Cloud Computing for Mobile user Offloading Computation to Save Energy

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***Abstract*— the cloud heralds a new era of computing where application services are provided through the Internet. Cloud computing can enhance the computing capability of mobile systems, but is it the ultimate solution for extending such systems' battery lifetimes? Cloud computing[1] is a new paradigm in which computing resources such as processing, memory, and storage are not physically pres- ent at the user's location. Instead, a service provider owns and manages these resources, and users access them via the Internet. For example, Amazon Web Services lets users store personal data via its Simple Storage Service (S3) and perform computations on stored data using the Elastic Compute Cloud (EC2). This type of computing provides many advantages for businesses—including low initial capital investment, shorter start-up time for new services, lower maintenance and operation costs, higher utilization through virtualization, and easier disaster recovery—that make cloud computing an attractive option. Reports suggest that there are several benefits in shifting computing from the desktop to the cloud.1,2 What about cloud computing for mobile users? The primary constraints for mobile computing are limited energy and wireless bandwidth. Cloud computing can provide energy savings as a service to mobile users, though it also poses some unique challenges.**

***Keywords mobile cloud computing, energy savings*.**

I. INTRODUCTION

Cloud computing is a new type of service provided through the Internet. In cloud computing, the computing resources such as processor, memory, and storage are not physically present at the users' location. Instead, the computing resources are owned and managed by a service provider and the users access the resources via the Internet. For example, Amazon offers Elastic Compute Cloud (EC2) and Simple Storage Service (S3); personal data can be stored on their cloud using S3 and computation can be performed on the stored data using EC2. This type of computing paradigm provides many advantages for businesses, including low initial capital investment, shorter start-up time for new services, lower maintenance and operation cost, higher utilization through virtualization, and easier disaster recovery. Such advantages make cloud computing an attractive option. Some reports [1], [2] suggest that there are only benefits in shifting computing from desktops to the cloud. How about cloud computing for mobile users? The primary constraints for mobile computing are limited energy and wireless bandwidth. In this article, we investigate how cloud computing may provide energy savings as a service to mobile users and describe challenges and possible solutions.

Techniques to save energy for mobile systems

Mobile systems, such as smart phones, become the primary computing platforms for many users. Various studies have shown that "longer battery lifetime" is the most desired feature

of mobile systems. A study in 2005 among users across 15 countries [3] also showed longer battery life was the top concern, above all other features, such as cameras or storage. A 2009 survey by Change wave Research [4] shows short battery life to be the most disliked feature on Apple's iPhone
3GS In August 2009, a Nokia poll showed that "battery life" is the most desired feature for music phones. There are many applications that are too computation-intensive to be performed on a mobile system. If a mobile user wants to use such applications, the computation has to be performed on the cloud. Other applications such as image retrieval, voice recognition, gaming, navigation, etc can be performed on a mobile system. However, they consume significant amounts of energy. Can offloading these applications to the cloud save energy and extend battery lifetimes for mobile users? Low power has been an active research topic for many years. In IEEExplore, searching "low" and "power" in the document title produces over 5,000 papers. Techniques for saving energy and extending battery lifetime can be classified into several categories: (1) Adopt new generation of semiconductor technology. As transistors become smaller, each transistor consumes less power. Unfortunately, as transistors become smaller, more transistors are used to provide more functionalities and better performance; as a result, power consumption actually increases. (2) Avoid wasting energy. Whole systems or individual components may enter standby or sleep modes to save power. (3) Execute programs slowly. When a processor's clock speed doubles, the power consumption nearly tulles. If the clock speed is reduced by half, the execution time doubles but only one quarter of energy is consumed. (4) Eliminate computation all together. This sounds like a free lunch but it is possible, except that the computation is not performed at the mobile system. Instead, computation is performed somewhere else and the mobile system's battery lifetime can be extended. This article focuses on the last approach for energy conservation.

II. RELATED WORK

In paper[1] author Computation Offloading sending computational tasks to more resourceful servers widely-used approach to save limited resources on mobile devices.To solve the offloading decision problem with delay constraints.

In paper [2] author Offloading is one major type of collaborations between mobile devices and clouds to achieve less execution time and less energy consumption. Find offloading solution that is resistant to network unavailability less execution time and less energy consumption benefits**.**

In paper [3] author Mobile systems have limited resources, suchn as battery life, network bandwidth, storage capacity, Mobile agents and virtualization make offloading feasible.
In paper [4] author the long-held dream of computing as a utility, Pay as you go, Data handling in the cloud is a very complex and dynamic process.
In paper [5] author offloading computation from smart phones to remote cloud Resources. The application will be executed locally or remotely.
In paper [6] author wide range of application many demand an ever increasing computational power. Improves performance and Battery life.
In paper [7] author Cloud computing enables highly scalable services to be easily consumed over the Internet on an as- needed basis cloud computing services is easier, faster, economical and also efficient.

