A Conceptual Framework for Mobile Service Value

Garyfallos Fragidis, Dimitri Konstantas

A Conceptual Framework for Mobile Service Value

Garyfallos Fragidis[12], Dimitri Konstantas[2]

[1] Technological Education Institution of Central Macedonia,
Faculty of Business and Economics,
Terma Magnisias, Serres 62124, Greece
garyf@teicm.gr

[2] University of Geneva, Faculty of Social Sciences,
UniMail en Battelle, Geneva, Switzerland
Dimitri.Konstantas@unige.ch

Abstract. Mobile services have unique characteristics and can provide opportunities for added value, new types of value and new ways of value configuration. Mobile cloud computing can boost the development of mobile services. In this paper we provide a user-driven and usage-oriented perspective on mobile services, especially when they are provided via the cloud. We examine the different perspectives on mobile services and outline models of mobile service provision. Mobile services are regarded as embedded in the daily activities of the mobile user in order to attain personal objectives. We provide an integrated view on mobile services that combines technological and usage aspects and emphasizes on value creation. This work helps understand better the provision, usage and value creation in mobile services and can provide new research and practical opportunities for developing new service models in mobile environments.

Keywords: Mobile service, mobile cloud computing, service value, value co-creation

1 Introduction

The substantial progress in mobile technologies and the wide availability of wireless Internet has driven to an increasing popularity of mobile computing. Mobile devices, especially smartphones and tablets, serve today as a multipurpose tool in everyday life practices of the people. They are used more and more to provide a variety of services ('mobile services') that go beyond communication and support a wide spectrum of human activities, including social interaction, entertainment, economic transactions, business operations, personal time management, data management, learning, healthcare and a variety of location-aware and context-aware services, such as navigation, tracking services, emergency services, etc.

A serious obstacle for the further development and use of mobile services stems from the technological limitations of mobile devices, especially with concern to resources (battery life, storage space, etc.) and capacity (processing, bandwidth, etc.).

Mobile cloud computing has been developed as a solution to these problems, by marrying together mobile technologies and cloud computing to extend the benefits of cloud computing to mobile services and applications. Mobile cloud computing can supposedly boost the development of mobile services, as well as enable the development of entirely new types of services [1] and become the dominant model for mobile applications in the future [2]. Huang, Xing and Wu [3], for instance, give a perspective of the 'service of the future' as a combination of people needs, the physical environment surrounding people and the virtual environments with which people interact. Research in the areas of ubiquitous and pervasive computing (e.g. [4]) recognizes the central role of the user in the interaction with cyber-physical systems, as a part of their everyday life practices.

In this paper we provide a user-driven and usage-oriented perspective for mobile service, especially when it is provided via the mobile cloud. We acknowledge that mobile services are embedded in people's everyday life practices. For this, we introduce concepts from service management to explore the meaning of service value, analyze the role of the user and examine the interaction, collaboration and co-creation of value between the user, the service provider and the mobile cloud actors that facilitate the provision of mobile service.

The emphasis on the mobile cloud is founded on its significance as a new technological approach that can empower the mobile user in his everyday activities and can support the emergence of novel distributed and collaborative models of service provision and consumption [2]. Notice that the business and usage or user aspects of the mobile cloud computing remain marginal in the literature (e.g. [4, 5]).

The purpose of this paper is to provide a framework that integrates concepts from mobile cloud computing on the one hand and service management on the other hand in order to understand better the usage and value creation in mobile services. Without good knowledge of the usage aspects of the mobile service, companies are prone to fail to support their customers and they may be missing opportunities for the development of new services and new business models.

The paper contributes in the literature in the following ways: first, it analyzes concepts and models of mobile service provision and explains the roles and activities of the different actors. Second, it integrates in the analytical framework the human aspects of mobile service regarding the usage and value creation with the computing operations for the provision of mobile service. Third, it introduces concepts of mobile service provision as a cyber-physical phenomenon that includes computing operations and value creation activities from the part of the user. Fourth, it provides a bridge between the technological, business and use aspects of mobile services and supports the better understanding of the relevant concepts.

