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A Hybrid Solution for Resource Discovery Problem in Grid Networks

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Abstract - Resource discovery involves finding and retrieving resources that are relevant to the user of the system. All existing intrusive methods to discover available resources have increased number of control messages, which increases message complexity and high maintainability. Our method, overcomes this problem.The method used is a hybrid of both intrusive and non-intrusive methods .First, the Passive Resource Characterization (PRC) paradigm is used for identifying the utilization of the nodes .The PRC algorithm , uses k-means clustering algorithm to passively distinguish between available and unavailable resources. This method is used as an enhancement to the existing intrusive method to fully characterize the network resources. Dedicated Resource Evaluator (DRE) is a hybrid node containing the PRC algorithm and the Name-Dropper Algorithm. DRE passively extracts the resource information from each node on the grid produced by the PRC algorithm. All the data analyzed are updated in the Resource Availability Table (RAT), only the under utilized nodes are computed and listed. DRE is queried whenever grid requires resources and the under utilized resources on the grid are made available to the requesting node by using the Name-Dropper algorithm. This approach reduces message traffic on the network, message complexity and also accurately determines the state of the resources.

Index Terms – Grid Computing, Intrusive Method, Non-intrusive Method, PRC, Resource Discovery.

1 INTRODUCTION

Resource Discovery is of great importance, as its needed paramountly in many distributed computing envi- ronments such as web, distributed file sharing systems and in grid [1]. Grid computing involves utilization of resources from multiple administrative domains to reach common goal. In a grid, different operating systems, different administrative domains, lack of portability between platform dependent applications make resource discovery more difficult. So, appropriate resource discovery mechanism is an important aspect of Grid Computing [2]. Resource discovery algorithms need to be efficient in terms of time and network communication. That is, machines should learn about each other quickly, without using large amount of communication. There are many methods to discover the resources. All of intrusive methods involve algorithms whose message complexity depends directly on the number of nodes in the network. These solutions also require client/server type software to be installed on each node in the network. These method increases the complexity of messages, as there are more number of messages to be transferred between the nodes [3].

This paper deals with the hybrid model that combines both intrusive and non-intrusive method to efficiently discover resources. A hybrid node namely, DRE consist of the hybrid method. It combines both PRC and the Name-Dropper algorithm. DRE is placed on the mirror part of the local cluster grid. Each time a node enters into the grid all its static information are documented. The resource information from the network traffic is produced by each node on the grid by using the PRC algorithm. The PRC algorithm extracts the signatures, to identify the sending node utilization from the network traffic. Using the k-means clustering the available and unavailable resources are clustered. All the available nodes are continuously updated in the Resource Availability Table. The DRE is queried when the grid nodes require grid resource .The under utilized resources on the grid are made available to the requesting node by using the Name-Dropper algorithm.

The organization of paper is as follows. Section 2 discusses the related work. The existing method is discussed in section 3. Section 4 explains about the proposed methodology which is the hybrid model. Section 5 presents the simulation results of the hybrid methodology. Finally, Section 6 concludes the paper.

2 RELATED WORK

For the resource discovery problem different algorithms are being used. All these intrusive methods involve with large message complexity [3].The Flooding algorithm is used by Internet routers today [4]. Flooding algorithm assigns to each node a fixed set of neighboring nodes .Each node contacts and updates informations only to their set of neighboring nodes [6]. The flooding algorithm could be very slow if an initial graph that has small diameter is not selected for the start [5].The Swamping algorithm is identical to the flooding algorithm except that each node may have open connections with all their neighbors and does not have a fixed set [6]. The disadvantage of the swamping algorithm is that complexity of this algorithm grows very quickly [5]. In Name-dropper algorithm, during each round, each node picks a neighbour ran-

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domly and passes the neighbour all its known informations. With this algorithm the nodes can learn about one another in O(log2 n) time, O(n log2 n) message complexity, and O(n2 log2 n) pointer complexity, all with high probability [7].

To reduce the number of messages, a variation of flooding called teeming is used. With teeming, a node propagates the inquiring message to each of its neighbour with a fixed probability.[8]. Distinctive awareness is introduced in [9]. In this algorithm, the nodes with distinct attributes are more significant and thus their status information gets propagated accordingly. To implement this algorithm, the concept of Grid Potential is used to encapsulate the relative processing capabilities of different nodes and networks that constitute the grid and only data corresponding to nodes with the highest grid potential gets disseminated [6].

The hybrid method of resource discovery detailed in this paper eliminates high network traffic and message complexity as there is no need to continuously probe resources for dynamic information such as memory utilization.

3 Existing Methodology

The existing methodology consists of the passive method. This passive method provides the ability to distinguish between available and unavailable nodes non-intrusively. The PRC method is used for resource discovery.

