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Research paper

Energy constrained max-min fair sharing resource allocation in mobile grid

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Abstract

In Mobile Grid Computing systems, the instinctive provisioning of services initially involves the discovery of mobile node. Resource allocation has been a great challenge for mobile grid environment. This paper presents an improved and efficient approach for optimized resource allocation. This Paper provides an energy efficient and effective solution to improve the efficiency of the grid. Proposed algorithm uses distance, bandwidth, CPU speed, and battery power as parameters. The detected power is applied to algorithm for a job scheduling algorithm. For the efficient resource allocation this paper is using a max-min algorithm with a job scheduling. These jobs are scheduled according to required power and available power. Using the described methods, the result shows power efficient and well maintained resource allocation for jobs sends to mobile grids.

Keywords: *Energy Dissipation; Job Scheduling; Battery Power; MAX-MIN Algorithm.*

1. Introduction

In last few decades, mobile devices have evolved as a primary and necessary device to perform extensive task and is getting used to store the significant amounts of data. Mobile computing main objective to access the service anytime and anywhere in addition to this grid devices can be exploited to harness the available ideal resources for improving the performance.

Majority of the recent grid infrastructure don't take mobile resources into account. In coming years, mobile grids will be purely prevalent, amalgamation of various types of mobile nodes is the necessity to pull out the resources and widen out the services collection. Mobile nodes are typically resource restricted: computing speed is low, battery limited, and keeping the data is limited to storage power. These constraints sluggish the application performance, and hamper operability. The mobile nodes in grid environment have two basic aspects: mobiles are used as the consumers of grid and resource providers. Owing to the constraints on process capability and energy of mobile devices, their amalgamation into the grid as suppliers of resource and not as consumers is somehow tough. To combine the mobile device into grid has three basic schemes. The word Grid symbolizes a scattered computing arrangement for deciphering innovative methodical and business complications. This is very different from surviving distributed computing systems, as it’s major focus is on sharing the bulky resources and inventive applications. This grid infrastructure and arrangement of resources can be seen as the marriage of different resources with various owners.

A foremost concern of this type of mobile grid configurations is the ordered task assignments and exploitation of underused nodes, normally mentioned as the load balancing problem. The task is distributed to the available resources by job allocator and tries to improve the quantified performance metric. [1 - 4].

1.1. Energy constrained optimized resource allocation in mobile grids

Optimized resource allocation in grids is a challenging problem where deadline and system heterogeneity has to take into the account. Scheduling of the jobs in mobile grid environment require a distributed algorithm with very robust architecture. It is essential to consider a cost effective pricing system, which will monitor the cost profit of mobile device owners to sanction complicated computational tasks to be executed on these devices. With restricted battery capability, energy management becomes the matter of concern. The heterogeneity of the nodes and jobs in various kind of computing structure is used to increase the performance up to the maximum level or the cost-effectiveness of the organization. The significant research area is to allocate the jobs to the available resources to improve the performance. This process is called resource allocation. Available resource allocation are allocated resources on few system. [8 - 10]

To provide a solution for resource management and making it energy efficient these papers detect some parameters and resources used for energy efficient. Then a suitable calculation is done for further process. Then the paper gives max-min algorithm and scheduled resource.

For providing better understanding this paper first gives a suitable introduction in section-one that is followed by a suitable earliest work’s description present in section two. Then the paper flows into problem definition and gives a best solution for the problem in section three. Then the paper gives a suitable conclusion in the last section.

1.2. Literature review

Li Chunlin et al. [11] have proposed an optimized resource allocation solution for energy constrained devices. Energy constrained optimize resource provisioning is framed as a functional optimization problem, that can be divided into two sub problems. Interaction between these two sub-problems is managed with the help of pricing variable. This paper suggests a price linked distributed energy constrained available resource allocation optimization procedure.
Abdul Aziz et al., [12] have proposed several heuristics for power constraints scheduling algorithm. This algorithm schedule the jobs with non-independent tasks on the computational grid. Proposed solution decreases the power intake by altering the status of the machines to hibernate or offline. The lowest cost has the advantage of the lowermost power consumption but it leads to the high response time.
Nikolaos D. Doulamis et al., [13] proposed fair scheduling algorithm and this is compared with other scheduling algorithms such as First Come First Served and Earliest Deadline First. Their proposed solution uses a max-min fair sharing method.