The rest of the paper is organized in six sections. In the next section we present an overview of mobile services and mobile cloud computing, by emphasizing on the use aspects of services and the service models. In section three we analyze the different perspectives on the concept of mobile service and we describe the related mobile service models. In section four we provide an integrated view on mobile service provision that combines technological and usage aspects, regards mobile service provision as a cyber-physical phenomenon and emphasizes on real world effects and value creation. In section five we develop a conceptual framework for the provision,

usage and value creation and co-creation in mobile services. The paper concludes with the main points of this work and the research implications.

2 Mobile Services and Mobile Cloud Computing

Mobile services are services that can be accessed and used with the use of mobile technologies and mobile devices, such as smart phones, tablets and other wireless devices. The great advantage of mobile services comes from their ability to support the mobility of the user. They are characterized by ubiquity, localization, improved personalization and increased convenience ([7, 8]) and, thus, they are different from other e-services and physical-world services [9]. Under certain circumstances [10], mobile services can provide new types of value (e.g. location-aware services), new ways for value configuration (e.g. real-time interaction with friends and other users who share the same context), rich experiences (e.g. context-aware services that adapt to the situation of the user) and opportunities for more added value (e.g. receiving service any time and especially at the moment it is needed). Satyanarayanan [11] describes the vision of mobile computing as "information at your fingertips anywhere, anytime".

Mobile cloud computing has been developed as the integration of mobile computing and cloud computing with the purpose to bring the benefits of cloud computing into the mobile environment [12, 13]. Cloud computing is a new computing paradigm [14, 15] that is based on the use of Internet infrastructure for the provision or sharing of computing resources, hardware and software, 'as a service', that is on demand and on temporary basis. Cloud computing has been recognized as the 'next generation computing infrastructure' [13] and a 'new economic and business computing paradigm' [16].

With the explosion of mobile applications in the first place and the supplementary support of cloud computing in the provision of mobile service, the significance of the mobile cloud computing was amplified. Mobile cloud computing can bring new types of services and it offers ample business opportunities [11].

The literature of mobile services and mobile cloud computing suffers from ambiguity. Yang et al. [12] distinguish three major approaches in the literature for mobile cloud applications: a) extending the access of cloud services to mobile devices; b) enabling mobile devices to work collaboratively as cloud resource providers; c) augmenting the execution of mobile applications on portable devices using cloud resources. In the first approach, users access with their mobile devices software/ applications "as services" offered on the cloud, with all the computation and data handling being performed in the cloud. The second approach makes use of the resource at individual mobile devices to provide a virtual, ad hoc and local mobile cloud environment. The third approach uses the cloud resources for the execution of the operations on mobile devices. We can gather that, from a usage point of view, mobile cloud applications can support the access of services offered in the cloud, while from a computing point of view, they can enable mobile devices to work

collaboratively as cloud resource providers or augment their operations by using cloud resources.

Regarding the typical service models of cloud computing [15], the mobile cloud is most often considered as a SaaS model, when it is used to access software offered on the cloud, and it is considered as IaaS or PaaS model, when it is used to augment the capability of mobile devices through partial or full offloading of the computational operations and data storage from the mobile devices [12]. Wan et al. [16] describe three basic mobile cloud computing service models that are based on the role of the mobile device. In 'mobile as a service consumer' (MaaSC), which is the most common model, the mobile device receives computing functions as single direction service from other actors that operate on the cloud. In 'mobile as a service provider' (MaaSP) the mobile device becomes the service provider of information or computing capacity through the cloud. 'Mobile as a service broker' (MaaSB) is a special case of MaaSP, because the mobile device provides services to other mobile devices or sensing nodes in its proximity.

In the literature we can find several examples of mobile cloud applications and services. Here we are interested in those that include user's involvement and provide direct benefits to the user. Common examples refer to mobile crowdsourcing [2, 11], collective sensing [3], location-aware and context-aware services [3, 17, 18], pooling mobile resources and sharing applications between mobile devices [19, 20].

3 A Service Terminology and Service Models in Mobile Environments

The discussion about the mobile service provision is prone to serious misunderstandings as concerns the meaning of the term 'service' when one adopts a user-driven and usage-oriented approach. The source of misunderstandings is the multiple dimensions of the concept of service and in particular the different uses of the term in computer science and in business science [21, 22]. Besides, there are different approaches in running mobile cloud applications [12] and commercial hype in mobile cloud computing [23]. In this section we attempt to clarify the concept of service in the mobile cloud. In particular, we distinguish between mobile service for the user and computing service for the operation of the mobile device in the mobile cloud. We name the former 'mobile service' and the later 'mobile cloud service'.

