Mobile Cloud Computing and Payments

Ion-Costel-Marius Bălțoi
Bucharest University of Economic Studies, Romania
marius.baltoi@ie.ase.ro

In recent days, mobile technologies, cloud technologies and payments technologies have evolved to the point they make daily life very easy. The combination of these technologies provides high quality services in a very simple and user-friendly way. Payments services are one of them and by using them together with mobile cloud technologies results in a top high-quality service. In this article we will make an analysis on the architecture of mobile cloud computing technology. The article also presents how to integrate the two emerging technologies, as well as a comparative analysis between two electronic payments processors: Braintree and Stripe.
Keywords: *Cloud Computing, Cloud Services, Mobile Cloud Computing, Mobile Payments*
DOI: 10.24818/issn14531305/26.1.2022.04

1 Introduction

Mobile cloud computing has evolved along the years and became more and more versatile. Now creating applications without using the cloud just make that particular application to start with a disadvantage. In this paper we will present some details about mobile cloud computing, will talk about the architecture of mobile cloud computing and how some payment methods can be integrated.

2 Mobile Cloud Computing

According to the study [1], financ organizations seek to improve busin processes and provide customers with financial services through mobile services (mobile payments). Thus, mobile banking applications run on smartphones, using technologies such as 4G/5G, e-wallet, cloud, etc.). These applications can be used on the virtual platform and in the cloud environment as Software as a Service (SaaS).

With the increase in the number of mobile applications and the development of the concept of cloud computing, a new concept for mobile services was introduced: mobile cloud computing. It has become an option for mobile application developers due to its advantages and growth potential.

The concept of mobile cloud computing refers to the infrastructure for storing and processing data outside the mobile device; thus, mobile applications transfer processing power and data to the cloud environment, bringing benefits to all users of smart devices (smartphones, payment devices, etc.).

In the source [2], the concept of mobile cloud computing is described as a new paradigm by which processing power and storage are moved from the mobile device to centralized platforms located in the cloud environment and which can be accessed via the Internet from a mobile device.

Mobile cloud computing can also be defined as a combination of mobile web and cloud computing through which users can access applications and services via the Internet [3].

Mobile cloud computing has established itself as an innovative solution due to both the innovation it brings and the technical advantages and constraints it solves. Among the constraints it solves are:

- extending battery life (power required is reduced due to the migration of complex processing from the mobile device to cloud servers);
- improving data storage and processing capacity (large files can be stored in the cloud in a secure environment and can be accessed as needed);
- increased reliability (information stored in the cloud benefits from permanent backups; thus, the probability of data loss is reduced; increased security against unauthorized access and data theft).

In addition, mobile cloud computing brings a number of advantages specific to mobile services:

- dynamic forecasting (dynamic display of required resources and execution of applications and services without prior reservation of resources);
- scalability (resources are shared and requirements for expanding mobile applications or services can be made without constraints from this point of view);
- multiple sharing (resources can be shared to support a large number of applications and users);
- ease of integration (multiple services can be integrated via cloud and internet to meet the needs of users).

3 Mobile Cloud Computing Architecture

The architecture of mobile cloud computing is shown in Figure 1. Thus, mobile devices A, B, C, D, E are connected to mobile networks through various components (for example, receiving transmitting stations, access points or satellites) and which establish connections between the mobile network and mobile devices. Through telecommunications operators, mobile networks are connected to the Internet. In the cloud environment are processed requests from mobile users through cloud services (developed based on the concepts of virtualization, service-oriented architecture, etc.) [4].