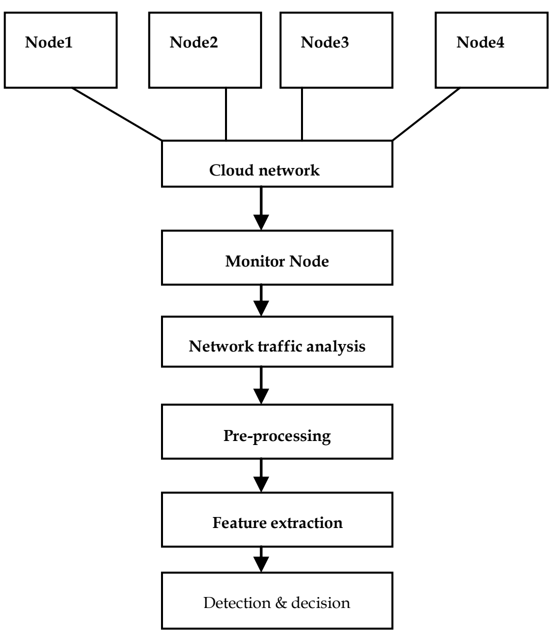

Fig. 1 Passive Resource Characterization algorithm.

3.1 PRC Algorithm

The Fig.1 shows the flow of the PRC algorithm. It consist of 4 steps,

- Network Traffic Analysis.
- Pre-processing.
- Feature Extraction.
- Detection and Decision.

3.2.1 Network Traffic Analysis

The network packets generated by the nodes in the network is captured by using the tcpdump application. The network traffic behaviour is captured numerically by building a time series for the node. A matrix of time series is generated for a network of nodes. The timestamp from each packet i that departs from the Network Interface Card (NIC) of each sending node n is used to generate a matrix of time series Tni.The time series contains a latent signature whose delay magnitude is relative to the utilization of the sending node. To obtain the signature additional refinement is done.

$$Tni = \begin{array}{ccccc} x_{11} & x_{12} & x_{13} & \ldots\ \ldots & x_{1n} \\ X_{21} & & & & \\ X_{31} & & & . & . \\ . & & & . & . \\ . & & & . & . \\ X_{n1} & & & \ldots\ \ldots & Tni \end{array} \quad (1)$$

3.2.2 Preprocessing

The preprocessing step is used for mapping the time series into some other domain. The IPS is the delay between each packet in the time series. The interpacket spacing of the time series IPSni (2) were n is the node number and i is the number of packets is calculated to infer the relationship between network traffic emitted by a node in the network and the utilization of the CPU.

$$IPSni = \begin{array}{ccccc} T_{12} - T_{11} & T_{13}-T_{12} & T_{14}-T_{13} & \ldots\ \ldots & T_{1i+1}-T_{li} \\ T_{22}- T_{21} & & & & \\ T_{32}- T_{31} & & & . & . \\ . & & & . & . \\ . & & & . & . \\ T_{n2}- T_{n1} & & & \ldots\ \ldots & T_{ni+1}-T_{ni} \end{array} \quad (2)$$

Inorder to remove larger delays in network traffic the unsupervised k-means clustering algorithm is used. Delays such as handshaking, congestion avoidance and slowstart are removed. All events having similar feartures are grouped using k-means clustering algorithm. The number of clusters is defined (k) in the k-means algorithm. The centroids are calculated by dividing the elements into k clusters and calculating the average of all the points in the cluster. The euclidean distance to the centroid is calculated for all the elements. The elements closer to the centroids are moved to it. Centroids are recalculated and again all the elements are visited and the elements closer to it are moved.This process repeats until there is no change in centroids.This algorithm has a running time of O(k.p .t) where k is the number of clusters chosen, p is the number of packets, and t is the number of iterations required for the algorithm to converge[3]. The number of iterations is less than the number of elements [16]. Thus the large delays are separated from the small delays. The lower delays corre-

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spond to the data delivery events. They are passed to the Feature Extraction stage.

3.2.3 Feature Extraction

The mean of the IPS, Avg IPSni is calculated in the feature extraction step. The overall delay strength of the time series is obtained.Lower average IPS indicates that the node has greater sender rate and higher average IPS indicates that the node has lower data send rate.

3.2.4 Detection&Decision

To separate the utilized and unutilized nodes ,a simple threshold on the energy value is used to decide along with the PRC algorithm.This threshold energy value is derived by initial calibrations on over utilized resources.This method when compared to other intrusive methods has very small message complexity . This analysis reveals that the different memory sizes are somewhat separable and future analysis is required.

4 Hybrid Method

The hybrid method consists of both the intrusive and non-intrusive method to resolve the resource discovery problem.The PRC algorithm can be used to enhance existing intrusive resource discovery.