Offloading computation to save energy

Sending computation to another machine is not truly a new idea. The currently popular client-server computing model is an example. Mobile users can launch web browsers, search the Internet, or shop on-line. What separates cloud computing from the existing client-server model is the adoption of *virtualization* in cloud computing. Through virtualization, cloud vendors can execute *arbitrary* programs given by the users. This is different from client-server computing because the programs running on the servers are managed by the service providers. In contrast, cloud vendors provide computing cycles and users, in particular, mobile users, can use the cycles to reduce the amounts of computation on the mobile systems and save energy. In other words, cloud computing provides the possibility of *energy savings as a service for mobile users.* This is called *computation offloading* [5]. Virtualization is a fundamental feature in cloud computing. Virtualization allows applications from different customers to run on different virtual machines; hence, providing separation and protection**.**

Energy analysis for computation offloading

Various studies about offloading focus on the question whether to offload computation to a server [6], [7]. The following is a simple analysis for this decision. Suppose the computation requires C instructions. Let S and M be the speeds, instructions per second, of the cloud server and the mobile system. The same task takes C S and C M seconds on the server and the mobile system respectively. Suppose D bytes of data are exchanged between the server and the mobile system. B is the network bandwidth. It takes DB seconds for transmitting and receiving data. Suppose the mobile system consumes Pc for computing, Pi while being idle, and Ptr for sending and receiving data. In general, transmission power is higher than reception power but we use the same power in this simplified analysis.
If the computation is performed at the mobile system, the energy consumption is Pc ×CM. If the computation is performed at the server, the energy consumption is Pi ×CS + Ptr ×DB . The amount of energy saved isPc ×CM− Pi ×CS− Ptr ×DB (1) Suppose the server is F times faster, i.e. S = F
×M. We can rewrite the formula as CM× (Pc −PiF) ×DB (2) Energy is saved when this formula produces a positive number. The formula is positive if (a) D B is sufficiently small compared with C M and (b) F is sufficiently large. The values of M, Pi, Pc, and Pth are parameters specific to the mobile system. For example, an HP iPAQ PDA with a 400 MHz (M =
400) Intel X scale processor has the following values Pc ≈ 0.9

W, Pi ≈ 0.3 W, and Ptr ≈ 1.3 W. If we use a 4 core server, with a clock speed of 3.2 GHz, the server speedup F may be given by S M≈3.2×1024×4×X400 , where X is the speedup due to additional memory, more aggressive pipeline, etc. If we assume X = 5, we obtain the value of F ≈ 160. The value of F can increase even further for cloud computing if the application is parallelizable, since we can offload to multiple servers. If we assume that F = 160, equation (2) becomes C400× (0.9 −0.3160) − 1.3 ×DB≈ (0.00225 × C) − 1.3 ×DB(3) For offloading to break-even, we equate equation (3) to zero, and we obtain ≈ 577.77 ×DC (4) where Bo is the minimum bandwidth required for offloading to save energy, determined by ratio of DC . If D C is low, then offloading can save energy. Thus offloading is beneficial when large amounts of computation C are needed with relatively small amounts of communication D. Existing studies focus on determining whether to offload by predicting the relationships between D,C, and B. Figure 1 shows how these variables affect the offloading decision. We use two examples to illustrate these factors: (1) chess game and (2) image retrieval.
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Applications for offloading

Chess is one of the most popular games in the world. A chessboard has 8 × 8 = 64 positions. Each player controls 16 pieces at the beginning of the game. Chess is *Markova*, meaning that the game is fully expressed by the current state, regardless of the history before reaching the current state. Each piece may be in one of the 64 possible locations and needs 6 bits to represent the location. This is an overestimate because some pieces have restrictions; for example, a bishop can move to only half of the board, i.e. 32 possible locations. To represent the current state of a chess game, 6 bits × 32 pieces = 192 bits = 24 bytes are sufficient; this is smaller than the size of a typical wireless packet. The amount of computation for chess is very large; Shannon and Allis estimated the complexity of chess to exceed the number of atoms in this universe. Chess can be parallelized [8], making the value of F in equation (2) very large. Since the amount of computation C is extremely large and D is very small, chess is an example where *offloading is beneficial* for most wireless networks. Image retrieval is an application where images similar in content to a query are retrieved from an image collection. The retrieval is done by comparing numerical representations of the images, called *features*. The features for the image collection may be computed in advance; for a query, its features are computed during retrieval, and compared with the image collection. Since most of the computation is done in advance, less computation is performed *online*, and the value of C is small. D is large since a large amount of data needs to be sent. As a result, even if the value of F becomes ∞, D B may still be too large when compared to C M in equation (2).