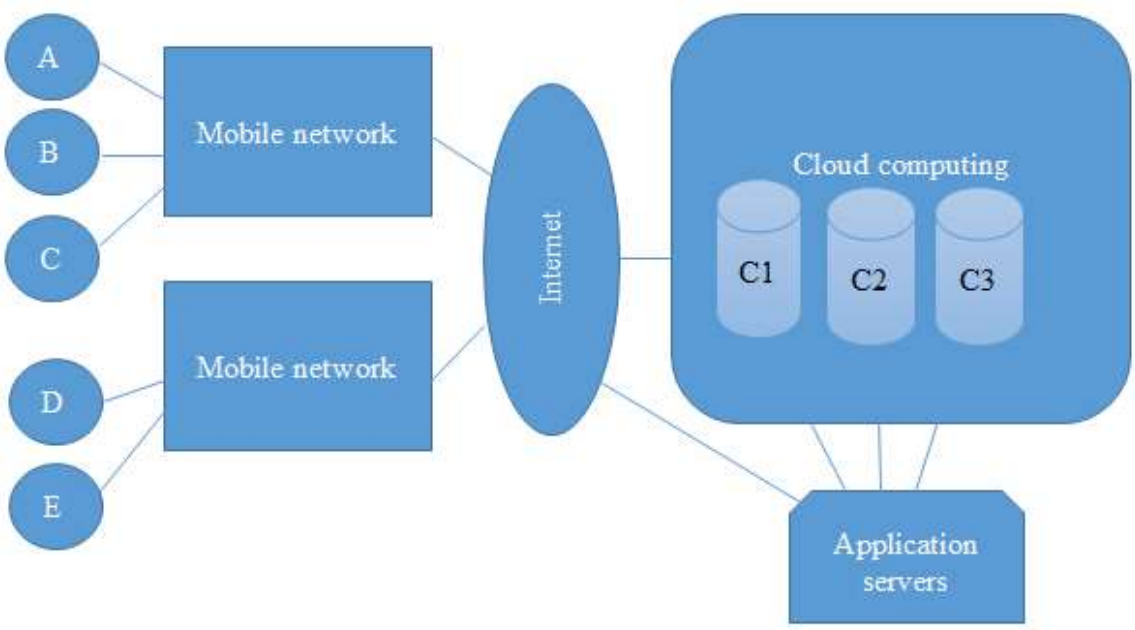

Fig. 1. Mobile cloud computing architecture

Cloud computing is a large-scale distribution system implemented based on a large number of servers in data centers. Cloud services are classified based on distributed levels in the form of a stack.