2. Problem identification

Singh A. [14] proposed an ant based resource discovery and mobility aware trust management. To begin with proposed algorithm, the super-grid nodes are designated in the network by swarm optimization based on various factors. Selected mobile nodes are employed in the node discovery process.
The architecture diagram clearly shows the job of mobile grid network step wise to provide energy efficient and scheduled resource allocation. The network first detects the parameters those are playing a vital role in energy detection of long range transmission parameters. Then in the second step the detected parameters converted into the right parameters so that this paper can apply max-min algorithm. Then max-min algorithm is applied and resources are scheduled for energy efficient sharing.
Here below architecture of the mobile grid network is given. There are a number of parameters required for jobs. The jobs are scheduled on grid application. The mobile connected with the stationary nodes. Following the architecture of network.

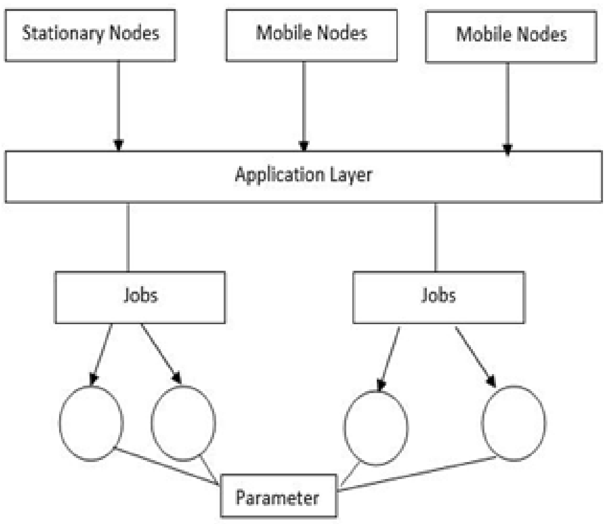

Fig. 1: Mobile Grid Architecture.

2.1. Estimation of parameters

The proposed architecture in figure 1 shows that a task which is produced by a mobile or stationary node will be received by application layer, which will divide the job further into smaller parts. Application layer assign these task to other nodes based on the mobility parameters.

2.2. Estimation of residual battery power

The battery power disbursed by the mobile node (Pc (t)) is determined after time t as given below-

$$\mathrm{Pc(t) = DPtx * c1 + DPrx * c2} \tag{1}$$

Where DPtx = Number of packets send by the mobile node after time t.
DPrx = After time t the number of data packets received by the mobile.
c1 and c2 are constant and their values varied between (0,1).
The residual battery power of a mobile node at a time t can be calculated with initial battery power (Pi) as:

$$\mathrm{p_{res} = Pi - Pc(t)} \tag{2}$$

2.1. Mobility calculation

Average Mobility can be calculated as below-

$$\text{Average Node Mobility=M1 – M2} \tag{3}$$

Where M1 and M2 are the first and second history respectively.

3. Proposed solution

In this step the paper suggests a scheme for fair scheduling, and compares it with various other scheduling algorithms such as the Earliest Deadline First (EDF) and the First Come First Serve schemes. Proposed scheme make the use of max-min fair allocation method for providing rational access to end users.
In case of sufficient available resources, proposed algorithm assigns enough computational processing power to each task to complete it within specified time period. In case if node is overwhelmed with task, idea here to honestly shrink the processing power sharing rates allocated to the jobs. The weight on each user might be expressed as the end user involvement to the organization or the dues he is ready to pay for services. In this algorithm, all tasks which have lower requirements than their share processing power rate are aided at their required CPU rates.
The processing rates of the tasks who has superior requirements than their rational stake CPU cycle rates are condensed to apt the total existing computational size in a rational fashion. Author adopted three different kind of fair scheduling methods. The first one is Simple Fair Task Order, in which task are schedules according to their respective fair completion time. Second is Adjusted Fair Task Order, which improves the previous strategy by adjusting fair completion time. And the third one is Max-Min Fair Share scheduling policy.
Paper present fair scheduling approach that obtains a fair task queuing order and processor assignment. Main goal in this algorithm is to assign a suitable rate
r_s^i to every task so that it is approximately close to its fair task rate r^i which is calculated by using max-min x_i fair sharing algorithm on the asked rate x_i.
The schedulable rates r_s^i are lower or identical to the job fair rates $r_s^i \le r^i$ they are preferred so as not to disrupt the CPU capacity. This is shown in the below constrained minimization problem:

