



Review Of ReseaRch

ISSN: 2249-894X

Impact Factor : 5.7631(UIF)

UGC Approved JoUrnAI no. 48514



MOBILE CLOUD DATA OFFLOADING: LIMITATIONS AND SOLUTIONS

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ABSTRACT

In recent years, growth in technology has brought tremendous changes in cloud computing. Currently, mobile application has adapted various cloud computing techniques which makes it possible to overcome the constraints by offloading the complex modules on cloud. One of the major solutions for this problem is mobile cloud computing, which uses cloud infrastructure to enhance the capabilities of mobile device to overcome this constraint. Most common limitations are server running out of space, limited battery, limited processing capabilities etc. To avoid those limitations, container based operating system can be used. Cloud services are application programming platforms where users can create new applications and integrate their functionalities. This paper is a literature review on various methods for offloading mobile phone data using cloud services. Different types of frameworks were studied to address the use of mobile offloading methods at different real-life scenarios. This paper broadly describes the techniques to offload the data to the server and the supporting Big data frameworks. Based on theoretical analysis, the key limitations are identified for data transfer and then propose a solution to minimize the limitations. The results provide insights regarding the evolution and deployment of data. The study also indicates that the offloading algorithm in cloud has demonstrated profound potentials for future technology and application development. As the domain of cloud storage has vast application, the study in the paper gives the principal understanding for implementation of offloading mobile data.

KEYWORDS — big data, cloud offloading, rattrap container, virtual machine.

INTRODUCTION

With the innovation of devices like smart phones, tablets, laptops, are becoming an essential part of human lifestyle, the devices are getting crucial since the usage of mobile internet. Users can get experience of various services from their own mobile devices by installing some application like camera applications, games, music applications and cloud applications. **The Cloud Services Market is projected to grow by 17.3% in 2019 to total \$206.2 billion** globally [1]. Cloud computing enables its users to host any services on the internet by providing on-demand computing resources from any remote distance on a mobile basis. The performance of offloading system depends on the Network infrastructure and protocols, as many mobile applications have been adapted to the technique of data offloading.

" International Conference on 'Recent Trends in Science' 8- 9TH March, 2019 J. S. M. Collge, Alibag-402201."

Cloud Computing enables users to use the pre-defined frameworks like storage, compute, virtualize, etc. Mobile computing was introduced due to the increase in the number of mobile applications. Computation offloading refers to the transfer of resource intensive computational tasks to an external platform. The main goal of the offloading is to minimize the overall energy used by the mobile application. With the frequent changes experienced in the wireless environment, the offloading choices can be determined with the help of an adaptive offloading algorithm. For mobile computation codes, the cloud should provide on-demand execution environments. The main drawbacks of mobile cloud usage of VMs are that the VM takes a lot of time to boot. Due to its performance, container-based virtualization has recently attracted a lot of attention. Building a virtualization based on containers is a good idea, but it also has some challenges and disadvantages.

In this paper, to address the challenges about mobile offloading there is a comparison between two systems which is the rattrap container and virtual Machines and see which one can offload the data efficiently. Cloud computing also has some big data to be transferred so this paper also looks at the Big data framework for cloud offloading.

LITERATURE REVIEW

A study conducted by [4] describes the future in cloud computing. The paper states how with the current technology there are some limitations for offloading the data and some existing techniques for data offloading. It also states the challenges and issues in cloud computing.

A study done by [3] states the limitations for cloud computing. Due to network problem and storage problem in cloud computing there are a lot of limitations for cloud offloading, so this study points out limitations and solutions for cloud offloading.

The research conducted by Kchaou *et al.*, 2015, presents the solution to offload the big data analytics in cloud computing. The research proposes a framework to offload big data in mobile cloud environment.

The study by [1] has conducted an experiment on container-based mobile data offloading in Cloud Computing. In this research there is a comparison between the rattrap container and virtual machines. There are some limitations and problems while - using virtual machines, so this paper attempts to prove how the container-based approach is better than virtual machines.

A study in 2017 carried out by [5] states, some of the challenging issues for offloading the data. The paper shows how efficiently the data is offloaded, what are the network complexities and major bottlenecks for data offloading. This paper also states the time and energy for offloading the data in mobile cloud computing.