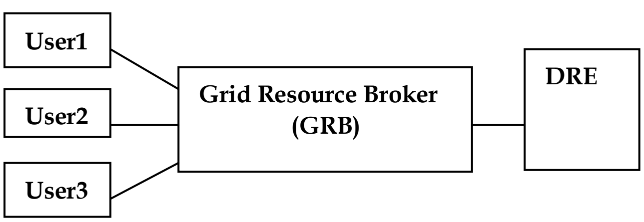

Fig. 2 Architecture of Hybrid Resource Discovery

Fig.2 shows the block diagram of the hybrid method. The user in the grid network when in need of the resources sends request to the Grid Resource Broker (GRB). The GRB forwards the request to the Dedicated Resource Evaluator (DRE). It is a node that works based on both the PRC algorithm and the Name-Dropper algorithm. DRE is placed on the mirror port of a switch connected to a local Cluster Grid. There are two tables maintained in the DRE namely Static Resource Information (STI) and the Resource Availability Table (RAT).

TABLE 1
Sample Resource Availabilty Table

Under Utilized Resources	Available Memory in the Under Utilized Resources
R1	64MB
R3	128MB
R4	192MB
R5	96MB
R8	128MB
R11	192MB
R12	64MB

Whenever a new node is connected to the grid network the STI is updated with all static informations such as operating system, CPU speed, CPU disk space, number of CPUs, etc. This static resource information is documented only once. The DRE passively extracts the network information using the PRC algorithm for each node in the grid. As data is analyzed, RAT is be continuously computed and updated. Only the available nodes are listed in the Resource Availability Table. The sample Table 1, list the under utilized resources, along with the available memory that were processed by the PRC algorithm. The DRE is queried when the Grid nodes require grid resource. DRE checks with the RAT to discover the available resource in accordance to the request.The under utilized resources on the grid are made available to the requesting node by using the Name-Dropper algorithm.

5 Simulation Results

The network has been simulated with 50 computers to compute 500 jobs, using Gridsim simulator. Resource discovery has been performed using both the intrusive method and the hbrid method; which includes both the passive solution and intrusive method. The performance comparison has beed based on the resource discovery time, total time taken to complete all the tasks.

The relation between the number of messages and the number of jobs (Gridlets) is shown in the figure 3. From the figure we can actually see that the number of messages is directly influenced by the number of processes and the number of Gridlets currently being executed in the node.

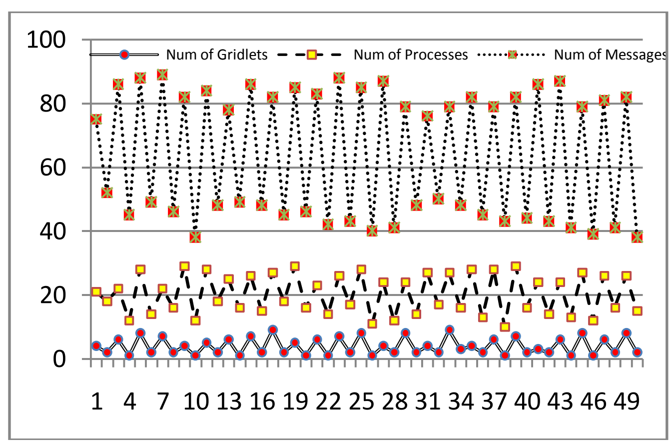

Fig. 3 Comparission of Number of 'Messages sent by the node, 'Number of processes running in the node and 'Number of Gridlets' that ate being executed in the node when a request is made.

In the above figure each alternative node is allocated with more number of processes which makes it unavailable for further allocation, whereas the other set of alternative nodes are allocated with fewer processes which will not affect the avaialability of the node. From figure 3 it is clear that when the nodes are executing more number of processes, they tend to communicate more, and thus generate more messages. By implementing this technique, we can know which all the un-

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avaialable nodes are by just monitoring the number messages sent by them. Thus the nodes can be clustered based on the number of messages sent by the nodes. A pictorial representation of the clustering process is shown in the figure 4. The nodes that are sending more messages and fewer messages through the network are clustered separately. The cluster shown in black rectangle is unavailable nodes and the other is the nodes that may be available. These nodes clustered with red rectangle are the nodes that are the result of passive solution.

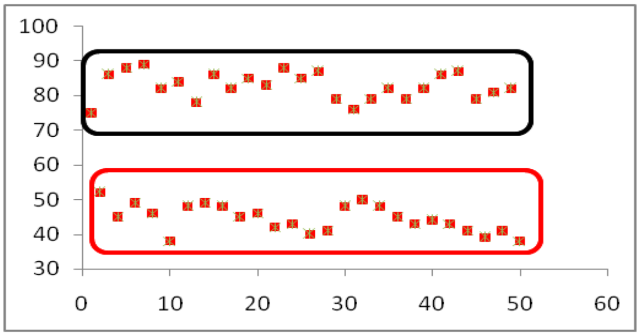

Fig. 4 Nodes that are clustered based on the number of messages it has sent. The black cluster represents the unavailable nodes.

