INTERNATIONAL JOURNAL OF TECHNOLOGY AND COMPUTING (IJTC)
ISSN-2455-099X,
Volume 2, Issue 3 March 2016.

Multiple Parameter Based Resource Allocation Algorithm in Cloud Computing through Auctioneer

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A B S T R A C T

Cloud computing is a model that is dynamically, delivered the software applications and hardware infrastructure as the services on the internet to the Cloud users. Clouds provide the services such as virtual servers, storage, application development, design, and testing and these services can access by multiple users at anytime and anywhere. Some time multiple clients send their requests simultaneously for the same resource therefore, it also faces some problems like scarcity of resources, security, fault tolerance and resource allocation. The optimal resource allocation and resource management is must to avoid these kinds of problems. Numbers of authors have proposed their techniques for resource allocation, from these some are market based resource allocation technique. The proposed algorithm is on the basis of Auction based techniques. In this paper, number of users can send their request for the different resources with multiple parameters. Seller and buyer has different point of view, customer wants to buy the resource with less price and seller wants to sell their resources with profit so, some techniques are based on the user point of view and some are based on the seller point of view, but the proposed technique beneficial for both because here providers and users send their bids and requirements to the auctioneer. This method dynamically calculates the price, gave the discount to the users on basis of time, and penalize to defaulter provider. Experimental result of this shows it also reduces the SLA violation, VM migration, and Execution time.

Keywords: Cloud Computing, Resource Management, Resource Management, Auction.

I. INTRODUCTION

Cloud computing is combination of earlier technologies like grid, distributed computing, utility computing, and Virtualization. It is a model that is dynamically delivered software application and hardware infrastructure as services on the internet. Consumers can pay for these services but they pay according to use mean to say the payment is paid by using pay-as-you-use model. This feature made it most cost effective. It is mostly used in business, due to its cost effectiveness and distributed features. It is cheaper to use, to maintain, and to upgrade. Number of autonomous users from number of different places can communicate, share their information and operations, hardware and software infrastructure, and storage also due to its distributed nature. Service Level Agreement (SLA) and Quality of Services (QoS) are main component of cloud computing. SLA is used by consumer for negotiation between user and service provider and QoS is helpful to making cloud services acceptable to end users. It also contains deadline, budget, file size, penalty rate ratio and requested length.

Deadline is the maximum time in which users wait for results. Budget is the total amount of user's that he wants to pay for the resources. Penalty Rate Ratio is a ratio of compensation for users if the deadline is missing by SaaS provider. Input File Size is the size of input file that is provided by consumer. Request Length is the Millions of Instructions (MI) necessary to complete the request [1]. The National Institute of Standards and Technology (NIST) defines cloud computing as " cloud computing a model for permitting convenient, on-demand network access to a shared pool of defendable computing resources (e.g. network, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. [2]

Service Model of Cloud Computing

There are three types of service model of Cloud Computing, as name Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS).

- **Infrastructure-as-a-Service (IaaS)**

IaaS is a Layer that delivered virtual computer infrastructures of computer to consumers, according to their demands. It offers operating system, storage, computer network, internet connectivity etc via internet as services. Clients specified their requirements on Service label Agreement (SLA) and pay for resources as pay per use. Iaas provider maintain only platform and software configuration like operating system, applications and network all under control of user. Iaas provider offered an unmanaged services, so customer design and run own operating system plus applications. It is more secure because resource are dedicate to a single client not allow to sharing with other customer. Amazon EC2,GoGrid and Flexiscale[4] are example of Iaas providers.[2][3][4]

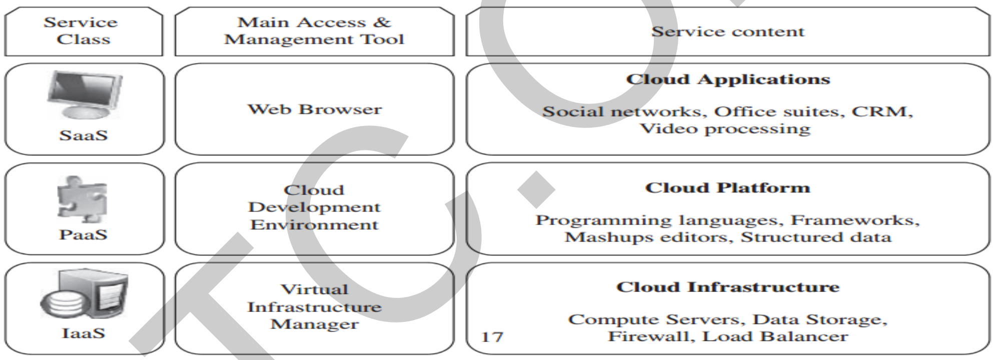

Fig. 1: Service Model of Clouding Computing [3]