A 'mobile service' is an electronic service that can be provided, accessed and used with the use of mobile technologies and mobile devices. Mobile services are used by users in commercial transactions, business operations, learning, healthcare, entertainment/ multimedia, gaming, social networking and collaboration, augmented reality, searching/ querying, etc. [5, 13, 23, 24].

A mobile service can be the mobile version of an e-service (as the term is described in [21]), or it can be provided only in a mobile form, such as some kinds of location-aware and context-aware services. Likewise, a mobile service can be the mobile counterpart of a physical world service, or it can be only in mobile form.

A mobile service is an electronic in nature service that is produced and consumed by real world entities: business entities, as service providers, produce and provide

mobile services as a part of their business functions; end-users as individuals consume mobile services in their everyday life practices. Thus, mobile services produce a real world effect.

Service providers can offer mobile service directly to the end user with the use of mobile computing technologies and Internet and wireless technologies. In addition, they can provide mobile service via the cloud, with the use of cloud resources and cloud computing technologies. In most cases, the user does not know (and perhaps does not care) about the way mobile services are transmitted and received by his mobile device. These relationships can be seen in figure 1.

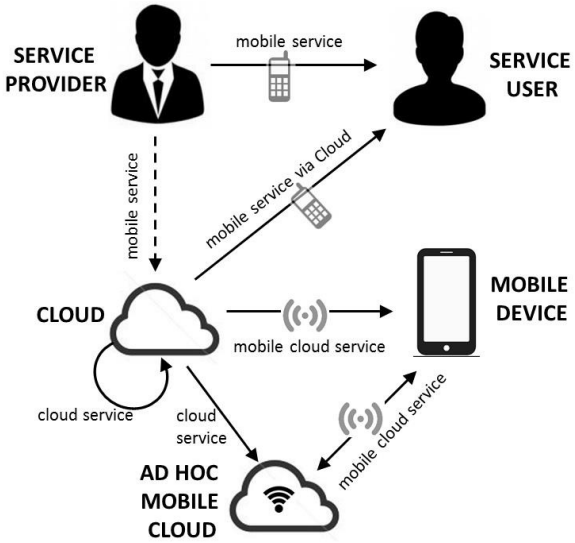

Fig. 1. Provision of mobile service and mobile cloud service

A 'mobile cloud service' is a computing service that is provided with the use of mobile computing technologies and cloud technologies and consumed by the mobile device of the user to run more efficiently and effectively mobile applications and provide mobile service to the user. For instance, in order to provide navigation service (mobile service) to the user, the mobile device uses cloud resources for processing location-aware data (mobile cloud service). Examples of mobile cloud services are related to the access, transmission and storage of data in the cloud, the outsourced execution of computing operations of the mobile device, the use of security services, etc. Mobile cloud services exist only in the virtual world of the cloud and serve the augmented operations of the mobile devices.

In figure 1 we see two approaches for mobile cloud service. In the first case the mobile device receives computing service from the cloud for the augmented execution of computing tasks. In this case we have basically a two-level architecture for the provision of cloud-based service that is consumed by mobile devices. In the second case the mobile device participates in a local and ad hoc cloud environment that

exploits distributed operations and opportunism and enables mobile devices to work collaboratively by pooling resources and sharing operations.

In figure 1 we can see the distinction between the cloud and the ad hoc mobile cloud. In the literature the term mobile cloud is used frequently as a general term to refer broadly to cloud services for mobile applications. However, in most cases it is simply cloud service that is offered to mobile devices, adjusted to the requirements of mobile computing. We can see also the provision of cloud service (iterative link) as a part of the operations of the different actors of the cloud ecosystem.