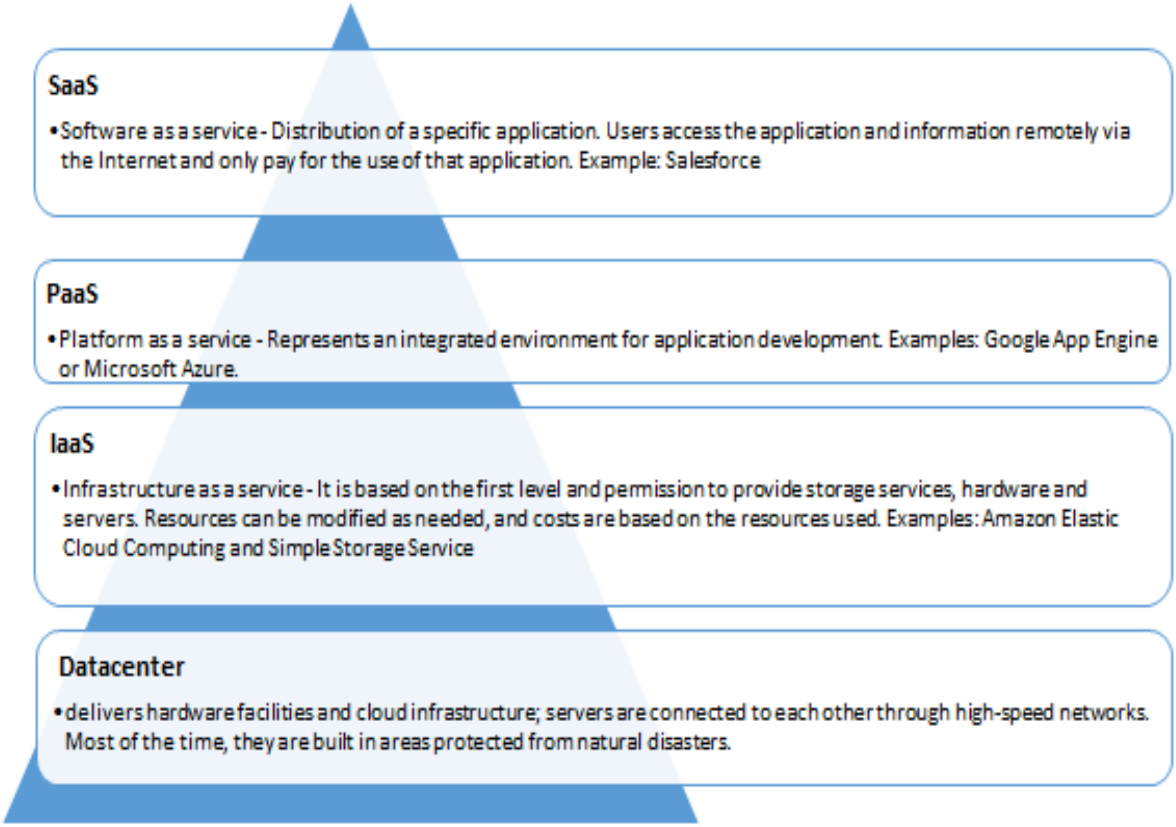

Fig. 2. Levels of cloud computing architecture [4]

Figure 2 shows the levels that are part of the cloud computing architecture. Even if they are arranged in levels, its architecture is quite flexible and efficient due to the fact that the upper layer is not required to be built directly on the layer directly below it; for example, the SaaS application can be implemented directly on IaaS, not necessarily on PaaS. Also, certain services can be considered part of several levels (for example, storage service).

According to the study [5], among the problems often encountered within companies are the numerous blockages of web services, blockages based on server problems. Based on these issues, the paper [6] proposes a new technique that can be applied by companies operating in the financial sector, called the Cloud-based Workload Optimization (Efficiency-aware Cloud-based Workload Optimization model - ECWO) and focuses on the workload of the cloud server in a dynamic manner. The proposed model has an efficiency-based approach, and targeted bottlenecks are addressed in two aspects, including server performance and network bandwidth.

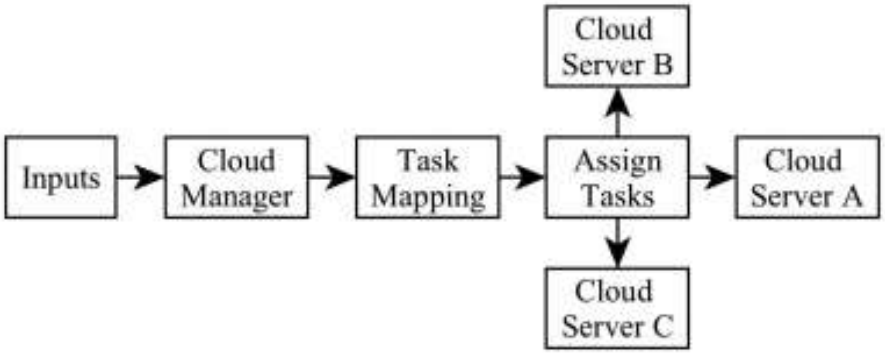

Fig.3. Cloud-based workload optimization model

Figure 3 shows the graphical representation of this technique and the task distribution in the cloud environment.

4 Integration of Payment Services Within Mobile Applications

At present, there are a lot of products available to users for online transactions, and the solutions range from facilitating the payment process to supporting the whole process. Thus, among the solutions we can list the records of transactions in the virtual environment, payment service providers (PSP), software for integrating banking services, schemes for digital content [7].

Payment service providers (PSPs) are organizations that operate payment systems and include the record of transactions in the virtual environment. Their role is to process payments on behalf of payers or beneficiaries (depending on the use of online transactions) and to establish the necessary partnerships with the financial system for the settlement of payments [7].

In the case of payments made online (e.g., e-commerce), direct interaction between platforms and financial institutions is avoided for security reasons. In addition to the high levels of security, the benefits offered to users include the acceptance of various payment currencies, the avoidance of unauthorized payments and fraud, the rapid handling of large sums of money. Also, in choosing the right provider for the implementation of electronic payment services, aspects such as time required for configuration, integration and compatibility with existing systems, quality of support services, accepted payment methods, accepted currencies and languages, multiple integration methods must be considered in various services [8].