LIMITATIONS AND SOLUTIONS

Limitations and solution in mobile cloud computing

A) Bandwidth

Network medium bandwidth constrains the transfer of data from the mobile device to a cloud-based server. There is a direct relation between data transfer rate and bandwidth. Higher the bandwidth, higher the data transfer rate [2]. Consistent bandwidth provision in wireless network will enable uninterrupted offloading mobile data.

B) Lack of Resource of Mobile Devices

On comparing mobile devices with old PC's it is witnessed that there is a lack of resources which make it very difficult for adaption for mobile cloud computing. To overcome the limitation, the devices should be added in a cloud infrastructure or a cloud container so that they can be used anytime for cloud application.

C) Challenges of Wireless Network and Access Control Policies

For better performance for sharing the data network bandwidth is important but variables like data rates, longer latency and connectivity are the main problems in mobile cloud computing. Some other factors are also responsible like weather changes, bandwidth, affect the network. As the wireless network is an important factor in cloud computing the functioning should be proper, there should be no latency, they should increase the bandwidth and a decrease in the connectivity gap.

D) Interoperability

There are a lot of devices running on a different platform including different android devices, iPhone. So, the variety of devices used by people is the same in one single network, so it has become a major challenge for offloading the data across all the platforms. Applications which run on cloud infrastructure should be supported by all the devices so that there is no problem or delays.

E) Data distribution over Mobile Cloud

Data with larger size are required to fragment and the fragments are offloaded on cloud servers. The mobile cloud converges the distributed data once all the fragments are received. There are some issues with in mobile cloud computing like battery life and performance of the device. Fragmenting data and distributed offloading reduce less dependency on mobile device performance and the battery life is managed. Mobile cloud distribution and convergence is a technique that provides performance improvement and solution to the power problem.

F) Basic Offloading Mechanism

Mobile cloud computing has seen an increase in mobile applications. For a long time, the idea of offloading computation has developed. Generally, there are 2 components in a basic offloading system. The client side is running on mobile devices that control the code for the offload. Virtual machines are used to achieve the frameworks and virtualization. In these, the cloud platforms have the same runtime environments as mobile devices.

G) OS-level Virtualization

Virtualization at the OS level is an effective way for cloud computing. Containers are the virtualization centre at the OS level. Sharing the host OS kernel requirement makes virtualization at the OS level unfit for mobile cloud computing.

H) System design for Rattrap container

Rattrap container customises mobile OS for mobile cloud offloading. Rattrap is a lightweight cloud platform. Rattrap capabilities makes it prominent choice to solve all the major issues addressed in the above section.

Features provided by rattrap for mobile offloading are follows:

- i. It improves the run time efficiency of mobile cloud environment.
- ii. It selects the best suitable mobile environments which reduces mobile environment overlaps.
- iii. It reduces the overhead on mobile device and enhances the offloading
- iv. Duplicate codes are blocked from transferring, hence reducing the network load.
Rattrap mainly consists of 4 components [1]:
 - i. Cloud Android Container where mobile OS are installed. Different version of android mobile OS can be installed in single container. It implements an execution environment to execute all the code for mobile computing
 - ii. Shared Resource Layer- overlaps and redundancy is avoided in this layer.

- iii. App Warehouse- duplicate data transfer can be avoided using code cache mechanism.
- iv. Security Controller- It is used for security in cloud computing.

Mobile cloud application needs to interface with the Android kernel. Interfacing with Android kernel requires compatible drivers for the given OS kernel. This makes the mobile cloud application dependent on the type of drivers supported by the kernel version. Android container drivers contain drivers for all the major kernel version removing the dependency. Therefore, the researchers [2] recommends android container driver instead of linking the drivers to the kernel for mobile cloud application interfacing. The cloud can simply load any modules in cloud container whenever it's possible.

