

An Age of Cloud in Mobile Computing (Mobile Cloud Computing)

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Abstract: Mobile phone market has been expanding swiftly in past few years and their demand has soared to new heights. In order to support such a high demand cloud computing appears to be right choice for mobile technology. Mobile cloud computing incorporates cloud computing concept to overcome many restraints of mobile devices such as battery life, bandwidth, scalability, diverse platform, storage to name a few. The mobile cloud computing market is predicted to further rise in the next coming years. The focus of this paper is to provide baselines for understanding cloud computing concept. At first an introduction to cloud computing with application areas and services are discussed then how mobile computing is combined with cloud computing to devise a new concept of mobile cloud computing. Various advantages, challenges, applications and architecture of mobile cloud computing is discussed in detail.

Keywords: Mobile Applications, Cloud computing, Mobile Cloud Computing, Mobile Computing.

I. INTRODUCTION

Over the past few years, there are major advances in the field of cloud computing. It has become a major research topic and has emerged as a new computing standard which is being adopted by many different research fields. Application areas of cloud computing are increasing at drastic rate. According to Cisco Visual Networking Index, cloud apps are expected to grow by 90% of total mobile data traffic by 2019 as compared to 81% at the end of last year. Also it is expected that Mobile cloud traffic will grow 11 times from 2014 to 2019. Figure 1 shows the expected growth rate from 2014-2019 of applications running on cloud.

This paper first gives overview of cloud computing along with various application areas and services of cloud computing. In next section Mobile cloud computing (MCC) is discussed in detail covering architecture of MCC, various advantages, challenges and application areas of mobile cloud computing.

II. OVERVIEW OF CLOUD COMPUTING

Cloud computing has changed the course of computation and way of providing services to consumers anytime and anywhere as needed. Cloud computing is capable of providing a virtualized environment in which software, storage, server and network all are provided as a service via internet. The services thus provided using cloud computing infrastructure provides very cost effective and flexible environment to perform the tasks required by users in on-demand milieu. In cloud computing environment, data is packed in centralized servers on internet and is provided on-demand to user such as desktop computers, smartphones, laptops, and further devices. The objective of cloud computing is to allow client devices use an infrastructure on lease instead of owning it, with increased capacity and capability. There are various areas where cloud computing is used as shown in the table 1.

Table 1: Services of Cloud Computing [2]

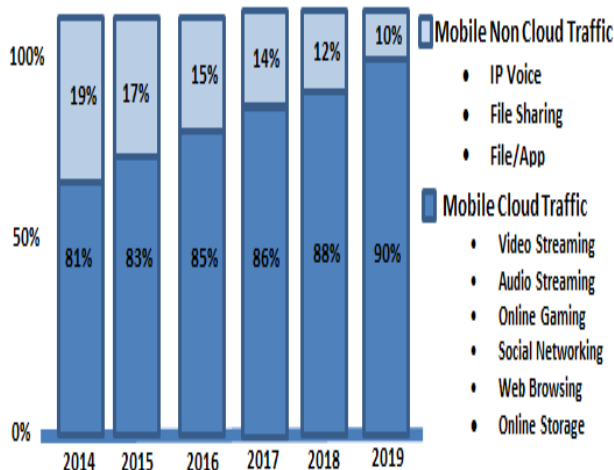


Figure 1: Cloud applications to grow 90% of mobile data traffic by 2019[1]

