Minimizing User Costs in Multi-Broker Mobile Cloud Computing Networks

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Abstract
The success and disruption of cloud computing over the past few years is unparalleled.In order to quickly allocate or reallocate virtual computing as well as storage resources, Infrastructure as a Service (IaaS) providers offer commercially accessible services that enable scaling out or in computing capabilities in response to changing needs.Users can provide new apps using IaaS services without having to manage the supporting infrastructure. In this study, the system takes into account an MCC model in which several brokers allot cloud resources to mobile consumers. The approach is distinguished by a heterogeneous cloud architecture and by the many cloud service providers' pricing models. Both a public cloud and a cloudlet are part of it. A competitive strategy and a compete-then-cooperate approach are investigated by the system as a performance bound. The computer creates a cooperative issue with the restriction that none broker should be required to shell out beyond the dispute price, with the objective of lowering the overall average broker price. The system uses a mix of the branch and bound paradigm with sophisticated convex relaxation techniques to develop a novel globally optimum solution algorithm to handle the ensuing non-convex cooperative issue.

1. Introduction

The term "mobile cloud computing" refers to the fusion of cloud computing, mobile computing, with wireless networks, which gives cloud computing providers, network operators, and mobile consumers access to extensive computational resources. The long-term objective of MCC is to make it possible for complex mobile apps to be executed that provide a rich user experience on a variety of mobile devices.[3] MCC offers commercial potential to both cloud service providers as well as mobile network operators.[4] According to a more comprehensive definition, MCC is described as "a rich mobile computing technology that takes advantage of unified elastic resources of different clouds as well as network technologies regarding unrestricted functionality, storage, along with mobility that enables a multitude of mobile devices whenever and wherever needed via the channel of Ethernet or Internet regardless of heterogeneous environments as well as platforms depending upon the pay-as-you-use concept.

Resource-constrained mobile devices can utilise the computing resources of various cloud-based services thanks to MCC's usage of computational augmentation techniques. There are four different kinds of cloud-based resources in MCC: hybrid (a blend of the previous three models), nearby immobile computing entities, distant immobile clouds, and proximate mobile computing entities.[1] Cloudlets and surrogates are members of close-by immobile computing

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entities, whereas massive clouds like Amazon EC2 belong to distant immobile groupings. The third category of cloud-based resources, proximal mobile computing entities, includes smartphones, tablets, portable computers, and wearable computing devices. Verizon, Vodafone, and Orange have begun to provide business cloud computing services.

A new technology named as mobile cloud computing has the ability to offer top-notch, multimedia-rich services in mobile contexts. Examples of applications include mobile learning, mobile healthcare, cloud-assisted video encoding, and multimedia rendering for interactive gaming. Computing-intensive operations can be continually offloaded and executed on "cloud" servers by mobile devices using MCC technology. For instance, "smart" phones, cameras, or glasses may carry out complicated motion-estimation or optimum cloud-based rate distribution while compressing a video sequence that has been recorded. This may improve the functionality of mobile gadgets, perhaps increasing the life of their batteries. However, users may incur sizable additional costs as a result of accessing cloud computing resources for subsequent MCC networks with plenty of multimedia. The outcome is, we concentrate on the issue of cost reduction for mobile users in upcoming MCC networks in this study.

Since they are the most convenient and effective communication tools, Mobile gadgets (which include cell phones & tablet PCs) are gradually becoming a crucial part of daily life since they are not limited by time or place. Mobile applications (like iPhone and Google apps) that are operated on mobile gadgets and/or on remote servers over wireless networks give users of mobile devices extensive experiences with a range of services. Mobile computing (MC), which is advancing quickly, is becoming a significant trend in the advancement of IT technology as well as in the domains of business and industry. However, the resources (such as battery life, storage capacity, plus bandwidth), as well as communications (such as mobility and security) of mobile devices face numerous difficulties. The insufficient resources severely hamper the development of service standards. The accelerated expansion of wireless networking, mobile computing, as well as online technologies over the past two decades has had a significant impact on society as a whole. Almost everyone with a mobile device has access to Internet-enabled technology including email, instant messaging, gaming, media streaming, plus navigation apps. We contend that the next wave of mobile applications will heavily rely on rich media and have more demanding Quality of Service (QoS) requirements. Web-based learning resources, educational games that blur the lines between education as well as entertainment, digital libraries that provide information on a range of subjects, as well as technologies that allow the general public to cooperatively evolve, preserve, alongside pass on information are examples of technologies that are altering the mobile landscape. A novel framework that moves computation and storage's physical location onto the network to save operating and maintenance expenses is made possible by the burgeoning cloud computing environment. The next-generation computer infrastructure has been generally recognised as cloud computing (CC). By enabling customers to access platforms, middleware services, and operating systems, as well as infrastructure (like servers, networks, and storages), and software (such as application programmes), offered by cloud providers (such as Google, Amazon, and Salesforce), CC offers various benefits. Additionally, CC gives users the ability to use resources elastically and on-demand. Mobile apps may therefore be swiftly deployed and

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distributed with the least amount of administration work or service provider involvement. Mobile cloud computing (MCC), which integrates CC into the mobile environment, is launched in response to the expansion of mobile applications and the support of CC for a number of services for mobile users. MCC offers additional services and features that allow users of mobile devices to benefit fully from CC.