Is sum, we can distinguish the following mobile service models:

a) Direct mobile service provision. The service provider offers mobile service to the user directly, without the use of any cloud resources.

b) Cloud-based mobile service provision. The service provider uses cloud resources in order to offer mobile service to the user. Satyanarayanan [11] refers to it as 'mobile Web-based service'. SaaS is the prevailing cloud computing model here. The users may not be aware that the mobile service is transmitted via the mobile cloud.

c) Mobile cloud service provision. The mobile device receives service from the cloud in order to augment its computing capacity by executing remotely computing operations and tasks. SaaS is the prevailing cloud computing model. The user is not directly involved. However, the user is aware and, in fact, decides for the use of mobile cloud services (e.g. by applying the required settings and possibly paying a fee).

d) Ad-hoc mobile cloud service provision. The mobile device participates in a local cloud (e.g. cloudlet, mCloud, etc.) that is created ad hoc with other mobile devices and cloud-based resources in proximity. The mobile device both receives and provides computing services in the ad hoc cloud; for instance, it offers computing capacity because it holds bigger battery resources and uses the bandwidth of an other smartphone in the ad hoc cloud, because it provides cheaper or faster Internet access. All cloud computing models can be applied here (SaaS, IasS and possibly PaaS). As in the previous case, the user is not directly involved, but is aware of the participation in the ad-hoc mobile cloud.

4 An Integrated View on Mobile Service

Mobile devices function in an autonomous way in mobile cloud computing, when they interact with other devices or mobile cloud resources to receive or provide service. In addition, they have their own objectives, such as reduce energy consumption or improve the quality of connection to the Internet. However, their objectives and their operations are closely related to the provision of mobile service to the user and they must serve the needs of the user. Mobile services and mobile cloud services are supplementary. It is difficult to see the mobile device in separation of the user, his activities and intentions. The mobile device is simply the smart and multi-functional tool that enables people receive service in a flexible way in their daily life practices, anytime and anywhere.

The combination of service concepts from the real world and the computing world

introduces the idea of mobile service provision as a cyber-physical phenomenon. This idea is not new in the literature of mobile cloud computing. Huang, Xing and Wu [3] suggest a user can be represented by a virtualized entity in the cloud, through his mobile device, an approach that can introduce a "next-generation mobile cloud computing service model" in that both physical systems and virtual systems are seamlessly integrated through virtualization technologies to provide service. The connection between a cyber-physical system (CPS) and cloud computing is envisaged also by Simmon et al. [26], who cast the term 'Cyber-Physical Cloud Computing' (CPCC). Moreover, research in the areas of ubiquitous computing, pervasive computing and the Internet of Things include also the user (as a human being) in the conceptualization of the cyber-physical framework. The National Institute of Standards and Technology (NIST) uses the term 'Smart Networked Systems and Societies' (SNSS) to describe the network of connected computing resources, things and humans [26]. Humans participate as an integral part of SNSS, especially through social networks, and social networking services allow people to access, store and share their real-life experiences. Conti et al. [4] place humans at the center of the 'Converged Cyber-Physical World', as humans use several computing devices in their everyday life practices. Likewise, Zhuge [27] suggests people live and develop in a 'Cyber-Physical Society', which is a multi-dimensional complex of the cyberspace, the physical space and the social space. Huang, Xing and Wu [3] suggest mobile devices have a dual character and operate in the physical world as cyber-physical system (CPS) and in a virtualized mobile cloud as cyber-virtual system (CPV).

The development of an integrated view on mobile service that combines technological and usage aspects and emphasizes on real world effects and on value creation requires inevitably to include explicitly the user and his context in the analytical framework. The mobile service should be seen as an embedded part in the life of the user that supports human activities and attains personal objectives. Hence, the mobile device facilitates the provision of mobile service and intermediates and connects the physical world of the user with the virtual world of the electronic systems. In sum, the mobile device can be seen as a cyber-physical system and the mobile service provision as a cyber-physical phenomenon.

This approach can have important implications for value creation in mobile service environments and can provide new research and practical opportunities. For instance, the interconnection of the cyber and the physical worlds enables the observation and measurement of human behavior, which can allow the analysis, modeling and experimentation with human behaviors, reveal behavioral patterns and support a dynamic adaptation of service provision [4]. Understanding better the individual and how it uses mobile service in the daily life practices is a key requirement for understanding service value, improving service provision and developing new services and new service models.

Input from the service management literature can help understand better the concept of mobile service. Recent research in service management focuses on the role of the service consumer/ user and on the creation and co-creation of value. Service value is created by users in their everyday practices [28], or co-created with the providers [29]. Service providers do not create value, but they only offer service, as a 'value proposition' and as input in the value creating process of the users. Service

providers can also support and facilitate the users in their value creating processes.

