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Resource Allocation and Storage Using Hungarian Method in Mobile Cloud Computing

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Abstract: Cloud computing is an emerging concept combining many fields of computing. It provides services, software and processing capacity over the internet. The mobile execution platform is being used for more and more tasks such as playing games, ticket purchase, health, micro payment, uploading video. The combination of cloud computing, wireless communication, portable computing devices is called mobile cloud computing which allows users an online access. But mobile devices will always have less security, resource poverty, less energy. In this paper we propose entropy based Hungarian method to allocate resources to the mobile devices by calculating entropy for each base station and frequent application method to reduce storage space.

Keywords: Hungarian method, resource allocation, storage, cloudlet, frequent applications, entropy

I Introduction

Mobile cloud computing is a technique or model in which mobile applications are built, powered and hosted using cloud computing technology. A mobile cloud approach enables developers to build applications designed specifically for mobile users without being bound by the mobile operating system and the computing or memory capacity of the Smart Phone Mobile cloud computing centered are generally accessed via a mobile browser from a remote web server, typically without the need for installing a client application on the recipient phone. Technology is advancing rapidly these days and innovation is what fuels the development. This steady improvement in technology has been a blessing and has made things easier for individuals as well as corporations. New devices are being created and numerous different applications are being introduced that save people a lot of time by simplifying things. Mobile devices are such a creation that lets users stay connected without any physical connection. New generation devices take into account the data requirements of users and offer digital data competence in mobile. In order to circumvent this problem, another latest technological innovation known as cloud computing was emerged. Cloud computing enables a device to communicate with a central repository in order to access the data irrespective of time or location. The basis of both these technologies lies with their ability to add the element of mobility for the user. This element is one of the reasons that form a relationship between these technologies. Being able to access the cloud platform through a mobile device is a significant breakthrough in the advancement of both these technologies. Cloud computing and mobile technologies have numerous features that alter their services to cater the user's individual requirements. Latest mobile technologies and a lot of cloud platforms are providing us a glimpse of the existing technology infrastructure, which is sufficiently competent to fulfill the needs of users. Scalability is also a supplementary feature that provides these technologies with the ability to upgrade or downgrade their services, as required. Scalability is what lures most users to these technologies and encourages their advancements. Mobility is the most important factor these days. People want to be able to do practically everything anywhere. Where mobile devices let the users carry a medium which enables them to access data not stored locally, cloud platforms offer high availability, which covers the "anywhere" requirement, and accessibility to all data, regardless of the time, which takes care of the "anytime" part. People always appreciate a technology that doesn't have a steep learning curve.

II. Applications

A. Convenient Commerce: The explosion in the use of electronic commerce (e-commerce) by the business sector has been tremendous since its inception only a few years ago. E-commerce is known as: buying and selling of products or services over electronic systems such as the Internet and other computer networks. From governments to multinational companies to one-person start-ups, e-commerce is increasingly viewed as a key business modality of the future. Ease of transaction, widening markets, and decreased overheads are factors that make e-commerce solutions more and more attractive, as evident with the growth of on-line sales

B. Mobile Learning: Mobile learning today is becoming more popular as there are many people using mobile devices to enhance their learning. Mobile learning (m-learning) is not only electronic learning (e-learning) but e-learning plus mobility. It is clear that learning via mobile brings many benefits for mobile users. It brings the convenience for them since they can learn anywhere they want in any convenient time from a portable device. However, there is some research pointing out restrictions of traditional mobile learning such as: expensive mobile devices, high cost of network, poor network transmission rate, and limited educational resources. As a result, it is difficult for mobile learning to take full advantage and to be popular as well.

C. Mobile Healthcare: The development of telecommunication technology in the medical field helped diagnosis and treatment become easier for many people. This can helps patients regularly monitor their health and have timely treatment. Also, it leads to increase accessibility to healthcare providers, more efficient tasks and processes, and the improvement about quality of the healthcare services. Nevertheless it also has to face many challenges (e.g., physical storage issues, security and privacy, medical errors). Therefore cloud computing is introduced as a solution to address aforementioned issues. Cloud computing provides the convenience for users to help them access resources easily and quickly. Besides, it offers services on demand over the network to perform operation that meet changing needs in electronic healthcare applications.

III. ISSUES

A. Cloud Integration: Cloud storage is the most obvious use of cloud computing in mobile applications. Most devices have limited storage to hold applications, data, multimedia and operating system. The open questions that arise in this context are data transfer size optimization, and data persistence versus data availability .Data transfer size optimization refers to how much data to move in a single transfer. Ideally the data transfer strategy should also have a degree of parameterization to handle stepping up and down the chunk size relative to network bandwidth, since bandwidth is highly variable in mobile applications. Data availability is important for completing tasks in a currently running process. Data persistence refers to storing data in the cloud until it is needed again in future. There is obviously a trade-off between them which requires taking into consideration of network connectivity, bandwidth, device capacity and latency. Caching can be used, but the use of cache on distributed databases requires additional efforts such as cache validation coherency.