$$\min(E) = \min \sum_{i-1}^{N} [r_i^s - r_i] \tag{4}$$

Subjected to

$$\sum_{pj}^{i} r_i^s \le C_j \text{ Where } p_j = \{i\text{: Ti scheduled on processor j}\} \tag{5}$$

The set $p_j$comprises all tasks reserved for processor j. The compete deviation E of the planned rates from the fair rates will be denoted as the scheduler error. The basic idea of the proposed approach is to implement an initial processor assignment and then properly reschedule the under flowed processors with the overflowed processors to explore the better processor capacity.

More iteration takes place in full algorithm implementation. Proposed approach allocate tasks to the existing processors so that their authentic rates are reserved as approximate to as their respective original fair rates. Still it does not provide any guarantee that a reasonable and practical solution is found, that means it does not provide any assurance that all the tasks are allocated to the offered processors deprived of any desecration of the individual deadlines. For overflowed processors rate reduction is required to achieve the feasible solution.

3.1. CPU Arrangement

To work well for the previous discussed scheme, it is essential to start with tuned CPU assignment. Bin packing problem is proposed a scheme similar to the heuristic algorithm. The algorithm first sorts the tasks with respect fair rates in a sliding order. The main objective is to shrink the energy depletion, increase the utility of application limited battery energy charge and certifying the targets of the grid submissions.
The QoS in mobile grid structure, of all applications hosted and running on mobile nodes must be well-ordered, so that they should not waste resources of the mobile device on the grid, which contain battery energy, memory and capacity of processor.
Proposed scheme reflects energy controlled resource provision optimization. It is presumed that the mobile grid system entails of various grids spots which cover mobile devices and stationery devices participating in grid. M mobile devices are connected to grid via a wireless sensor network. This set M have n number of mobile devices, marked as mi, mi+1… mn (where i =1 to n).
Let us assume, node m has a set of applications Ai (i=1 to n) and set of resources Rj (where j=1 to n) and available capacity Ck (where k=1 to n). A node assess its energy consumption rate er_i for completing the task of application set Ai (where i=1 to n), while energy consumption remains Ci .
Mobile device enforces the limitation as given below:

$$er_i t_i \le c_i \quad (6)$$

e_i^n is energy intemperance of nth job.

$$\text{Here } e_i^n = {p_{res}}/{t} \quad (7)$$

If t is taken as single unit case then,

$$e_i^s = p_{res} \quad (8)$$

The term p_{res} is determined in the equation (1).
j is used to signify the collections of all the jobs produced by application i,

$$j_i = \{j_i^1, j_i^2, j_i^3, j_i^4 \dots\dots..j_i^n\} \quad (9)$$

Each grid job can be described as –

$$j_i^n = (t_i^n, e_i^n) \quad (10)$$

t_i^n is time taken by the ith application to finish the nth task.
e_i^n is the energy dissipation of n^{th} job.
Due to non-dependency of jobs on each other, submission order will not make any significant impact on execution result. The client's application set is denoted as –

$$A \le \{A1, A2, A3 \dots\dots Ak\}, \text{ for } 1 \le k \le N \quad (11)$$

Let e_i^n is the energy intemperance triggered by application's nth job, t_i^n is the execution time of the grid application i on the grid device.
The energy intemperance of application i's nth job may be describing as below:

$$e_i^n \in er * t_i^n \quad (12)$$

In Heterogeneous nodes the energy utilization of the mobile device may vary with response time of the grid application and network's bandwidth. All grid applications consumes the energy

$$\sum_{i=1}^{l} e_i^l \quad (13)$$

This does not surpass the total capacity of the energy. So below resource consumption checks needs to be validate:

$$\sum_{i=1}^{l} e_i^l \le C_{eI} \quad (14)$$

We define the energy consumption of each application Aᵢ as the sum of the energy consumed by N grid jobs.
The energy consumption of all grid jobs of each application A should be less than the available resources of e_i^l.

