Cloud-Assisted Mobile Computing and Pervasive Services


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In order to provide rich mobile pervasive services to end users, advancing mobile communication technologies and deployment of smart devices have become key issues in both industry and academia. However, the limited onboard computing, energy supply, and storage capabilities of mobile devices are hampering their ability to support the increasingly sophisticated applications demanded by users. Recently, mobile cloud computing (MCC) technologies for mobile devices have emerged to overcome these limitations. These technologies can minimize the requirements of computing power and storage to deploy pervasive applications in mobile devices. Developments of innovative and pervasive mobile services (mobile video streaming, rich media dissemination, surveillance, e-gaming, healthcare, etc.) can be greatly facilitated by cloud computing platforms employing advanced technologies.

In response to the call for contributions, we received 40 submissions. After two rounds of careful reviews, nine outstanding papers have been collected for this Special Issue, which are classified into three categories:

- New mobile cloud computing architectures
- Computation offloading for mobile cloud computing
- Cloud-assisted pervasive services and applications

The volume opens with a comprehensive survey article, "Mobile Cloud Computing Service Models: A User-Centric Approach," by Huang *et al.*, which reviews diverse ways of combining cloud computing and mobile platforms toward a new computing/communications paradigm so that readers will be able to have a holistic view on current developments and the vision of user-centric MCC. The article provides a complete taxonomy of mobile cloud computing service model and a new genre of real-world commercial applications. The authors envision the seamless integration of heterogeneous cloud platforms and mobile devices into a human-centric computing ecosystem. In the second article, "Follow Me Cloud: Interworking Federated Clouds & Distributed Mobile Networks," Taleb and Ksentini present the Follow Me Cloud (FMC) concept and propose its framework, aimed at smooth migration of all or only a required portion of an ongoing IP service between a data center (DC) and a user equipment (UE) device of a Third Generation Partnership Project (3GPP) mobile network to another optimal DC with no service disruption. In the third article, "A Distributed Cloud Architecture for Mobile Multimedia Services," Felemban *et al.* present a distributed cloud architecture for mobile multimedia users. The key idea of this architecture is the integration of base stations and cloudlets to guarantee quality of service (QoS)-based services. The integration entails resource management protocols which addresses various QoS requirements such as aggregated radio channels and buffer allocations.

Regarding the efficiency of MCC, the computation offloading to the cloud effectively expands the usability of mobile terminals beyond their physical limits, and also greatly extends their battery charging intervals through potential energy savings. In the fourth article, "When Mobile Terminals Meet Cloud: Computation Offloading as the Bridge," Ma *et al.* present an overview of computation offloading in MCC, and identify the key issues in developing new applications that effectively leverage cloud resources for computation-intensive modules, or in migrating such modules in existing applications to the mobile cloud. They analyze two representative applications in detail from both macro and micro perspectives: cloud-assisted distributed interactive mobile applications and cloud-assisted motion estimation for mobile video compression, to illustrate the unique challenges, benefit, and implementation of computation offloading in MCC. In the fifth article, "Toward a Unified Elastic Computing Platform for Smartphones with Cloud Support," Zhang and Wen present a unified elastic computing platform that supports application offloading for smartphones in order to reduce energy consumption on smartphones, with an infrastructure-based cloud and an ad hoc virtual cloud formed by a cluster of smartphones. For this plat-

form, the authors present both an offloading policy and an offloading mechanism under which applications are delegated to the cloud for execution.

The remaining articles focus on cloud-assisted pervasive services and applications. In the sixth article, "CitySee: Not Only A Wireless Sensor Network," Liu *et al.* share their early lessons learned from CitySee, the largest environment monitoring system (consisting of 1196 sensor nodes and 4 mesh nodes) integrating both the underlying wireless sensor network (WSN) techniques and the upper-layer cloud computing applications, such as a sensing as a service (SaaS) cloudlet. While going through the challenges (e.g., hardware, software, and protocols) of CitySee, the authors concentrate on how to combine and evolve WSNs with cloud computing in order to provide satisfactory pervasive services to both network designers and users with respect to scalability, performance, privacy, cost savings, and so on, toward an innovative, pervasive, and easy-to-use cloud service platform. In the seventh article entitled "Toward Cloud-Based Vehicular Networks with Efficient Resource Management," Yu *et al.* propose integrating mobile cloud computing technology into vehicular networks, such that vehicles and roadside units can share computation resources, storage resources, and bandwidth resources. A hierarchical cloud architecture is proposed with a design of three-layered structure, including a vehicular cloud, a roadside cloud, and a central cloud. A game-theoretic approach is proposed to effectively model and optimize the resource allocation scheme among virtual machines (VMs) in cloud cites. Moreover, to support VM migration triggered by vehicle mobility, an optimal resource reservation scheme is designed to conserve virtual resources for migrated VMs and guarantee the continuity of mobile vehicular services. Simulations are conducted to verify the efficiency of the proposed cloud resource management strategies.

With the support of MCC, wireless body area networks (WBANs) can be significantly enhanced for massive deployment of pervasive healthcare applications. However, several key issues and technical challenges are associated with the integration of WBANs and MCC. In the eighth article, "Cloud-Enabled Wireless Body Area Networks for Pervasive Healthcare," Wan *et al.* study a cloud-enabled WBAN architecture and its applications in pervasive healthcare systems. They highlight the methodologies for transmitting vital sign data to the cloud by using energy-efficient routing, cloud resource allocation, semantic interactions, and data security mechanisms. A methodology to manage private cloud infrastructures for e-health applications is addressed in the ninth article, "An Auto-Scaling Mechanism for Virtual Resources to Support Mobile, Pervasive, Real-Time, Healthcare Applications in Cloud Computing," in which Ahn *et al.* propose a new approach to scale virtual computing resources up and down to process real-time tasks delivered from e-health applications. The workload prediction mechanism is used to scale the virtual resources up to prevent missing deadlines of real-time tasks. These e-health applications work as a real-time monitoring system to check on patient's health conditions periodically, and possibly increase their sampling rates and bandwidth requirements to process all real-time tasks whenever these applications detect abnormal symptoms.

In closing, we would like to thank all the authors who submitted their research work to this special issue. We would also like to acknowledge the contribution of many experts in the field who participated in the review process, and provided helpful suggestions to the authors to improve the contents and presentation of the articles. We would in particular like to thank Professor Xuemin "Sherman" Shen, Editor-in-Chief, for his support and very helpful suggestions and comments during the delicate stages of concluding the special issue.

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