This makes offloading save energy only if B is very large; thus offloading saves energy only at high bandwidths.

Does cloud computing make computation offloading more attractive?

The analysis indicates that the energy saved by computation

offloading depends on the wireless bandwidth B, the amount of data to be transmitted D, and the amount of computation to be performed C. However, there is a fundamental assumption underlying this analysis: all the data needs to be sent to the service provider. This is because the model is based on the assumption that the server does not already contain the data. The client needs to offload the program and the data to the server. For example, a newly-discovered server for computation offloading does not already contain a mobile users' personal image collection. However, cloud computing changes that assumption: the cloud stores data and performs computation on the stored data. For example, services like Google's Picasa and Amazon's Simple Storage Service (S3) can store data, and Amazon's Elastic Compute Cloud (EC2) can be used to perform computation on the data stored using S3. This results in a significant change in the value of D for most applications. There is no longer a need to send the data over the wireless network; it suffices to send a pointer to the data. Also the value of F is elastic: large numbers of processors can be obtained on the cloud. This increases the energy savings in equation (2): very small D and very large F imply that energy can always be saved. Does this mean that cloud computing is the "ultimate" solution to the energy problem for mobile users? Not quite. While cloud computing has tremendous potential to save energy, there are several issues to be considered. Some of the issues with cloud computing include privacy and security, reliability, and handling real-time data.

Reliability:

Another potential concern with cloud computing is reliability [11]. A mobile user performing computation on the cloud is dependent on the wireless network and the cloud service. Dependence on the wireless network immediately implies that cloud computing may not even be possible (let alone energy efficient) when wireless network connectivity is limited. This is typical in regions like national parks; a user capturing images in the park may not be able to organize, retrieve, or identify any images inside the park. Mobile cloud computing is also difficult in locations such as the basement of a building, interior of a tunnel, subway etc. In this case, the value of B in equation (2) can become very small or even zero, and cloud computing does not save energy. Dependence on the cloud for important computations could lead to problems during service outages. Several service providers such as Google, Amazon, and T-Mobile have experienced reliability issues.

Real-time data:

Some applications have real-time data. Examples include chess, searching newly captured images for CBIR, mobile surveillance, and context-aware navigation. In such scenarios, D in equation (2) is no longer a pointer to the data, it refers to the actual data. For applications like chess, the value of D is small and hence offloading can still save energy. When the value of D is large, offloading may not save energy. In such scenarios, performing the computation on the mobile system may be more energy efficient. A possible solution is partitioning computation between the mobile system and the cloud to reduce the energy consumption. Such a solution may include partially processing the real-time data on the mobile system. If the processed data is smaller in size, sending the processed data to the server reduces the wireless transmission energy.

The mobile cloud

The analysis presented in this article indicates that cloud computing can potentially save energy for mobile users. However, not all applications are energy-efficient when migrated to the cloud. Mobile cloud computing services would be significantly different from cloud services for desktops since they must offer energy savings. The services should consider the energy-overhead for privacy, security, reliability, and data communication before offloading.

III. PROPOSED SCHEME

In this section the day's primarily users do offload omputation in mobile phones. Here our aim is how to maintain the battery for longer and computation done in other system (i.e., cloud).Cloud vendors thus provide computing

cycles, and users can use these cycles to reduce the amounts of computation on mobile systems and save energy. Thus, cloud computing can save energy for mobile users through computation offloading

Some applications including chess, searching newly captured images for content-based image retrieval, mobile surveillance, and context-aware navigation have real-time data. In such scenarios, *D* is no longer a pointer to the data; it refers to the actual data. For applications like chess, the value of *D* is small and hence offloading can still save energy. When the value of *D* is large, offloading may not save energy. In such cases, performing the computation on the mobile system may be more energy efficient. A possible solution is partitioning computation between the mobile system and the cloud to reduce energy consumption. Such a solution may include partially processing the real-time data on the mobile system. If the processed data are smaller in size, sending the processed data to the server reduces the wireless transmission energy.

IV.CONCLUSION

Agenda of the project is to develop a tool which has to show the less energy consumption while uploading data from the user to Cloud server and has to compare the energy in both offloading and on loading. Cloud computing can potentially save energy for mobile users not all applications are energy efficient when migrated to the cloud. Cloud computing services would be significantly different from cloud services for desktops because they must offer energy savings. The services should consider the energy overhead for privacy, security, reliability, and data communication before offloading.

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