- **Platform-as-a-Service (Paas)**

A platform is required to run application and Paas provider provide platform as a service to the developers on the internet. Paas offer to clients' tools, application programming interface, protocols, operating system and storage. It is also once another unmanaged cloud service so that user set it according to his/her use. Developers create and deploy their applications in given environment without any care which operating is used, how many processors are required and how much memory used, they only aware about the programming language that is required to create an application. They are not able to create a specific operating system as developer of Infrastructure-as-a-Service (Iaas); this is main difference between IaaS and PaaS. Google App Engine, Microsoft Windows Azure and force.com and cloud 9 Analytics examples of IaaS.[4][2][3]

- **Software-as-a-Service (SaaS)**

Saas is also known as online delivery of software. In this model applications are available in form of network based services, can be accessed by users on the internet by web browser, without need of any license. Applications are developed, managed hosted and sold by SaaS provider, so customers does not have need to install or maintain any software. It provides fully managed service. Users pay on bases of usages. Security is major issue in SaaS. Google Maps, salesforce.com, Netsuite and Oracle CRM etc are examples of SaaS provider.

Resource Allocation

Resource Allocation (RA) is a process of allocating the existing resources to the needed cloud applications, in the Cloud computing, over the internet. In cloud computing Resource allocation is one of the most challenging issues because limited resources are distributed in unlimited users. From a customer perspective resource allocation link with how services are spread in users. The main advantage of resource allocation is that user has not need to install any new software or hardware to access the cloud applications, to build up the application and to host the application on the internet. So, now place and medium are not restraint to access the different kind of data at different place on different system. Users can achieve their applications and data anywhere in the world, on any type of system. Cloud providers can distribute their resources over the internet during the scarcity of resource [5]. Cloud provider has considered four different modes to hiring the computing capacities: [5]

- **Advance Reservation (AR):** Resources are booked in advance for a specific time and they should be accessible at a specific time.
- **Best-effort:** Requests for the resources by the users are placed in a queue and resources are provisioned as soon as possible.
- **Immediate:** When a consumer submits their demand for the resources, the cloud provider provisioned resources immediately and some time the request is rejected that is based on the availabilities of the resources.
- **Deadline sensitive:** Believed that resource allocation to be preemptible but there is a limitation to their preemptability. It is pre-emptible only if the scheduling algorithm of Haizea can assure that it can be completed before its deadline [5].

II. LITRATURE SURVEY

T. R. Gopalkrishnan Nair and Vaidehi M [6] offered a model, named as Ruled Based Resource Allocation Model (RBRAM) which deals with the efficient resource utilization in M-P-S (Memory-Processor-Storage) Matrix Model. Authors state that resource allocation rate should be larger than resource request rate. Cloud priority manager, Cloud resource allocation, virtualization system manager and end result collection are major components of the system. The performance of the cloud system should be analysed by authors using the Cloud Efficiency Factor. However, for future work authors also identified other parameters of Cloud System.

Chenn-Jung Huang, Chih-TaiGuan, Heng-MingChen,Yu-WuWang, Shun-ChihChang, Ching-Yu Li and Chuan-HsiangWeng [7] proposed resource allocation mechanism that is based on Support Vector Regression (SVR) and Genetic Algorithm (GA). Support Vector Regression (SVR) is used by the authors to designed Application service prediction module to estimate the utilization of the resources according to the Service Level Agreement (SLA) of each process. Then to redistribute the resources to the Cloud customers author designed global resource allocation module with Genetic Algorithm (GA).