The mobile technologies have some value potential, but value is created by the user only when the mobile service is used. If it is not used for some reason (e.g. technological restrictions, computing failures, security issues, wrong settings in the mobile devise, ignorance of user for the existence or the usage method of the service, etc.), then it creates no value at all. In addition, the same service will bring different value to different users. For instance, the value of the mobile cloud services varies for different mobile devices, with different technical features, or for the execution of different tasks that have different computing needs.

Value is created in the context of the user. The notion of the context includes anything that characterizes the situation of the user [30]; key dimensions of the context refer to the time and location. The context is a key characteristic of mobile service and offers plenty opportunities for the development of personalized services and further service innovations [31]. Mobile devices are in most cases strictly individual and, therefore, mobile services can be personalized to each user. Hence, besides contextual, value of mobile service is highly personalized and experiential.

5 A Conceptual Framework for the Provision, Usage and Value Creation in Mobile Services

In this section we present a conceptual framework for the provision and usage of mobile service and the creation and co-creation of value in mobile service. The framework considers mobile service provision as a cyber-physical phenomenon that is enabled by mobile devices and facilitated by mobile cloud technologies and resources. The proposed framework is depicted in figure 2.

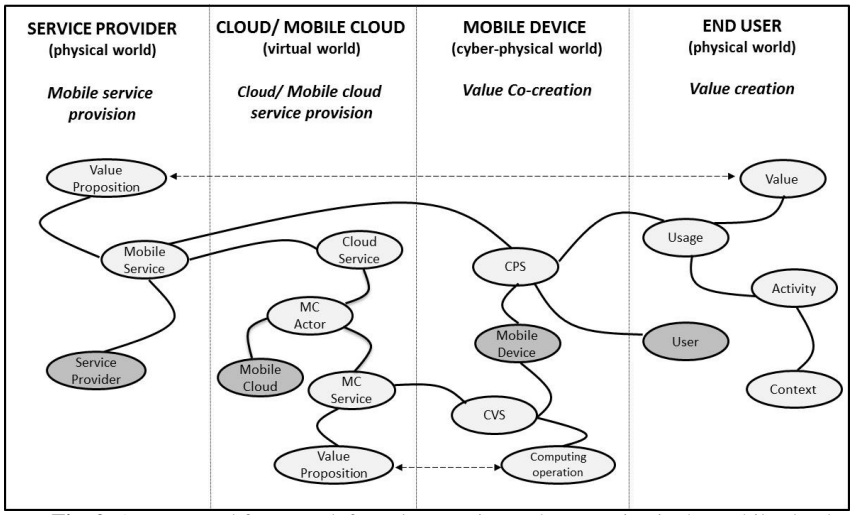

Fig. 2. A conceptual framework for value creation and co-creation in the mobile cloud

The *Service Provider* is the business entity that provides Mobile Service. The key activity here is the provision of Mobile Service. Mobile Service can be provided directly by the Service Provider or with the support of Cloud Service, provided by a Cloud Actor. The Service Provider makes a Value Proposition to the User through the offer of the Mobile Service. The Value Proposition describes the potential uses and value of the Mobile Service.

The *User* is the human entity that consumes Mobile Service through the use of a Mobile Device. The basic activity of the User is the creation of value. Value is created by the User as an outcome of the meaningful Usage of Mobile Service, which takes place as a part of the daily Activities of the User in the Context of his life.

The *Cloud/ Mobile Cloud* refers to the general cloud computing idea and infrastructure. It is a middle layer between the User and the Service Provider and facilitates the provision of Mobile Service to the User. The key activity here is the provision of computing service as Cloud Service and Mobile Cloud Service. Cloud Service supports the provision of Mobile Service by the Service Provider. Mobile Cloud Service supports the virtualization of the operations of the Mobile Device in the Mobile Cloud. The MC Actor is a resource (i.e. network, infrastructure, platform or software) and service provider of Cloud Service or Mobile Cloud (MC) Service. Value Proposition of MC Service refers to the potential use and value of MC Service and it is a key selection criterion for MC Service.

The *Mobile Device* serves as an interface of the User in order to receive Mobile Service and participate in the Mobile Cloud. It is a middle layer that refers to: a) the interaction of the User with the Service Provider, directly or through the Mobile Cloud, in order to receive Mobile Service (as Cyber-Physical System), and b) the computing operations of the Mobile Device (as Cyber-Virtual System) in order to interact with other MC Actors and receive or offer MC Service. The key activity is the co-creation of value, as a result of the interaction of the User with the Service Provider and possibly other Users. Value co-creation exists also when Mobile Devices interact with other Devices and MC Actors and they work collaboratively in the mobile cloud.