2. Literature Survey

Despite the fact that mobile devices now have more storage, feature support, as well as apps, they are still constrained by bandwidth, processing power, and energy. Ample computing power is available through cloud computing, and it is very accessible. This article offers a perspective on mobile computing that overcomes the fundamental limitations that have prevented us from entering a brand-new world in which users' cognitive abilities are seamlessly enhanced by mobile computing using compute-intensive features like Speech recognition, computer vision and graphics, machine learning, augmented reality, planning, and decision-making, as well as natural language processing, pose and gesture recognition, and other compute-intensive capabilities. The essay will describe some of the problems we have and the answers we are looking at. The way we interact with the physical and digital worlds is being pushed to new heights by a fresh wave of mobile apps are now accessible in the Google Play Store as well as the Apple App Store. These applications demand computationally intensive skills. These features go against the mobile devices' resource-poor character, which is inherent to mobility [1].

A brand-new kind of service offered through the Internet is cloud computing. Businesses may benefit from its many benefits, including inexpensive startup costs, quick startup times, and minimal maintenance and operating costs, increased utilisation through virtualization, and simpler disaster recovery. For many people, mobile devices like smartphones have replaced desktop computers as their main computing platforms. Cloud suppliers offer processing cycles that consumers may employ to minimise the amount of computation performed on mobile systems and conserve energy. When a lot of compute (C) and only a little communication (D) are required, offloading is advantageous. Studies already published concentrate on anticipating the connections between D, C, and B in order to decide whether to unload. For the majority of applications, this causes a sizable shift in the value of D, while the value of F is elastic. However, there are a number of concerns with cloud computing to be taken into account, including privacy and security, dependability, and handling real-time data. Partitioning processing between the mobile system and the cloud is a potential remedy for lowering energy usage [2].

Since 2009, mobile cloud computing has becoming more popular. It blends mobile technology with cloud technology. General Purpose Mobile Cloud Computing along with Application Specific Mobile Cloud Computing are two methods that may be used to realise it. Although mobile devices' operating systems, memory, and processing speed have all improved, there are still some limitations. The data transport bottleneck in cloud computing is the main obstacle for mobile devices. In order to enhance the effectiveness of data access, both wired and wireless networks frequently employ data caching. The cooperative cache-based data access framework for mobile cloud computing is discussed in this research. Infrastructure as a Service, Platform as a Service, also Software as a Service make up the three levels that make up MCC's overall architecture. In contrast to PaaS, which offers a parallel programming environment for designing, testing, and deploying unique applications, IaaS gives users access to storage, hardware, servers, and networking components. Amazon's Elastic Cloud and S3 (Simple Storage Service) are two examples of IaaS [3].

The problems of mobile cloud computing, such as reaction time, user experience, cloud computing cost, mobile network capacity, and scalability, are examined in this study in order to make Cloud Mobile Media (CMM) applications practical. In order to solve the CMG difficulties, it also examines adaptive mobile cloud computing approaches, such as a rendering adaptation methodology that dynamically changes the intricacy as well as depth of visual rendering in response to network and cloud computing limits. Cellular network tests show that the suggested method may considerably enhance user experience and guarantee scalability of the CMG strategy. By 2016, it is anticipated that consumer cloud mobility services would generate $6.5 billion in annual revenue. Furthermore, a shift in the mobile application market from native to mobile cloud computing-based applications will make it possible to develop more potent applications and experience more significant growth [4].

Despite the fact that mobile computing is now a reality, its true potential lies in enhancing users' cognitive abilities through computationally intensive features. This essay explores the technological challenges that this change faces and suggests a fresh design to address them. When using cloud-based, resource-rich mobile computing, a mobile device travels with its user throughout the real world, which makes advantage of temporarily customized nearby infrastructure. This architecture makes it easier to meet high-definition video and high-resolution photos, which are dynamically generated and received by numerous people, are at their peak bandwidth consumption. For the smooth improvement of human intellect, precise interactive reaction is required. Resource scarcity is a significant barrier for many apps that have the ability, without a hitch, improve human cognition since these applications frequently need computation and energy that exceed the hardware's capability on mobile devices. The current cutting edge tasks involving face with speech recognition including language translation is comparable to human performance when performed in a lab with plenty of processing power. The true problem, though, is maintaining their cutting-edge quality and performance in the wild [5].

