# **1. Introduction**

In the past a few years, the computation speed and storage space of mobile devices has improved a lot with the development of hardware. This technology progressing makes mobile devices do more complexity works and have more diversity functions. However, mobile devices still can’t deal with some complex computation such as object recognition and detection, virtual text translation and big data analysis, for their high demand to be used in mobile devices. So the mobile cloud computing (MCC) was put forward and be focused on many researchers.

Traditional mobile cloud systems highly depend on cloud server, so mobile device is only a terminal of the server. This kind of system have rather good performance under a stable network, but the WAN today is unstable and has high latency, so the benefit of the system may lose or have a worse performance than just using the mobile device to do calculation. Many studies showed us various of new mobile cloud systems to handle the problem, such as [1, 2, 3, 4]. [1] puts forward a new theory called the CloneCloud which can build a virtual mobile system on the server and run partitions of mobile applications on these virtual systems. But the problem is virtual system is very heavy for the original system. So this can bring additional costs and will make the computation slower. [2] designed a structure called Weblet to split the original application into many components. These components can be organized, migrated between server and mobile devices, and when the application starts to run, they will link together and execute as a whole application. This is a flexible and significant system, even provides support to many programming languages. But this also brings a middleware to the server, which may cause additional cost. Another problem is this system has to be paused when migrate Weblet. This is OK for a small application, but it will cause unacceptable cost if the whole application has to pause and restart. [3, 4] use Cloudlet to build VMs and these VMs are used to execute special functions and communicate between cloud and mobile devices. This method brings too much middleware and hard to realize real-time elastic MCC, for the VMs needs much time to download and be initialized.

These solutions only focus on the design of MCC system and the offloading strategy was ignored, but this is very important for a MCC system. In fact, the implement methods of system have rather tiny influence to the MCC efficiency. In almost all MCC strategies, applications is divided into partitions and the ones which have complex computation will be offloaded. [5, 6] describe many kinds of offload strategies. Some kinds of offloading situations such as linear, tree and graph offloading structures are discussed in these researches. Our purpose is to focus on both implementation and offloading strategy of MCC to put forward a new MCC system with efficient offloading strategy. So this system can be used directly in commercial products and we can also do more research to make it faster. In this paper, many related works will be discussed in the next section. Then we first put forward an OSGi-based cloud system, then describe and prove our efficient offloading strategy. System model will be showed in Section 3, then we put forward our offloading strategy and prove it in Section 4. Next section shows details of how we implement the system based on Felix-OSGi framework. The experiments of the system and offloading strategy are described in Section 6. Finally, in section 7 we conclude the whole paper.

# **2. Related Works**

In these years, there are many related researches about OSGi-MCC system and offloading strategy such as [7, 8, 9 ,10], [5, 6].

[1] Chun, Byung-Gon, et al. "Clonecloud: elastic execution between mobile device and cloud." Proceedings of the sixth conference on Computer systems. ACM, 2011.

[2] Zhang, Xinwen, et al. "Towards an elastic application model for augmenting computing capabilities of mobile platforms." Mobile wireless middleware, operating systems, and applications. Springer Berlin Heidelberg, 2010. 161-174.

[3] Satyanarayanan, Mahadev, et al. "The case for vm-based cloudlets in mobile computing." Pervasive Computing, IEEE 8.4 (2009): 14-23.

[4] Soyata, Tolga, et al. "Cloud-Vision: Real-time face recognition using a mobile-cloudlet-cloud acceleration architecture." Computers and Communications (ISCC), 2012 IEEE Symposium on. IEEE, 2012.

[5] Tao, Yaling, Yongbing Zhang, and Yusheng Ji. "Efficient Computation Offloading Strategies for Mobile Cloud Computing."

[6] Jia, Mingming, Jiannong Cao, and Lei Yang. "Heuristic offloading of concurrent tasks for computation-intensive applications in mobile cloud computing." Computer Communications Workshops (INFOCOM WKSHPS), 2014 IEEE Conference on. IEEE, 2014.