4. Simulation results

NS2 is used for implementation of proposed work. Fig.2. gives an idea about a sample network topology used in the simulation. In this simulation, 30 grid nodes are organized in a 1000 mt. x 1000 mt. area for 50 seconds simulation time. Out of total 30 grid nodes, 20 nodes behaved as mobile grid nodes (in blue color in figure 2) and 10 nodes are behaved as the super grid nodes (in red color in figure 2). It is assumed that each node is moved independently with same average speed i.e. 2m/s. 250 meter is the transmission range of all the nodes. Service Location Protocol is used for discovery of the desired services.

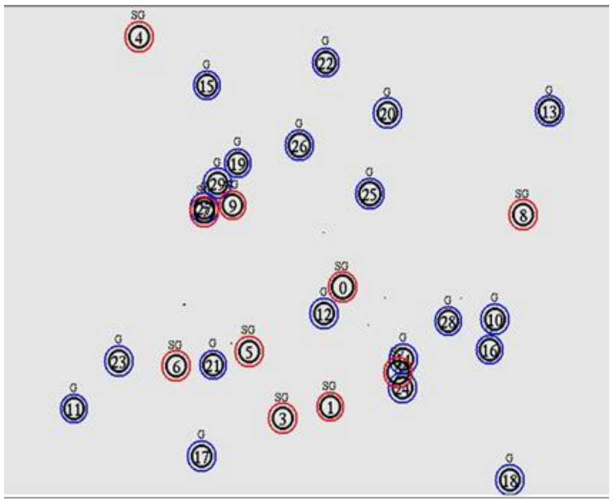

Fig. 2: Simulation Topology.

Simulation setting and parameters are given in table 1.

Table 1: Simulation Parameters

Grid Nodes	20
Super Grid Nodes	10
Area Size (Meter)	1000 X 1000
Mac Protocol	802.11
Radio Range	250 meter
Simulation Time	50 second
Service Discovery Protocol	SLP
Server Application	SLPSA
Client Application	SLPUA
Speed	2 meter/second
clients	4
Requested Load	10kb to 50kb
No. of Flows	1,2,3,4 and 5.

We compare our Energy Constrained Max-min Fair Sharing and Resource Allocation (EMMFSRA) technique with EDF technique [13]. We evaluate mainly the performance according to the following metrics.

Average Delay: is measured as the average delay followed by each client while getting the requested service.

Packet Delivery Ratio: is the ratio of number of the devices for the successful data transmission.

a) Based on load

In first experiment, vary the load of the clients as 10 to 50 kb with speed as 2m/s.

Fig. 3. gives an idea of the delay of EMMFSRA and EDF techniques. Delay of the proposed algorithm is 54% less than the EDF.

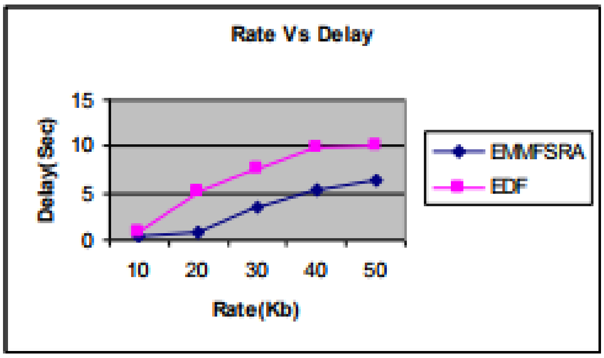

Fig. 3: Rate vs. Delay.

Fig.4. discuss the delivery ratio of EMMFSRA and EDF. Delivery ratio of EMMFSRA is 25% better than EDF.