3. Proposed System

The suggested system, which combined the branch and bound paradigm with cutting-edge convex relaxation techniques, presented a novel globally optimum solution algorithm to handle the ensuing non-convex cooperative issue. The resultant ideal remedy offers a lower constraint on the customer cost that can be achieved without total broker collusion. Multiple brokers assign cloud resources to mobile users through the system's MCC paradigm. The concept is distinguished by the diverse cloud architecture and cloud service providers' disparate pricing models. Two groups of cloud reservation schemes are examined by the system. These involve competitive strategy and, as a performance constraint, a compete-then-cooperate strategy.

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In contrast to earlier research, the suggested method takes into account a more complicated scenario in which various brokers distribute cloud resources to mobile consumers. The prototype is distinguished by a heterogeneous cloud architecture alongside through the heterogeneous pricing models of cloud service providers. The system is about to enter a solely competitive scenario during which competing brokers try to reserve computational resources via local cloudlets as well as remote public clouds, which have fewer computational resources but shorter interruptions.

Fig 1: System Architecture

The system provides theoretical findings that demonstrate the existence of disagreement points (i.e., the equilibrium reservation plan from which no broker has an incentive to unilaterally deviate) as well as convergence of the optimal responses employed by the brokers to these disagreement points. The system formulates a problem with the aim of reducing the overall average price of all brokers with the limitation that no broker ought to charge a price that is greater than the dispute price.

Each broker uses the statistical properties of aggregate task flows to reserve cloud resources for a collection of various mobile users. The broker then assigns incoming computing jobs to the reserved clouds and offers its consumers cloud services at a consequent cheaper price. The pricing approach for computing services may get considerably more complex when cloudlets are incorporated into MCC networks. In reality, cloudlets have very limited computing resources available to them. Therefore, sophisticated resource allocation policies should be used when there are more compute demands than the system can handle. Among these, rules based on dynamic pricing, such as auctioning, provide more resources to users who are willing to shell out more to use them.

When a non-convex cooperative issue results, the system designs a new globally optimum solution method to tackle it using a mix of the branch and bound framework and sophisticated convex relaxation techniques. The results then underline the fact that the cooperative advantage is minimal in crowded markets, that is, markets with a high number of brokers, and demonstrate that significant cooperative gains may be realised beyond pure competition in markets with only a few brokers. The following benefits of the suggested strategy are listed:

- Users find it to be more useful.

- In comparison to the current solution, it is extremely inexpensive.
- High quality at an affordable price.

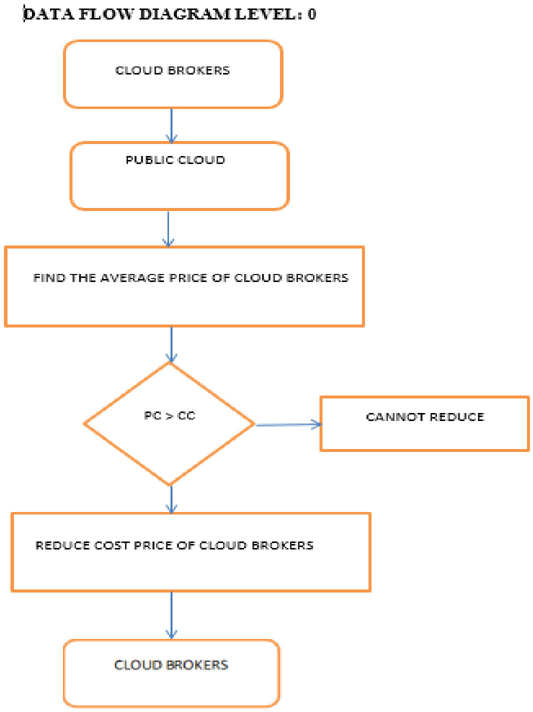

Fig 2: Flow Diagram

The next section provides an explanation of the many phases that are involved in putting the suggested technique into practice:

1. Find cloud broker amount

Find out first how much the cloud broker is ready to pay. Mobile users create computational jobs, which they then offload to the cloud server through the appropriate brokers to perform. Both the public cloud and the cloudlet are available for reservation by each broker, who subsequently makes the booked resources available to its consumers. Each broker aims to reduce the average payment made by its subscribers while still adhering to QoE restrictions. Brokers come in two varieties: dedicated and non-dedicated. By securing cloud resources at a lower price for a group of mobile users followed by reselling those reserved services at a higher price, dedicated brokers may make money. As a bonus, non-dedicated brokers provide their clients with subsidised cloud resources.