Mobile Cloud Service is based on the dynamic pooling, sharing and composition of resources and it can be even more interactive and collaborative than Cloud Service. For instance, while in cloud computing the client regularly receives services only, in the mobile cloud the client usually both receives and provides services. In certain cases, such as in mobile crowdsourcing, value is always co-created as a result of the active participation and contribution of a large number of users.

6 Conclusions

Mobile devices, especially smartphones and tablets, are used today more and more to provide a variety of mobile services. In this paper we analyzed the concept of service in mobile environments and distinguished between ‘mobile service’ on the one hand as an electronic service that is provided through mobile devices and with the use of mobile technologies and possibly cloud computing technologies, and ‘mobile cloud

service' on the other hand as a computing service for the improved performance of the mobile device through the virtualization of its operations in the mobile cloud. Based on this distinction and on the complementary relationship between mobile service and mobile cloud service, we analyzed mobile service provision as a cyber-physical phenomenon. At the end we developed a conceptual framework for mobile service provision and for the creation and co-creation of value in the mobile cloud.

This paper integrates concepts from mobile cloud computing and service management and provides a user-driven and usage-oriented perspective for mobile service that explains mobile service provision, value creation and value co-creation. The paper integrates the human-related aspects for the use of service and the creation of value with the computing operations for the provision of the mobile service. Certain concepts of the service management literature, especially for the creation and co-creation of value, are relevant in mobile cloud computing.

The conceptual framework provides some key concepts for the analysis and the better understanding of the usage of mobile service by the user. Understanding better the service user and how he creates value in his context and in his daily life practices, in which mobile service is naturally embedded, is a key requirement for the creation of service value, for service improvement and for the development of new services and new service models.

Future research can develop further and refine the proposed conceptual framework, as well as explore its practical implications. For instance, it can be used for the analysis of use and the identification of use patterns of mobile services (e.g. who uses them, when, where, with what application and technologies, with what resources, with whom else, for what reason, etc.). Such use patterns can be useful for the service improvement and the development of new service. In addition, use patterns can be used for the assessment of the mobile service models in terms of the technological restrictions and limitations in the use of mobile cloud services, the functional requirements and the motivation of the users to receive mobile cloud services and share their resources in the mobile cloud.

References

1. Smura, T., Kivi, A., Töyli, J: A framework for analyzing the usage of mobile services. Info, 11(4), pp. 53-67 (2009)
2. Fernando, N., Loke, S. W., & Rahayu, W.: Mobile cloud computing: A survey. Future Generation Computer Systems, 29(1), pp. 84-106 (2013).
3. Huang, D., Xing, T., & Wu, H.: Mobile cloud computing service models: a user-centric approach. Network, IEEE, 27(5), pp. 6-11 (2013).
4. Conti, M., Das, S. K., Bisdikian, C., Kumar, M., Ni, L. M., Passarella, A., and Zambonelli, F.: Looking ahead in pervasive computing: Challenges and opportunities in the era of cyber–physical convergence. Pervasive and Mobile Computing, 8(1), pp. 2-21 (2012).
5. Rahimi, M. R., Ren, J., Liu, C. H., Vasilakos, A. V., & Venkatasubramanian, N.: Mobile cloud computing: A survey, state of art and future directions. Mobile Networks and Applications, 19(2), pp. 133-143 (2014).