Infrastructure as a service (IaaS), platform as a service (PaaS) and Software as a service (SaaS)	In IaaS, infrastructure required for the task is provided by the service provider on pay-per-use structure. PaaS provides platform to deploy applications on demand. SaaS is a service provided by cloud service providers for running applications without installing on the customers individual devices via internet.
Public cloud , Private cloud and hybrid cloud	Public clouds share virtualized resources publically. These clouds are suited in that environment where confidentiality and security is not of much concern. A private cloud is a cloud which is solely dedicated to a specific organization and is available to users existing in the organization in a private network. This cloud is

	not shared with other organizations. Hybrid clouds are a combination of private and public clouds. In this some services are available to all and some services are available to users only existing in the organization.
Test and development	The best scenario for the use of a cloud is a test and development environment. This involves securing a budget, setting up your environment through physical assets, significant manpower and time.
Big data analytics	Retailers and suppliers are extracting information derived from consumers' buying patterns to target advertising and marketing campaigns to a particular segment of the population. Social networking platforms are now providing the basis for analytics on behavioural patterns that organizations are using to derive meaningful information.
File storage	Cloud can offer you the possibility of storing your files and accessing, storing and retrieving them from any web-enabled interface. There is also the possibility to store the data either on or off premises depending on the regulatory compliance requirements. Data is stored in virtualized pools of storage hosted by a third party based on the customer specification requirements.
Disaster recovery	Cloud provides cost effective disaster recovery elucidation for a faster recovery from a mesh of different physical locations at a much lower cost than the traditional disaster recovery site with fixed assets, rigid procedures and a much higher cost.
Backup	Cloud-based backup allows users to automatically dispatch data over the network providing security, availability and capacity.

III. MOBILE CLOUD COMPUTING

Mobile cloud computing is a combination of mobile computing and cloud computing. Cloud computing is already discussed above. Mobile computing includes various portable computing devices along with communication technologies allowing users to access internet and data on their devices from anywhere without needing a connection to a physical link. Mobile cloud computing (MCC) provides a new infrastructure in which data processing and data storage are done over the cloud

instead of mobile device itself. The working of mobile cloud computing is shown in figure 2. In the figure 2, the mobile devices including laptops, PDA and smartphones connect to the internet via some Wi-Fi connection or by radio links. The service providers residing on internet can be thought of as a cloud. The users or consumers can send their particular request for service to these providers via some web interface. The service providers then responds back with the required resources needed to fulfill the requested service. Monitoring and other management tasks for ensuring apposite service contentment are also handled by the cloud service provider itself.

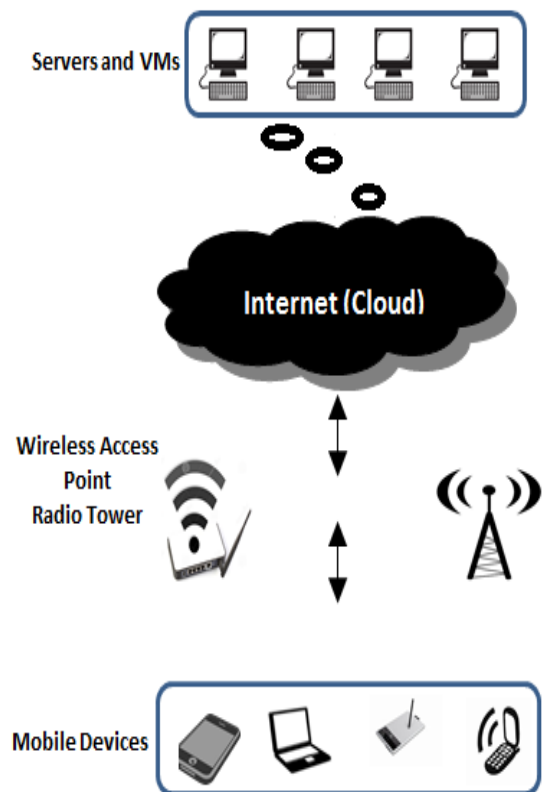


Figure2: Overview of Mobile cloud computing [3]

IV. ARCHITECTURE OF MOBILE CLOUD COMPUTING

An architecture of operational mobile cloud computing as shown in figure 3 is proposed by N. Fernando, S. Loke and W. Rahayu [4]. There are five components in the architecture:-

1. Job handler: - It is responsible for partitioning the applications into manageable jobs, scheduling and maintaining the jobs in the job pool.
2. Resource handler: - It is liable to search and find mobile resources and to connect and maintain connections and to communicate with other exterior devices.
3. Cost manager: - It is responsible for managing user priorities like how much memory will be consumed, how fast execution is required. After that depending upon kind of job required and available resources, cost manager decides whether to perform certain action or not.