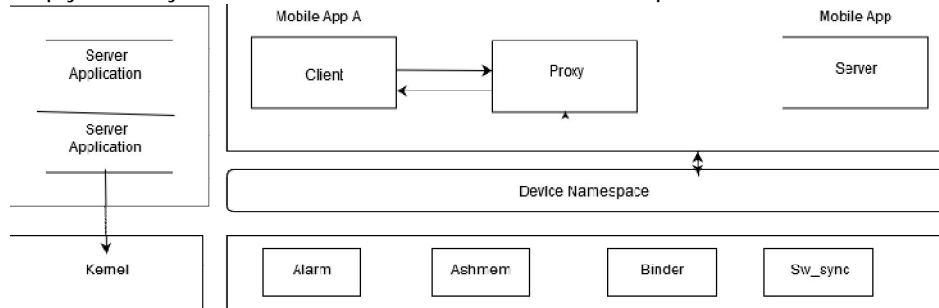


Fig 1. Rattrap architecture

Layer 1 in Fig. 1 shows the different types of pseudo drivers. The Rattrap supports multiple types of pseudo drivers one of them is Binder driver. Binder drivers are not hardware-related. Mostly binder drivers are used to implement system calls with the help of kernel in the container. Binder drivers are mostly used for extension of kernel. Binder driver loads the container which results in extension of kernel and so it can make specific system calls

Android Boot in Cloud Android Container

Android OS works on a flash memory. This memory is known as RAM, but still android OS boots slowly as compared to OS in the container, so Rattrap has its own features and techniques which skips the boot loading process. So instead of booting the kernel it directly starts hosting the kernel

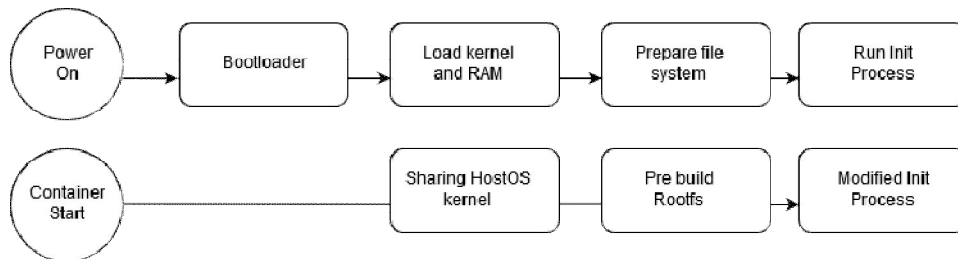


Fig 2. VM booting process and Container booting process

As mentioned in the above Fig 2. Comparison of android OS in a container and android in mobile devices is shown. Android booting in mobile devices completes in four steps whereas in container there are only 3 steps. There are three major differences in booting process between container and android device in mobile devices, the bootloader in android OS self-tests before booting as this step does not exist in the container. Before starting a cloud container, the root file is always mounted in initrd.img file. The container always modifies the booting time which will modify the init process.

I) Customized OS for Offloading

Research says that offloading the data requires 31.6 percent of the Android OS [2]. Rattrap has an option for customizing the operating system. By customizing the container in can be compatible with any computer or cloud environments, also it does not have any drawbacks or any performance issues.

Many system components are removed in cloud container. Hardware related devices like camera applications and music applications does not exist in a container. These components are removed as they may occupy some space which will affect the performance.

J) Security Discussion

The cloud server serves many different applications in a mobile cloud environment, if there is any type of malware or virus in any of the application then it would cause a major security issue. Any container has a lightweight runtime environment, so it provides with some security measures the container automatically will check the offloading requests. When there is any detection of malware or viruses the application will be blocked.

K) Proposed Framework for Big data mobile offloading

Big data

Big data shows the volume of the data which is to be stored or to be offloaded. Big data technologies are used to get any type of information from the data.

The framework shows how cloud computing is used in big data.

The main purpose of this framework is to offload the data in a distributed manner and show the results

Big data uses cloud computing-based distribution techniques for offloading the data.