Zhen Xiao, Weijia Song and Qi Chen [12] want to achieve two goals one is avoid the overload and other is green computing for dynamic resource allocation through virtualization technologies. The needs of cloud customers that are based on dynamically changing that are designed and implemented system multiplexes virtual to physical resources adaptively. The multiplexing is done through Usher Framework. Authors designed a load prediction algorithm to guess future resource utilization without seeing into virtual machines. Authors had used “skewness” metric to compute uneven consumption of server. They also defined concept of “Hot Spots” and “Cold Spots” servers. In order to calculate the performance of the algorithm designed authors used trace driven simulations.

Qiang Li, Qinfen Hao, Limin Xiao and Zhoujun Li [13] introduce VM-base architecture for adaptive management of virtualized resources in cloud computing. Authors also considered a resource controller named Adaptive Manager that dynamically adjusts multiple virtualized resource utilization

INTERNATIONAL JOURNAL OF TECHNOLOGY AND COMPUTING (IJTC)
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to achieve application Service Level Objective (SLO) using feedback control theory. Adaptive Manager has a multi-input, multi-output (MIMO) resource controller which controls CUP scheduler, memory manager and I/O manager based on feedback mechanism. Each Virtual Machine has sensor module to periodically measure the performance of application which transmits information to the adaptive manager. Authors adopted Kernel based Virtual Machine (KVM) as a tool for infrastructure of virtual machine.

III. AUCTION

In Auction based model there is an Auctioneer who conducts the auction. Buyer and seller send their bids to auctioneer, he find the winner and assign the service provider to users according to their requirement [11]. Following are the basic terminologies in auction:

- **Bidder:** A bidder is the one who wants to buy the services in auctions.
- **Seller:** A seller who wants to sell commodities. The commodities can be bandwidth, licenses of spectrum, and time slots etc.
- **Auctioneer:** An intermediate agent called an auctioneer who hosts and directs auction processes.
- **Commodity:** A commodity is a object traded between a buyer and a seller. Each product or commodity has a value at which the buyer/seller wants to buy/sell.

IV. PROPOSED WORK

There is r-number of users that send their request to auctioneer for multiple resources and on the other hand s-providers that are send their bids to the auctioneer to sell their resources. So the auctioneer is responsible for accurate matching between user and provider. The implementation of proposed algorithm is based on 'Combinatorial Auction based Resource Allocation'. Many market based algorithms are designed for seller side auction or some for buyer side auction but in proposed algorithm both buyers and sellers send their bids to auctioneer. Between user and provider, Auctioneer works like a trading agent who would decide the scheme for resource allocations. In 'Combinatorial Auction' providers and users send their bids and ask respectively to the auctioneer for a bundle of resources than a single resource. If single commodity is not received from a requested set of commodity the buyer is not satisfied because buyer needs, complete set of commodities. Auctioneer sends messages to both providers and users about starting the auction and set a timer for receiving requests and bids for the resources from buyers and sellers respectively. After this, buyer or users send their requests to auctioneer with price that they willing to pay. The buyer list is sorted in descending order by the auctioneer according to bid density. Similarly, Auctioneer received the offers from the sellers or providers and arranged it in ascending order according to bid density. Then starts the matching, if all the requested resources attributes are matched with offered attributes of resources by the first provider then match them otherwise access the next provider. This process will continue until all requests are not fulfilled. If winner sellers are unable to satisfy the users then they get penalty. In proposed algorithm users will get discounts if they will buy the resources more than three days and it also helpful to provide the optimal resource allocation in Clouds.

Parameters of Proposed Algorithm

- Let Users (U) and number of users i={1,2,3,4......................r}
- Cloud Provider (P) and the number of Providers j ={1,2,3.4.5................s}
- Total number of resources L and L={1,2,3,4.............l}
- Task (T) and total number of task T={T_1, ...,T_n}
- Users U_i can request for different kind of resources with their different attributes. {A^i_1 .... A^i_L} this vector divide the requested resources with their attributes.
- Similarly Providers P_j can offered different kind of resources with their different attribute. {A^j_1................A^j_L} this vector categorise the different offered resources with their attributes.
- The quantity of resources that is requested by users {Q^i_1..............Q^i_L}.
- The offered quantity of resources by Providers {Q^j_1.............Q^j_L}.