4. Privacy and security manager: - It requires sensors as an input along with network interfaces to find the best policy to adopt for ensuring security.
5. Context manager: - It is responsible for adapting according to the client's requirements, context, and resources for cost effectiveness.

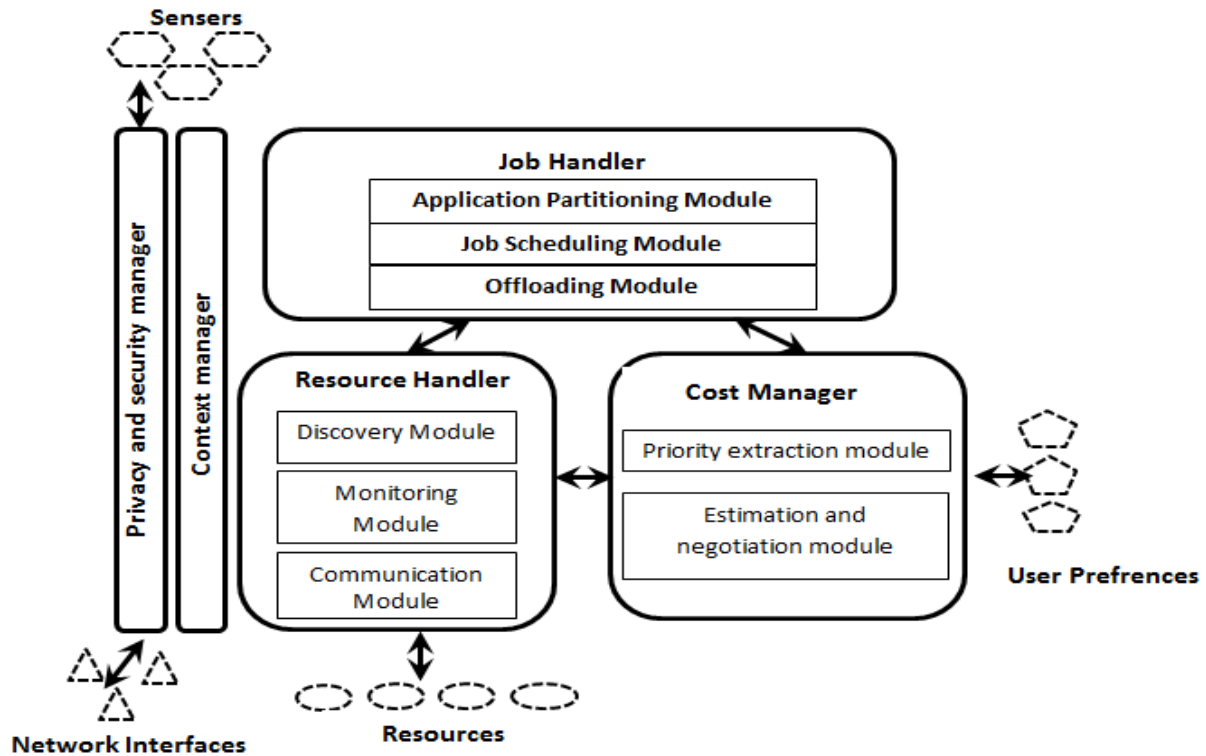


Figure 3: Architecture of Mobile Cloud Computing [4]

V. ADVANTAGES OF MOBILE CLOUD COMPUTING

Mobile Cloud computing is known to be a promising solution for mobile computing due to many reasons (e.g. Mobility, communication, and portability). Following confab will define how the cloud is used to overcome problems in mobile computing:-