6. Leimeister, S., Riedl, C., Böhm, M., Krcmar, H.: The Business Perspective of Cloud Computing: Actors, Roles, and Value Networks. 18th European Conference on Information Systems (ECIS), Pretoria, South Africa (2010)
7. Heinonen, K., Pura, M.: Classifying Mobile Services. Proceedings of Helsinki Mobility Roundtable. Sprouts: Working Papers on Information Systems, 6(42) (2006) http://sprouts.aisnet.org/6-42
8. Rowley J.: An analysis of the e-service literature: towards a research agenda. Internet Research, 16 (3), pp. 339-359 (2006).
9. Baldauf M., Dustdar S., Rosenberg F.: A survey on context-aware systems. International Journal of Ad Hoc and Ubiquitous Computing, 2(4), pp.263-277 (2007).
10. Verkasalo H.: Contextual patterns in mobile service usage. Pervasive and Ubiquitous Computer, 13(5), pp. 331–342 (2009).
11. Satyanarayanan, M.: Mobile computing: the next decade. ACM SIGMOBILE/ Mobile Computing and Communications Review, 15(2), pp. 2-10 (2011).
12. Yang, L., Cao, J., Yuan, Y., Li, T., Han, A., & Chan, A.: A framework for partitioning and execution of data stream applications in mobile cloud computing. ACM SIGMETRICS/ Performance Evaluation Review, 40(4), pp. 23-32 (2013).
13. Dinh, H. T., Lee, C., Niyato, D., & Wang, P.: A survey of mobile cloud computing: architecture, applications, and approaches. Wireless communications and mobile computing, 13(18), pp. 1587-1611 (2013).
14. Youseff, L., Butrico M., and da Silva D.: Toward a unified ontology of cloud computing. Proceedings of the Grid Computing Environments Workshop, Austin, Texas, USA, November, pp. 1–10 (2008).
15. Mell, P., Grance, T. The NIST definition of cloud computing (2011).
16. Qi, H., & Gani, A.: Research on mobile cloud computing: Review, trend and perspectives. Second International Conference on Digital Information and Communication Technology and it's Applications, pp. 195-202 (2012).
17. O'Sullivan, M. J., & Grigoras, D.: User experience of mobile cloud applications-current state and future directions. IEEE 12th International Symposium on Parallel and Distributed Computing (ISPDC), pp. 85-92 (2013).
18. Lin, C. Y., & Hung, M. T.: A location-based personal task reminder for mobile users. Personal and ubiquitous computing, 18(2), pp. 303-314 (2014).
19. Dihal, S., Bouwman, H., de Reuver, M., Warnier, M., & Carlsson, C.: Mobile cloud computing: state of the art and outlook. info, 15(1), pp. 4-16 (2013).
20. Huerta-Canepa, G., & Lee, D.: A virtual cloud computing provider for mobile devices. Proceedings of the 1st ACM Workshop on Mobile Cloud Computing & Services: Social Networks and Beyond (2010).
21. Baida, Z., Gordijn, J., & Omelayenko, B.: A shared service terminology for online service provisioning. In Proceedings of the 6th international conference on Electronic commerce, pp. 1-10 (2004).
22. Cardoso, J., Voigt, K., & Winkler, M.: Service engineering for the internet of services. In Enterprise Information Systems, Lecture Notes in Business Information Processing, pp. 15-27 (2009).
23. Liu, F., Shu, P., Jin, H., Ding, L., Yu, J., Niu, D., & Li, B.: Gearing resource-poor mobile devices with powerful clouds: architectures, challenges, and applications. IEEE Wireless Communications, 20(3), pp. 14-22 (2013).
24. Wang, Y., Chen, R., & Wang, D. C.: A Survey of Mobile Cloud Computing Applications: Perspectives and Challenges. Wireless Personal Communications, pp. 1-17 (2014).
25. Wan, J., Liu, Z., Zhou, K., & Lu, R.: Mobile cloud computing: application scenarios and service models. 9th IEEE International Wireless Communications and Mobile Computing Conference, pp. 644-648 (2013).

26. Simmon, E., Kim K.S,, Subrahmanian E., Lee R., de Vaulx F., Murakami Y., Zettsu K., Sriram R.D: A vision of cyber-physical cloud computing for smart networked systems. NIST (2013).
27. Zhuge, H.: Cyber-Physical Society—The science and engineering for future society. Future Generation Computer Systems, 32, pp. 180-186 (2014).
28. Grönroos, C., & Voima, P.: Critical service logic: making sense of value creation and co-creation. Journal of the Academy of Marketing Science, 41(2), pp. 133-150 (2013).
29. Vargo, S. L., Lusch, R. F.: Service-dominant logic: continuing the evolution. Journal of the Academy of Marketing Science. 36/1, pp. 1-10 (2008).
30. Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M., and Steggles, P.: Towards a better understanding of context and context-awareness. Handheld and ubiquitous computing, Springer Berlin Heidelberg, pp. 304-307 (1999).
31. De Reuver, M., & Haaker, T.: Designing viable business models for context-aware mobile services. Telematics and Informatics, 26(3), pp. 240-248 (2009).