The passive solution provides a subset of nodes which does not contain any busy nodes. The resultant subset of passive solution does are the nodes that may be free for allocating new tasks, which are clustered based on the messages they send through the network. From this partial solution the nodes that are actually available and are ready to be allocated with new task is found using intrusive method.

A hybrid of passive and intrusive method for identifying the actually available nodes reduces the time taken for resource discovery. It also affects the number of messages sent in the network for resource discovery purpose itself, which is shown in the figure 5. It compares the percentage of messages sent for resource discovery against the total number of messages. In hybrid method the percentage of messages for resource discovery is around 50% while it is around 70% for pure intrusive method. Thus the resource discovery techniques itself uses most of the bandwidth of the network; it can be reduced by implementing the hybrid method.

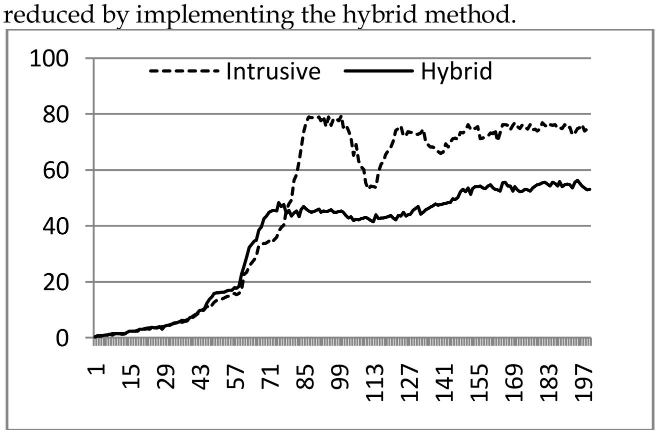

Fig. 5 Percentage of messages sent for resource discovery (vs) total messages sent by the node.

The time taken for discovering available resources reduces when hybrid method is implemented. The comparission for time taken to identify resources is shown in figure 6 for 200 gridlets.

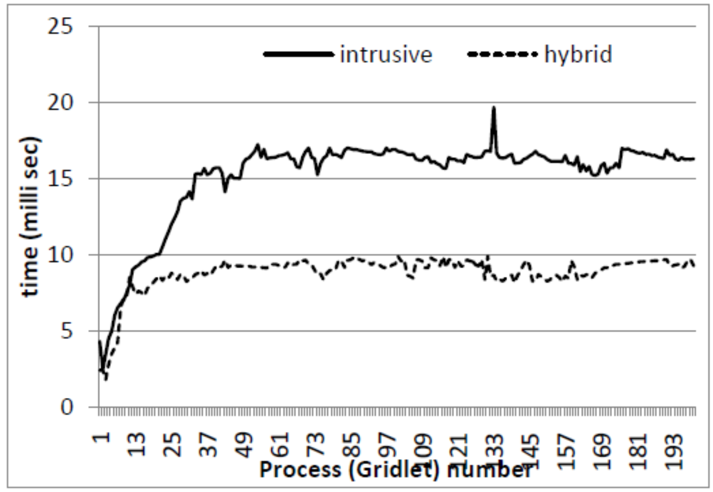

Fig. 6 Comparission of time taken to identify nodes for resource allocation by intrusive and hybrid method.

From figure 6 it is clear that the time taken for resource discovery reduces when hybrid method is implemented. Thus the processes start to execute quicker and the time taken to complete all the processes in the grid reduces.

6 CONCLUSION

In this paper a hybrid method for resource discovery is suggested. The hybrid method uses both the intrusive and a passive solution to check node availability. By using this me-thod the network traffic and the message complexity is de-creased as the need of sending messages to the nodes to ascer-tain its CPU availability is reduced. The passive solution works based on the number of messages transferred by the nodes to the network. This method monitors the messages in the network and clusters the nodes based on the messages it is sending to the network. The resultant cluster of nodes given by the passive solution is a set of nodes that may be available in for resource allocation, but it does not guarantee the node to be available, hence it is a passive solution. The results of pas-sive solution are updated to a Resource Availability Table (RAT) periodically. After identifying the nodes by passive solution we use intrusive method to assertain the availability of a node before allocating a process to the identified node. In this me-thod the number of messages exclusively sent for re-source discovery is reduces to around 20% and the time taken for resource discovery is also reduced to a great extent.

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