1. Extended Battery Lifespan: - As battery life is a major concern in mobile devices. With cloud computing approach the processing is done over the cloud thus saving the huge quantity of power consumption.
2. Increased data storage: - Another constraint of mobile devices is limited storage capacity. With cloud computing, the developers are able to develop and store large amount of data on cloud and then can access it via internet.
3. Improved processing power: -The processing power is also increased as the resources required for running the applications are not limited and are available on demand.
4. Improved Reliability: - : The data stored over the cloud is considered very reliable and can be easily backed up in case of any data loss due to accidental reasons.
5. User Access:-With the Mobile cloud services; one can have the information about a particular user's location, context, and requested services to improve user experience.
6. Improved Availability: - The data is always available to clients from anywhere and anytime when stored over the cloud.
7. Scalability: Mobile applications running on cloud need various resources which are provided on pay per use basis. The resources required for running the app can be scaled up and down depending upon the requirements of the user.
8. Multi-tenancy: Even the service providers from different sources can share their resources with one another over the cloud and provide it to the end user.
9. Ease of Integration: Various services provided from different providers are integrated using cloud and is provided to the users on demand.

V. CHALLENGES IN MOBILE CLOUD COMPUTING

The main challenges of mobile cloud computing are because mobile devices constraints such limited energy, bandwidth, limited performance, connectivity [5].

But these challenge are more complicated when the application is designed, programmed and deployed actually on mobile device.

But when we are considering the same to be done on cloud then they are not that much complicated but they have other kind of challenges when done on cloud. These challenges are briefly outlined in figure 4

Challenge Type	Description
Mobile Communication	1. Low Bandwidth
	2. Resource poverty of mobile devices
Network Challenges	1. Inherent challenges of wireless network
	2. Various Network Access Schemes
	3. Lack of Speedy Mobile Internet Access Everywhere
	4. Seamless Connection Handover
Challenges related to Mobile Applications	1. Interoperability
	2. Cloud Application Flexibility
	3. Mobile Cloud Convergence
Challenges regarding Security	1. Information Security
	2. Privacy and Confidentiality
	3. Malicious Attacks
	4. Network Monitoring
	5. Compliance and Enforcement
	6. Incident Response

Figure 4: Various challenges in Mobile cloud computing [6]

VI. MOBILE APPLICATIONS USING MOBILE CLOUD COMPUTING

Below are some of the mobile applications that are based on mobile cloud computing:-

1. Mobile Commerce: - Using the M-commerce mobile application one can make online payments for anything purchased over the internet like e-banking, e-shopping, e-advertising, etc. As a mobile application it has to face similar challenges that a mobile device faces. So when this application is integrated with cloud computing approach it can handle these issues easily.
2. Mobile Learning: -As this is an era of learning over the internet. Various mobile applications are developed for proving such a service. Limited storage and slow processing inherent in mobile devices are bottleneck for delivering efficient service. But with integration with cloud computing these challenges are easily controlled.
3. Mobile Healthcare:- With all the patients records saved over the cloud in large amount using a health care mobile application ,it is very convenient for doctors and other health care organizations to diagnose and treat the patients easily.
4. Mobile game: - Mobile games are the video games that are played over the mobile devices. There are potential users of such mobile games applications and bringing huge profits to the service providers. But the challenges that these service providers and the users have to face are mainly storage capacities. But with cloud computing these issues are resolved.
5. Mobile social networking: - Mobile social networking is at its highest peak of growth. It allows various mobile users to share their data that includes messages, pictures, audio, and video over the cloud. These sharable data requires a lot amount of storage, security, integrity and fast processing .With cloud environment such sharing becomes really easy task.

6. Mobile sensing:- Mobile sensing make use of various sensing equipment installed on the mobile devices to collect the data such as health monitoring, thumb impression, retinal scans etc.

VII. CONCLUSION

Cloud computing has gained significant attention in last few years. Cloud computing has been integrated with various fields in computing. One of them is Mobile computing and after integration it is called mobile cloud computing. This paper discusses the concept og cloud computing with various applications and services provided by it. Then introduction to Mobile computing and various advantages, architecture and challenges faced in mobile cloud computing is discussed in detail.

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