Table 1: Parameter of Proposed Algorithm

Parameters	*Description*
U	User
r	Number of Users
P	Provider,
s	Number of Providers
L	Number of Resource type
Q	Quantity of Resources
A	Attribute of Resources
wr	Total weight of Resources
p	Bid Price
t	Time
T	Task
Tn	Number of Task
bt	Bid thickness
Tq	Total quantity of offer/requested resources
Qa	Assign Quantity
Amr	Average market price
pp	Payable Price
TP	Total Price
PA	Penalty
Uw	Price of Ultimate winner
Dp	Price of defaulter Provider
D	Discount
DR	Discount rate
Dp	Discount Price
VM	Virtual Machine

Proposed Algorithm with their Phases:

- **Phase1**
  i. Number of Cloud Providers registered them to Auctioneer and advertises about their services and resources.
  ii. Multiple users send their request to Auctioneer for resources.
  iii. Auctioneer set the timer for auction and sends messages about this timer to both Cloud resource providers and users.
- **Phase2**
  i. Resource Providers $P_{j,}$ {1, 2, 3 ...s} check the availability of resources if resources are available then each provider generate a set of resources with their attributes.
  ii. Providers send their resources set to Auctioneer and create price value for each set of resources.
  iii. Providers send their bids to an Auctioneer.
  iv. Multiple Users also create required resources sets with their attributes and create price value for each set according to their budget.
  v. Users send their Bids and required time for resources to an Auctioneer.
- **Phase3**

i. Auctioneer sent the messages about close the bidding process to Providers and Users.

- **Phase4**

Winner Determination

Auctioneer received the bids with attributes and quantity for the offered resources by different Providers and he calculates the winner Provider. He also received the bids for the resources (with their attributes, quantity and required time for resources) from multiple Users and then Auctioneer calculates the winner from Users. He creates two lists one for users and other for cloud providers. After this he sorts the user list according Eq. (1) and Eq. (3) and sort the Providers list according to Eq. (4) and Eq. (5). The sort operation is depends upon offered and requested resources (with their bid, attribute and quantity) by providers and users. Auctioneer sorts the Users list in descending order and Provider list in ascending order. For sorting process in this algorithm used the bid thickness bt and total weight of resources wr. Total weight of resources depends upon their number of attributes of resources and quantity of resources. Calculate the winners as following:

$$wr_i = \sum_{L=1}^{l} A_L^i * Q_L^i \quad \text{... Eq. (1)}$$

In equation (1) wr_i used for total number of resources requested by users, A_L^i is attribute of resources that are requested by the user i for resource L, Q_L^i is quantity of resources L that required by user i. Equation (2) calculate the bid price p of user i at time t and t_L^i is requested time for resource L by user i.:

$$p_i^t = p_i * t_L^i \quad \text{... Eq. (2)}$$

Eq. (4.3) evaluates the bid thickness bt_i that is depends upon bid price p for resources L by user i and total weight of requested resources by users i.

$$bt_i = \frac{p_i^t}{wr_i} \quad \text{... Eq. (3)}$$

Similarly, in equation (4.4) find the total weight of resources offered by Provider j like user i in equation (4.1).

$$wr_j = \sum_{L=1}^{l} A_L^j * Q_L^j \quad \text{... Eq. (4)}$$

Compute the bid thickness in Eq. (5) like equation (3).

$$bt_j = \frac{p_j}{wr_j} \quad \text{... Eq. (5)}$$

- **Phase5**

Allocation of Resources

After prepared the sorted lists for users and providers, Auctioneer starts the matching between both lists. Firstly he will match the first User from Users list to first Cloud Provider from provider list with their requested and offered resources, attributes of resources and quantity of resources. If attributes of the requested type of resources from the first User matched with the attributes of offered type of resources by the first Provider then assigned otherwise check the next Provider. Before assigning the Cloud Provider to User, check the requested capacity and quantity of the resources should be less than or equal to the capacity and quantity of the Provider resources. This process will run until the first user not satisfied. When first user fully satisfied then next user starts matching with providers same steps will run until the all users are not satisfied. Then, Auctioneer will send the result to Provider and user by message.

- **Phase6**

Calculate the Price

Price calculation must be cleared to attract the multiple users and providers. In this algorithm used the average price of user and provider to calculate the payable cost by users, as used in [8].

