-code" [5]. This strategy is typically used for building information infrastructures [6].

A first-rate e-health system saves lives, provides better patient care, allows complex but useful epidemiologic analysis and saves money. However, there may also be concerns about the costs and

0167-739X/$ – see front matter
http://dx.doi.org/10.1016/j.future.2014.01.004

complexity of e-health systems implementation, and the need to address issues about the energy footprint of the highly-demanding computing facilities. The paper entitled "*A Novel Energy-Driven Computing Paradigm for e-Health Scenarios*" by Marina Zapater Sancho et al. [7] proposes a novel and evolved computing paradigm that: (1) provides the required computing and sensing resources for patient care scenarios, (2) allows the population-wide diffusion, (3) exploits the storage, communication and computing services provided by the cloud, and (4) tackles the energy-optimization issue as a first-class requirement. This computing paradigm and the proposed multi-layer top-down energy optimization methodology were evaluated in a scenario for cardiovascular tracking and analysis, and the obtained results were highly promising. The solution implements Mobile Cloud Computing (MCC) [8] and deals with the typical challenge of distributing efficiently the computation on the cloud [9]. The use of MCC is becoming popular to automate health-care systems [10]. Concerning the energy consumption aspect, important efforts have been done to deal with this issue [11,12]. Unfortunately, the current solutions are suitable only for specific settings or under particular restrictions.

Geographic Information Systems (GIS) have gained popularity in recent years because they provide spatial data management and access through the Web. The paper entitled "*A Cloud Integrated Web Platform for Marine Monitoring Using GIS and Remote Sensing: Application to Oil Spill Detection Through SAR Images*" by Diego Fustes et al. [13] gives a detailed description of a tool that offers an integrated framework for detecting and localizing marine spills using remote sensing, GIS and cloud computing. Advanced segmentation algorithms are presented to isolate dark areas in SAR (Synthetic Aperture Radar) images, including fuzzy clustering and wavelets. In addition, cloud computing was used for scaling up the algorithms and providing communication between users. Several segmentation algorithms and combination of them were evaluated, and in various cases the obtained results were highly accurate.

Finally, the remaining selected works are focused on the use of mobile computing devices and wireless ad-hoc networks, as key enablers of solutions for ambient assisted environments and ubiquitous computing. As they reflect, interoperability, composition and coordination of mobile devices and sensors can be used to monitor people and environments, and thus increase the smartness and reactivity of those environments towards people. The paper entitled "*Mobile and Ubiquitous Architecture for the Medical Control of Chronic Diseases through the Use of Intelligent Devices: Using the Architecture for Patients with Diabetes*" by Vladimir Villarreal et al. [14] presents a mobile monitoring application that focuses on simplicity, extensibility, scalability, heterogeneity and application customization, in order to allow a patient to monitor a chronic disease using a mobile device. The application was developed following a semi-automatic process, which allows developers to obtain systems to monitor several diseases. These systems can be adapted to the particular user needs. The article also presents ontologies that allow classifying medical elements, a layered architecture to organize the computer devices participating in these solutions, and a set of design patterns (known as MobiPatterns) that define the control modules participating in the application.

Many of these solutions are supported by a Mobile Ad hoc Network (MANET), which is a wireless mesh characterized by the dynamic nature of their members. The creation of these networks occurs in a no planned manner and as a response to the distribution of services at each moment of its life-time. The topology of a MANET can rapidly change and, therefore, these networks require mechanisms that allow networked devices to discover and communicate with each other in spite of their mobility. The MANET can be applied on situations where the deployment of a network without a fixed infrastructure is required. The paper entitled "*An Architecture for Automatic Service Composition in MANET Using a Distributed Service Graph*" by Unai Aguilera et al. [15] proposes a new protocol for the automatic composition of services in MANETs. The protocol is based on the construction and maintenance of a distributed service graph. This graph allows obtaining the dependencies among different services provided by the networked devices during the MANET life-time. Following an approach similar to earlier works [16], discovery is performed without the usage of repositories for centralizing service registration. In addition, intermediate nodes store service advertisements from nodes and they are able to answer search queries and, therefore, to reduce the number of propagated messages. The graph is then used during the services composition process to reduce the time needed to locate valid solutions. Remarkably, previous solutions have not applied the advantages of semantic descriptions oriented to functional composition of services, as undertaken in this work. However, ontologies have been applied extensively in grid and P2P networks for service discovery [17], and also hybrid mechanisms based on routing protocols have been used for such a purpose [18].

Today, formal and informal meetings require the support of digital information and ubiquitous software systems that integrate the participating devices in a smooth way. Thus, the information flow among them should be done as seamless as possible to avoid jeopardizing the natural interactions among participants. Trying to contribute addressing such a challenge, the paper entitled "*Clairvoyance: A Framework to Integrate Shared Displays and Mobile Computing Devices*" by Christian Berkhoff et al. [19] presents a framework that allows the integration of mobile computing devices and large-screen TVs through a mobile ad hoc network. This framework, named Clairvoyance, eases the implementation of shared displays as support of formal and informal meetings. It also provides a set of services through an API, which can be used to develop ubiquitous applications that support meetings in particular scenarios. This framework adheres to the general architecture proposed by Rodriguez-Covili et al. [20].

Other similar frameworks, like MOVE [21] or CGLXTouch [22], implement solutions to support specific situations; therefore, they impose several restrictions to be used during formal or informal meetings. Other approach used to synchronously share content among people during meeting is the sharing of video streaming [23]. However, such an approach imposes also several restrictions to the end-users.

The guest editors want to gratefully acknowledge the reviewers as well as the session chairs of UCAmI 2012 & IWAAL 2012 for their help in selecting the papers for this special issue. We want also to thanks the authors for the effort spent in improving and extending the original proposals. Finally, we would like to thank the referees of this special issue for the high quality of their reviews and also to the editor-in-chief for their support.

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