B. Trust, Security and Privacy: A never ending issue will always be security in cloud computing related to multi-tenancy, concurrency, scale and distribution. First, direct concerns arise from aspects such as lacking control over data and code distribution in distributed infrastructures, potential data loss. Second, indirect issues arise from providing virtually unlimited computational resources to perhaps untrustworthy entities.

C. Resource Allocation: The full potential of mobile cloud applications can only be unleashed, if computation and storage is offloaded into the cloud, but without hurting user interactivity, introducing latency or limiting application possibilities. The applications should benefit from the rich built-in sensors which open new doorways to more smart mobile applications. As the mobile environments change, the application has to shift computation between device and cloud without operation interruptions, considering many external and internal parameters.

IV. Related Work

In [1] "On networking and computing environments' integration: A novel mobile cloud resources provisioning approach" by Skoutas, D.N. , Skianis, C. A Mobile Cloud Resources Provisioning (MCRP) scheme, which is flexible enough to adapt to the various general MCC reference use cases being described. The main novelty feature of the employed MCC Service Admission Control algorithm lies in the fact that it jointly handles radio and computing resources rather than confronting the problem as two independent resource management sub-problems

In [2] "Optimal resource allocation for multimedia cloud in priority service scheme "by He, Yifeng; Guan, Ling employ the queuing model to optimize the resource allocation for multimedia cloud in priority service scheme**.** Specifically, formulate and solve the resource cost minimization problem and the service response time minimization problem respectively.

In [3] "Dynamic resource allocation for MMOGs in cloud computing environments" by Kuochen Wang an adaptive neural fuzzy inference system (ANFIS) and also an artificial neural network (ANN) to predict the load of each zone and decide a resource allocation policy to be performed by the VMS

In [4] "Optimization of Resource Provisioning Cost in Cloud Computing "by Bu-Sung Lee **,**Niyato, D. an optimal cloud resource provisioning (OCRP) algorithm is proposed by formulating a stochastic programming model. The OCRP algorithm can provision computing resources for being used in multiple provisioning stages as well as a long-term plan, e.g., four stages in a quarter plan and twelve stages in a yearly plan. The demand and price uncertainty is considered in OCRP. In this paper, different approaches to obtain the solution of the OCRP algorithm are considered including deterministic equivalent formulation, sample-average approximation, and Benders decomposition. Numerical studies are extensively performed in which the results clearly show that with the OCRP algorithm, cloud consumer can successfully minimize total cost of resource provisioning in cloud computing environments.

In [5] "Resource Allocation for Service Composition in Cloud-based Video Surveillance Platform "by H**assan,** M.M., Qurishi, M.A., Alghamdi, A. Utilization of computational resources is managed through accessing various services from Virtual Machine (VM) resources. A single service accessed from VMs running inside such a cloud platform may not cater the application demands of all surveillance users. Services require to be modeled as a value added composite service. In order to provide such a composite service to the customer, VM resources need to be utilized optimally so that QoS requirements are fulfilled. In order to optimize the VM resource allocation, we have used linear programming approach as well as heuristics.

V . Proposed Method

A Cloudlet: Resource poverty is a fundamental constraint that severely limits the class of applications that can be run on mobile devices. This constraint is not just a temporary limitation of current technology, but is intrinsic to mobility. mobile users seamlessly utilize nearby computers to obtain the resource benefits of cloud computing without incurring WAN delays and jitter. Rather than relying on a distant "cloud," a mobile user instantiates a "cloudlet" on nearby infrastructure and uses it via a wireless LAN. Crisp interactive response for immersive applications that augment human cognition is then much easier to achieve because of the proximity of the cloudlet.

B Hungarian Method: The Hungarian method is a combinatorial optimization algorithm that solves the assignment problem in polynomial time and which anticipated later primal-dual methods. Given n workers and tasks, and an $n \times n$ matrix containing the cost of assigning each worker to a task, find the cost minimizing assignment.

First the problem is written in the form of a matrix as given below

a1	a2	a3	a4
b1	b2	b3	b4
c1	c2	c3	c4
d1	d2	d3	d4

Where a, b, c and d are the workers who have to perform tasks 1, 2, 3 and 4. a1, a2, a3, a4 denote the penalties incurred when worker "a" does task 1, 2, 3, 4 respectively. The same holds true for the other symbols as well. The matrix is square, so each worker can perform only one task. Then we perform row operations on the matrix. To do this, the lowest of all a_i (i belonging to 1-4) is taken and is subtracted from each element in that row. This will lead to at least one zero in that row (We get multiple zeros when there are two equal elements which also happen to be the lowest in that row). This procedure is repeated for all rows. We now have a matrix with at least one zero per row. Now we try to assign tasks to agents such that each agent is doing only one task and the penalty incurred in each case is zero.