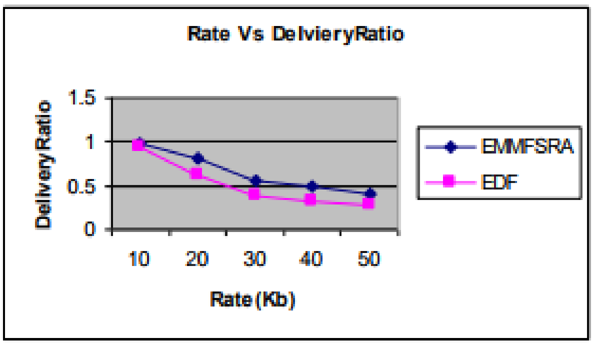

Fig. 4: Rate vs. Delivery Ratio.

Fig.5. demonstration the fairness of EMMFSRA and EDF techniques which is 18% better than EDF.

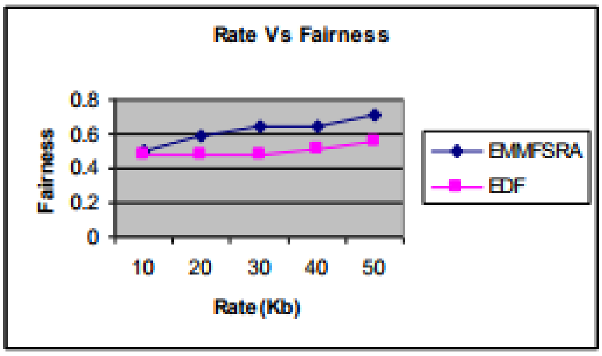

Fig. 5: Rate vs. Fairness.

Fig. 6 .shows the bandwidth of EMMFSRA and EDF techniques. EMMFSRA is 18% of higher than EDF

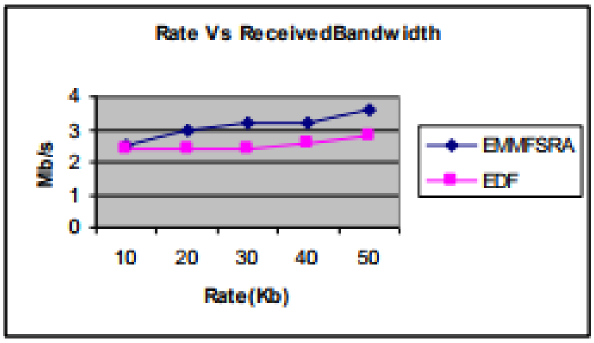

Fig. 6: Rate vs. Received Bandwidth.

Fig.7. shows the energy consumption of EMMFSRA and EDF. EMMFSRA approach has 16% less energy consumption than EDF approach.

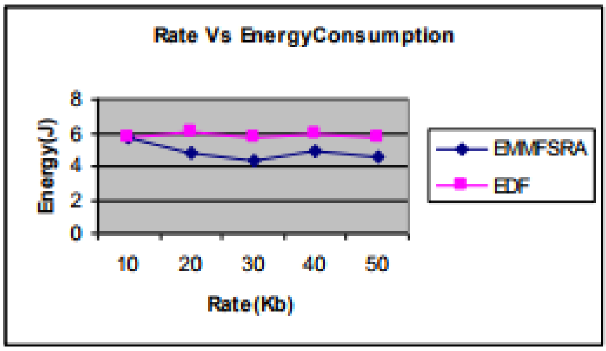

Fig. 7: Rate vs. Energy Consumption.

b) Based on Flows with different number of flow scenarios

In second test we fluctuate the number of flows as 1,2,3,4 and 5.

Fig. 8. shows the delay of EMMFSRA and EDF techniques. Proposed EMMFSRA approach has 40% less delay than EDF.

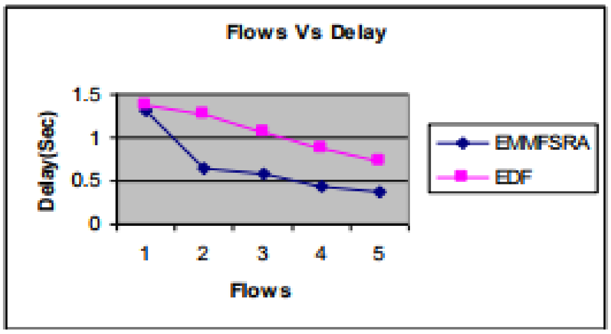

Fig. 8: Flow vs. Delay.