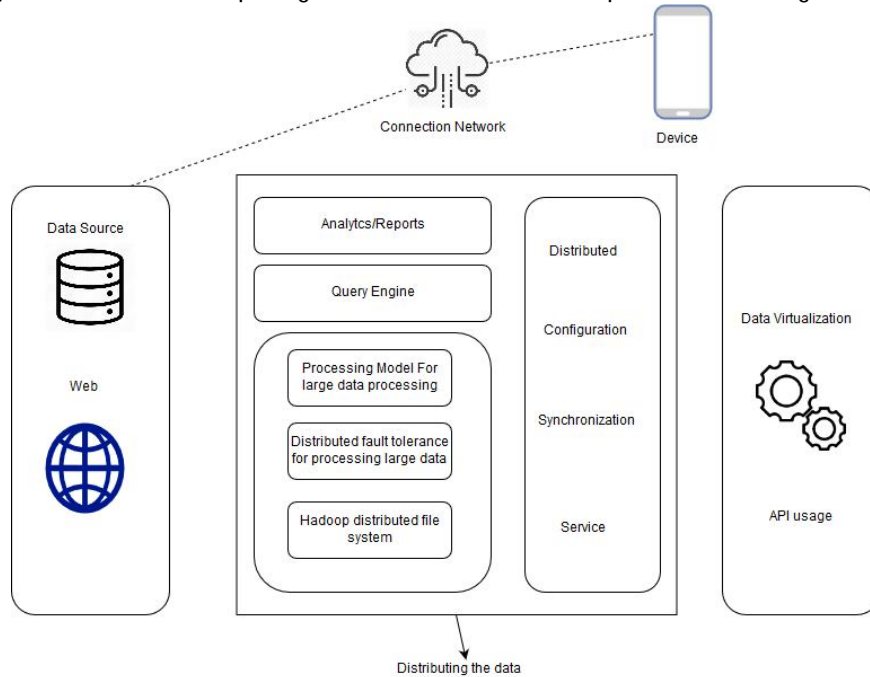


Fig 3. Big Data offloading framework

Full data sharing is done via network connection.

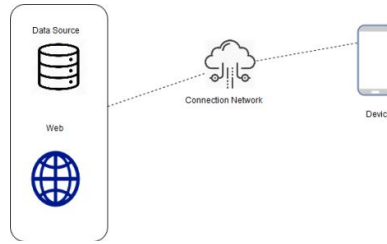


Fig 4. Data sharing

L) Data sharing

As shown in fig 4 data can be shared from one mobile device to a data server by any network services or cloud services. Data will be stored on a storage server or on cloud storage. After transferring the data in the storage, it must be offloaded from one storage to another. The distributed algorithm is implemented on distributed storage servers.

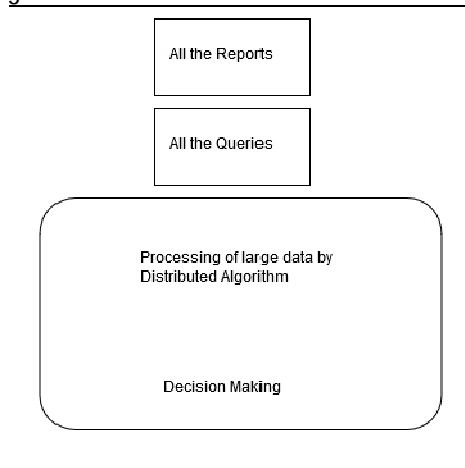


Fig 5. Distributed algorithm

M) Distributed algorithm

Fig. 5 shows the components of Distributed Algorithm. The data is offloaded, distributed and shared equally in the servers. Queries are triggered on distributed data. All the reports can also be seen after the offloading of the data.

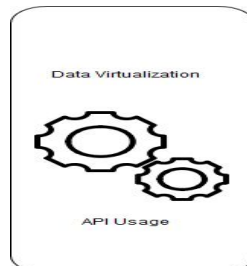


Fig 6. Data virtualization

N) Data Virtualization

The offloaded data is stored on a virtualized platform. Virtualization enables the data to migrate as per requirement. As shown in fig 6 the virtualization platform provides a set of APIs' to perform operations on the data. Data virtualization also shows all the results about data offloading.

IV. CONCLUSIONS

This paper concludes

1. The Rattrap is a lightweight container-based cloud platform designed offloading the data. Rattrap removes some drawbacks by introducing OS-level virtualization and also provides an execution environment for mobile computing.
2. The Big Data Framework proposes a Big Data Analytics - based offloading framework in the mobile cloud environment.

So, this states that creating a container like Rattrap is a very good technique for offloading the data as it saves time without any performance issues.

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