0	A2'	0'	A4'
b1'	B2'	B3'	0'
0'	C2'	C3'	C4'
d1'	0'	D3'	D4'

C Entropy Formula: The information

function allows us to compute the amount of information Often, it's more interesting to compute the amount of information contained in the complete distribution of signal states (for example, a database column of values). Multiplying the information scores for each signal state by a weighting term equal to the probability of the signal ($I_i = p(s_i) * \log(p(s_i))$).Summing these information scores ($H = \Sigma_{i:\,n} I_i$). Multiplying the result by -1 to make the overall value positive ($H = -1 * H$). Combining these operations into one formula produces the formula for computing the entropy (H) of a discrete random variable:

$H(P) = -\Sigma_{i:n}\, p(s_i) * \log(p(s_i))$

The entropy formula takes as input the probability distribution of the signals (denoted with a capital P) as the basis for computing an entropy score.

After subscribers sign up, information about their identity (telephone number) and what services they are allowed to access are stored in a "SIM record" in the Home Location Register (HLR).

Once the SIM card is loaded into the phone and the phone is powered on, it will search for the nearest mobile phone mast (also called a Base Transceiver Station/BTS) with the strongest signal in the operator's frequency band. If a mast can be successfully contacted, then there is said to be coverage in the area. The phone then identifies itself to the network through the control channel. Once this is successfully completed, the phone is said to be attached to the network.