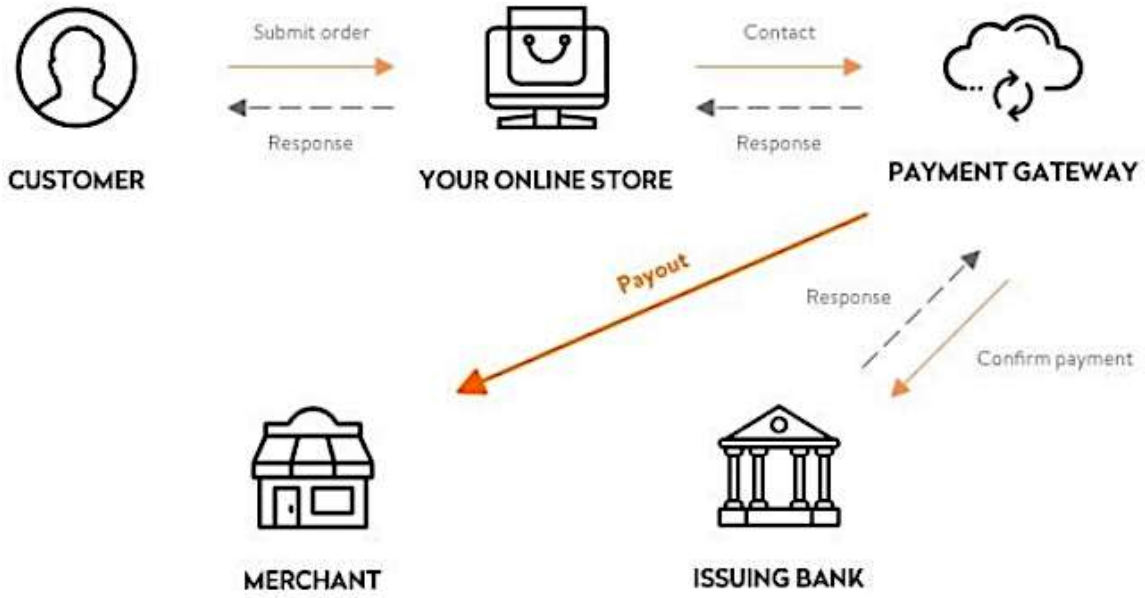

Fig. 4. Interaction in the payment process **[9]**

For a particular case involving e-commerce, Figure 4 [9] shows how electronic payment providers intervene in the payment process. Thus, after sending the order to the online store, a request will be sent to the payment service provider. It will check the balance of the paying account and send a reply to the electronic payment provider. In case of a positive response, the payment is made from the paying account to the seller, and the online store will send a response to the customer informing him about the acceptance of the payment. In case of a non-payment balance, the customer is also informed.

There are a lot of electronic payment processors worldwide; these include Stripe, Braintree, mPower, PayPal, Amazon Payments, Authorize .Net, WePay, PayU,

Skrill, SecurionPay, BlueSnap, 2CheckOut, etc. All of them have in common the basic functionality, that of intermediating electronic payments and establishing communication channels between banks. They target a diverse target audience, starting with large online stores, businesses of various sizes or individuals who make money transfers.
In the following, only Stripe and Braintree will be analyzed by comparison. They can be integrated into web and mobile applications, with support for various programming languages, including Java, Ruby, PHP, Python, etc.

Stripe
Stripe was launched in 2011 and is one of the systems in which transaction security is the main goal. Also, one of its advantages is that it is an API (application programming interface) and can be easily implemented by developers in various programming environments. It makes it easier for customers to store multiple cards and allows direct payments to a bank account. The Stripe platform allows payment in over 135 coins.
The Stripe Connect service is involved in the transactions, which supports the acceptance of payments and the sending of money to third parties. Through this service, you can create a complex system, but at the same time, easy to use. Connect also offers additional services, such as analytics. The necessary documentation for developers can be found online and also has detailed instructions for using the APIs needed to process payments.

Braintree
From a technical point of view, Braintree offers developers a whole set of tools (Software Development Kit - SDK) necessary for integration into mobile applications or websites, facilitating the integration and processing of electronic payments.
Braintree is constantly improving its services, providing developers with tools that increasingly facilitate the integration of electronic payments; thus, in October 2018 it introduced Samsung Pay as a new payment method for US users, helping to increase the loyalty of its users and increase security in order to avoid fraud.
Braintree's innovative services include Braintree Extend; it was created to support partnerships between its users. Thus, this product facilitates the expansion of online stores and the secure distribution of payment information between partners, even if it integrates different payment solutions. Braintree also opens up new business opportunities through reward programs to increase customer loyalty.