2. Find amount of pure competition

Then ascertain the average cost of the market. These are computed by cloud service providers. Finding the allocation plan for all MSPs that lowers the average cost of each user consuming the cloud service by collectively deciding regarding the cloud reservation plus job outsourcing plans of each of the brokers is an appealing design aim from the perspective of the entire system. However, since different brokers might be operated by various companies, they might be self-centered and only interested in lowering their own prices. In other words, the brokers have no incentive to work together if the final price is more than what might be obtained via pure competition.

3. Find amount of compete then cooperate competition

Then ascertain the average cost of competition before joining forces. Additionally, cloud service providers calculate this. A concept from cooperative game theory known as disagreement point (DP) denotes a cooperative game's players (or brokers) must have the minimum utility to be motivated to work together. Relying on a pure competition strategy is one possible method for determining the DP in a multi-entity market. A Nash equilibrium (NE) of the competitive market corresponds to the ensuing DP in this scenario, assuming one exists. Then, we examine the existence and attainability of DP after providing a formal definition of it.

4. Reducing price

Calculate and contrast pure competition, then collaborate to increase it and lower the cost of cloud brokers. Additionally, greater optimality precision attained at the expense of greater computational complexity, whereas in highly dynamic mobile environments, the optimality precision can be decreased in favour of a lower computational complexity so that brokers can quickly update their cloud reservations to accommodate the time-varying computing traffic load.

4. Results

Companies can expand or decrease their computer capacity thanks to the disruptive phenomenon known as cloud computing. In order to tackle the ensuing non-convex cooperative issue, this research suggests a globally optimum solution algorithm based on a branch and bound paradigm as well as sophisticated convex relaxation techniques. A heterogeneous cloud architecture and several cloud service provider pricing models are characteristics of the MCC model used by the system to assign cloud resources to mobile users. The ideal approach offers a lower constraint on the customer cost that can be achieved without total broker collusion. For the situation of varied numbers of brokers, the impacts of Plots illustrating the brokers' competitive versus cooperative behaviours are based on the typical transmission latency that brokers provide for the public cloud.

The system demonstrated through this process that in markets with a small number of brokers, there may be significant cooperative benefits above pure competition, and it was highlighted that the Cooperation yields little in marketplaces with a lot of brokers.

Fig 3: User Login

Fig 4: Customer and Selling Details

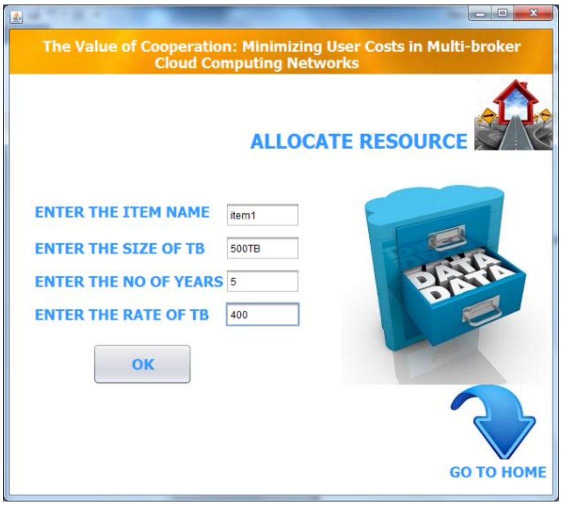

Fig 5: Resource Allocation

5. Conclusion

By taking into account a scenario including many brokers and heterogeneous cloud structures plus pricing techniques, the system offered a solution for the issue of user cost minimization in mobile cloud computing networks in this study. The system put out a situation in which brokers

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engage in just competitive behaviour, and it theoretically showed that there are Convergence of the finest replies and areas of contention from different brokers to those places. The algorithm then created a cooperative issue to reduce the average price that all brokers could achieve, ensuring that no broker's price would be greater than the disagreement point. Through the use of a newly developed algorithm, the system was able to solve which results non-convex problem in the best possible way globally. For the situation of varied numbers of brokers, The implications of the brokers' average transmission delay to the public cloud on their competitive versus cooperative actions are shown. Unsurprisingly, the average price grows monotonically as the transmission delay increases, as longer transmission delays translate into shorter waiting times and, ultimately, a lower task rate that the public cloud will allow. The system demonstrated through this process that in marketplaces with only a few brokers, considerable cooperative benefits above pure competition may be realised, and we emphasised our point that the cooperative profit is modest when there are a lot of brokers.

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