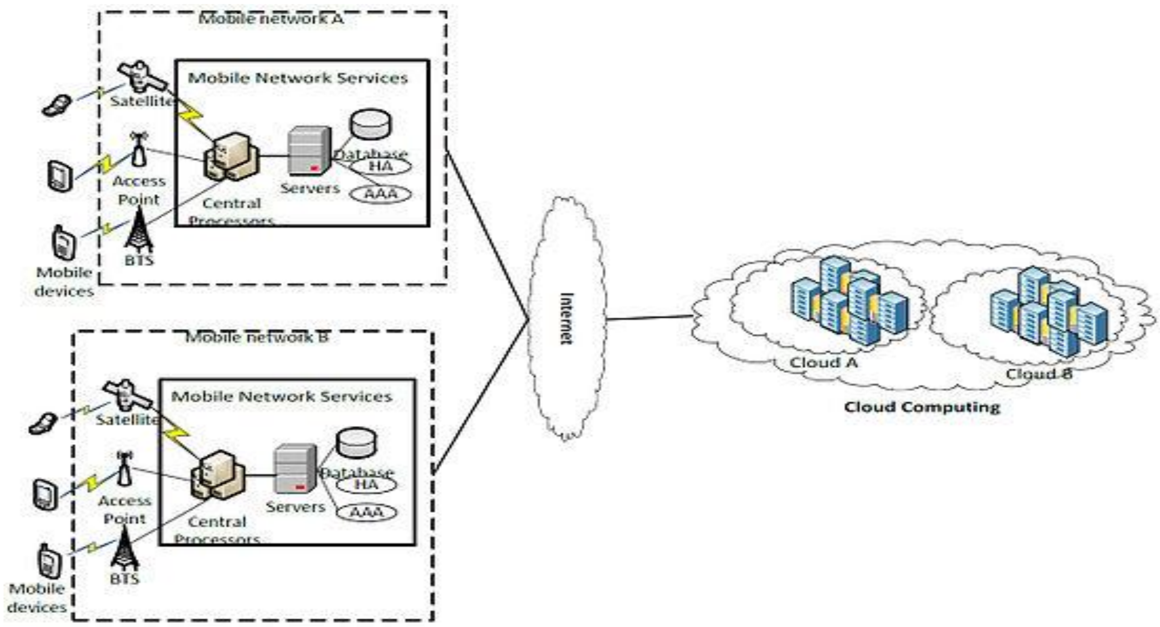

Fig1: Mobile cloud computing with base stations

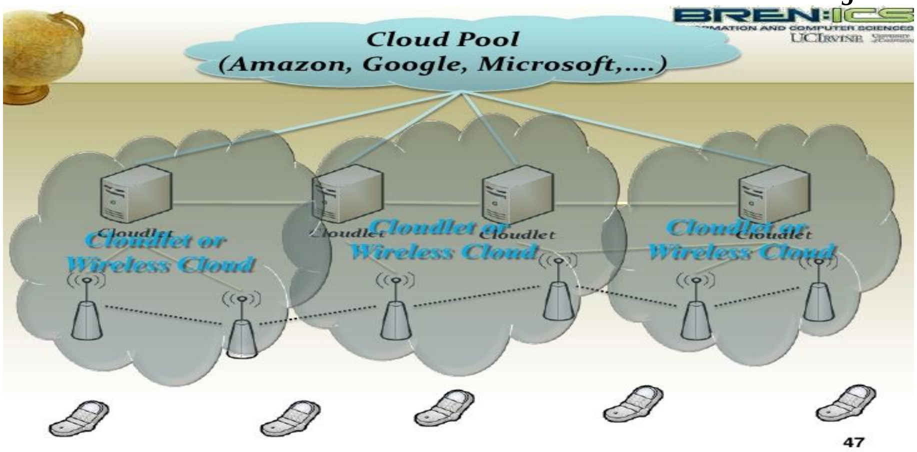

Fig2: Mobile network with cloudlets

The key feature of a mobile phone is the ability to receive and make calls in any area where coverage is available. This is generally called roaming from a customer perspective, but also called visiting when describing the underlying technical process. Each geographic area has a database called the Visitor Location Register (VLR), which contains details of all the mobiles currently in that area. Whenever a phone attaches, or visits, a new area, the *Visitor* Location Register must contact the *Home* Location Register to obtain the details for that phone. The current cellular location of the phone (i.e., which BTS it is at) is entered into the VLR record and will be used during a process called paging when the GSM network wishes to locate the mobile phone. Every SIM card contains a secret key, called the Ki, which is used to provide authentication and encryption services. This is useful to prevent theft of service, and also to prevent "over the air" snooping of a user's activity. The network does this by utilizing the Authentication Center and is accomplished without transmitting the key directly. Every GSM phone contains a unique identifier (different from the phone number), called the International Mobile Equipment Identity (IMEI). This can be found by dialing *#06#. When a phone contacts the network, its IMEI may be checked against the Equipment Identity Register to locate stolen phones and facilitate monitoring.

In mobile cloud computing there will be a number of cloudlets and base stations. Each mobile is associated to one specific base station. In MCC adjusting bandwidth and allocation resources is a major issue In order to overcome the problem we propose Entropy based Hungarian method to allocate resources to the mobile devices. Consider BS1,BS2….BSn are d n number of base stations in a cellular network.C1,C2,…..Cn be n number of cloudlets and M1,M2,….Mn be n number of mobile devices. Some devices will access the corresponding cloudlet and some of the devices will try to access the services in other cloudlets. This will lead to co channel interference .To avoid overload in the network we calculate entropy for all cloudlets with the number of mobile devices. For cloudlet 1, E (C1) =-(Mi/M) log2 (Mi/M) For cloudlet 2, E (C2) = - (Mi/M) log2 (Mi/M) Where Mi- Number of mobile devices trying t o access cloudlet1 M-Total number of mobile devices..Apply Hungarian method on the obtained values. Select minimum value from each row and each column.

TABLE 1
ROW REDUCED MATRIX

Cloudlets/base stations	B1	B2	B3
C1	25	40	35
C2	40	60	35
C3	20	40	25

TABLE II
COLUMN REDUCED MATRIX

Cloudlets/base stations	B1	B2	B3
C1	0	15	10
C2	5	25	0
C3	0	20	5

TABLE III
ALLOCATION TABLE

Cloudlets/base stations	B1	B2	B3
C1	X	**0**	10
C2	5	10	**0**
C3	**0**	5	5

Hence the devices in base station 1 will be allocated to cloudlet3, B2 to C2 and B3 to C3. The total cost is 40+35+20=95

Frequent Application Method: With the emergence of new applications the data we process are not static but the continuous dynamic data. Because the data come with high speed and are continuous and unbounded there are three challenges for data storage.

- First each application could be examined once.
- Second although the data are generated the memory space could be used is limited.
- Third the data should be delivered as fast as possible.

We cannot save all the applications and their related information in the memory due to the restriction of memory space. The user always tries to access applications from the cloud. In order to avoid that we will store frequently accessing applications in the cloudlets instead of storing all the applications in the cloudlet by calculating entropy for each application and will set some threshold value. If the entropy value is equal to or greater than the threshold value it will be considered as frequent application and stored in the memory. Whenever the user try to access infrequent application the cloudlet will retrieve the requested application from the main cloud so that the storage space can be saved and the accessing time can be saved.

VI. Conclusion

In this paper we have proposed the entropy based Hungarian method to allocate resources in mobile cloud computing to reduce overload and channel interference and frequent application method to save storage space. In future we can extend the proposed method to provide security also in different mobile devices.

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