Table 1. Braintree vs Stripe

Characteristic	Braintree	Stripe
Fees Credit and Debit	2.9% of transaction amount + 30 cents per transaction	
Fees Refunds	No fees for refund or failed transactions.	
Fees International Payments	1% per transaction	None
Accepted cards	Visa, MasterCard, AMEX, JCB, Discover	
Other payment types	PayPal, Venmo, Appl Pay, Android Pay	AliPay, Apple Pay, Android Pay
Other billing services	Recurring billing, subscriptions, discounts codes	
Mobile payments	Yes	
Native languages	Java, Ruby, PHP, Python, Microsoft .Net, Node	Java, Ruby, PHP, Python, Node, Go
POS Terminals	No	

Table 1 presents a comparative analysis of the characteristics of the two payment services. Thus, at the level of fees charged, both charge the same fee for payments and are borne by the beneficiary from the amount received. They have no fees for failed transactions. The 2 services accept Visa, MasterCard, AMEX, JCB, Discover cards and pay via Apple Pay or Android Pay. It also accepts recurring bill payments, subscriptions and discount codes. At the technology level for which it supports integration with other applications and systems, Braintree offers a complete set of tools for developers in Java, Ruby, PHP, Python, .Net, Node JS. Neither of the 2 payment service providers offers contactless payment support at the sales terminals.

5 Conclusions

We saw that the architecture of mobile cloud computing is organized in levels and each level has a specific work to do. Beside that we made a small presentation of two providers of payment methods and a comparison between them, comparison which considered characteristics like fees, refunds, programming language and others characteristics.

References

[1] A. Q. Gill, D. Bunker and P. Seltsikas, "An Empirical Analysis of Cloud, Mobile, Social and Green Computing: Financial Services IT Strategy and Enterprise Architecture," in *IEEE Ninth International Conference on Dependable, Autonomic and Secure Computing*, 2011, Sydney.

[2] AEPONA, "Mobile Cloud Computing Solution," AEPONA, Detroit, 2010.

[3] J. Christensen, "Using RESTful web-services and cloud computing to create next generation mobile applications," in *Proceedings of the 24th ACM SIGPLAN conference companion on Object oriented programming systems languages and applications*, New York, 2009.

[4] H. Dinh, C. Lee, D. Niyato and P. Wang, "A survey of mobile cloud computing: architecture, applications, and approaches," *Wireless communications mobile computing*, vol. 13, no. 18, pp. 1587-1611, 2011.

[5] R. Totamane, A. Dasgupta and S. Rao, "Air cargo demand modeling and prediction," *IEEE Systems Journal*, vol. 8, no. 1, p. 52–62, 2014.

[6] K. Gai, Z. Du, M. Qiu and H. Zhao, "Efficiency-Aware Workload Optimizations of Heterogeneous Cloud Computing for Capacity Planning in Financial Industry," in *IEEE 2nd International Conference on Cyber Security and Cloud Computing*, New York, 2015.

[7] Institute for Prospective Technological Studies, "Research study on the integration of e-payments into the online transaction process," Institute for Prospective Technological Studies, Amsterdam, 2001.

[8] E. Oat, "Integrating payment solutions to online marketplaces," Aalto University , Espoo, 2016.

[9] M. D and K. Abrosimova, "Mobile App Payment Gateway Integration," Yalantis, 15 February 2019. [Online]. Available: https://yalantis.com/blog/payment-systems-integration-app-stripe-braintree-square/. [Accessed 15 April 2019].

Ion-Costel-Marius BĂLȚOI has graduated the Faculty of Economic Cybernetics, Statistics and Informatics in 2016. He holds a bachelor degree in Economics Informatics and he has completed the master's program of Economics Informatics. Currently he is Java Developer and he is involved in teaching and research activities at the Bucharest University of Economics Studies. He is interested in Java programming, emerging technologies and business development.