Fig. 9. shows the delivery ratio of EMMFSRA and EDF. Delivery ratio of EMMFSRA is 2% higher than EDF.

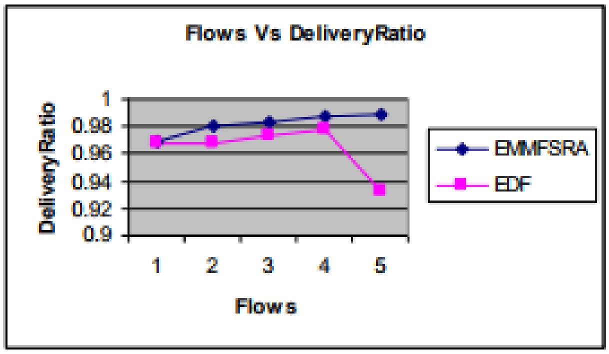

Fig. 9: Flow vs. Delay Ratio.

Fig. 10. shows the fairness of EMMFSRA and EDF. The fairness of EMMFSRA has 2% higher than EDF.

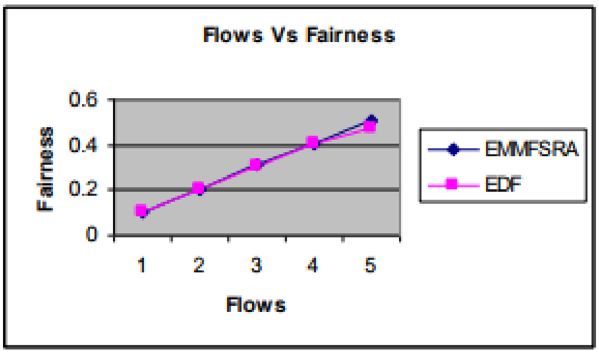

Fig. 10: Flow vs. Fairness.

Fig.11. shows the received bandwidth of EMMFSRA and EDF. The received bandwidth of EMMFSRA approach has 2% of higher than EDF approach.

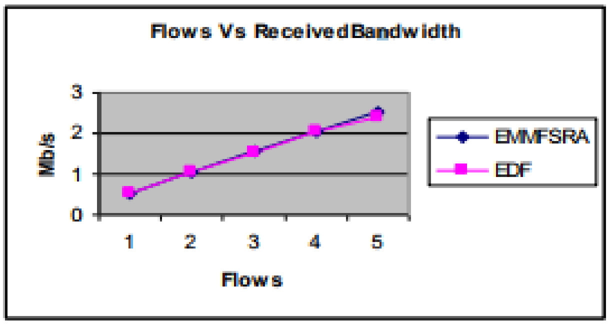

Fig. 11: Flow vs. Received Bandwidth.

Fig. 12 shows the energy consumption of EMMFSRA and EDF. Energy consumption of EMMFSRA approach has 3% less than EDF.

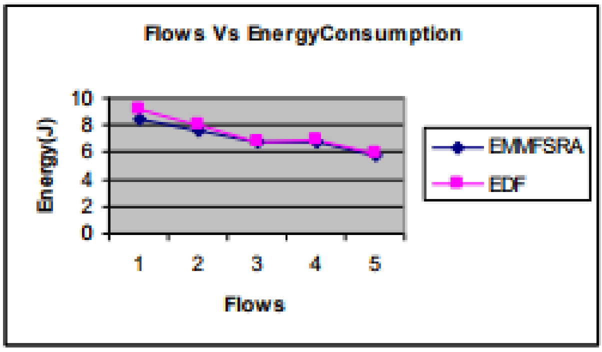

Fig. 12: Flow vs. Energy Consumption.

5. Conclusions

This paper describes about the min max algorithm applied in the resource allocation and the resources are scheduled for mobile grids. The proposed method takes place with all the three steps. Proposed solution improve the Singh A.14] in the terms of energy efficient and a well maintained procedure. The response time is reduced to a lower amount. This proposed method doesn't do any modification to the existing hardware. There is no network alternation needed for this method. This paper suggests using fewer complexes and more energy efficient algorithm in the future. The above proposed method can be advanced caching theory in the future.

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