In Eq. (6) and Eq. (7) evaluate the Total Quantity of requested resources and offered resources respectably to find out the average of requested resources and offered resources.

$$Tq_i = \sum_{L=1}^{l} Q_L^i \quad \text{... Eq. (6)}$$

$$Tq_j = \sum_{L=1}^{l} Q_L^j \quad \text{... Eq. (7)}$$

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By Eq. (8) find out average market rate of resources and Eq. (9) calculate the payable price of user i to provider j.

$$Amr_i^j = \frac{1}{2}\left\{\left(\frac{p_i}{Tq_i}\right) + \left(\frac{p_j}{Tq_j}\right)\right\} \quad \text{... Eq. (8)}$$

$$pp_i^j = Amr_i^j * Qa_i^j * t_i^L \quad \text{... Eq. (9)}$$

Eq. (10) calculate the total payable price that paid by users to providers

$$TP_i^j = \sum_{L=1}^{l} pp_L^j \quad \text{...Eq. (10)}$$

Eq. (11) and Eq. (12) find out the discount that is given by provider to user.

$$D_j^i = pp_i^j * DR_j^t \quad \text{... Eq. (11)}$$

$$Dp_j^i = pp_i^j - D_j^i \quad \text{... Eq. (12)}$$

Eq. (13) evaluates the penalty for defaulter provides [9]

$$PA = {(Uw - Dp)}\Big/{\sum_{i=1}^{r-1}(Uw - Dp)} \quad \text{... Eq. (13)}$$

- **Phase7**

Allocate the virtual machine and payment

i. Users who have won in auction send their tasks with time to assigned provider.
ii. If given time will more than or equal to three days then Provider will give the discount to User.
iii. If winner Provider is fail to satisfied the user then he will have to pay penalty.
iv. Provider send task completion message to related user.
v. Then user gave the payment to Cloud Provider that calculated by Auctioneer.

V. COMPARATIVE ANALYSIS OF EXPERIMENTAL RESULTS

The proposed algorithm has been compared using VM Migration, SLA Violations and Execution Time.

- **VM Migrations**

Figure 2 shows that proposed algorithm has minimum VM migrations as compared to Random overlap algorithm. The Random Choice (RC) policy selects a VM to be migrated according to a uniformly distributed discrete random variable, whose values index a set of VMs allocated to a host [10]. At 0.1 threshold valued, an existing approach has 517 VM migrations and proposed approach has 429 VM migrations. For all the threshold values, our proposed algorithm shows best results.

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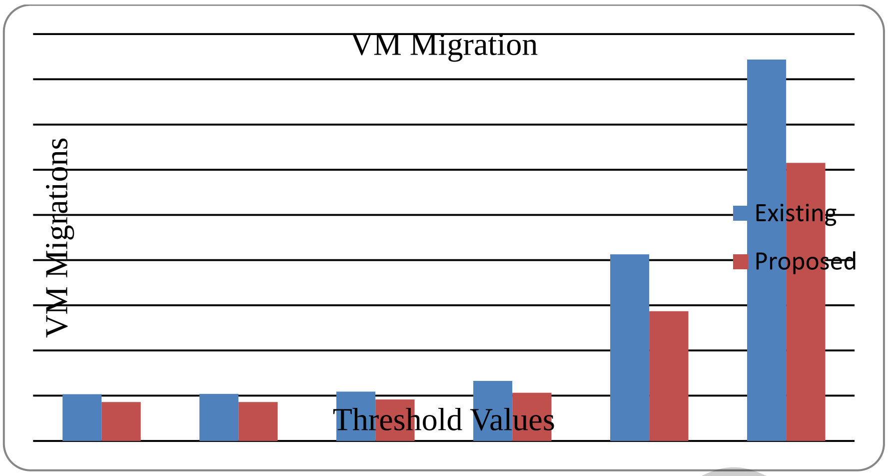

Fig. 2: VM Migration

SLA Violations

In proposed algorithm number of SLA (Service level Agreement) Violations decreased as compared to Random Choice Policy that exposed in figure 3. At threshold value 0.4, number of violations in existing system are 0.000837 where in proposed system these values are 0.000749, that are fewer than existing algorithm.

SLAV= SLATAH * PDM

Where SLATAH is SLA violation Time per Active Host and PDM is Performance Degradation due to Migrations [10].

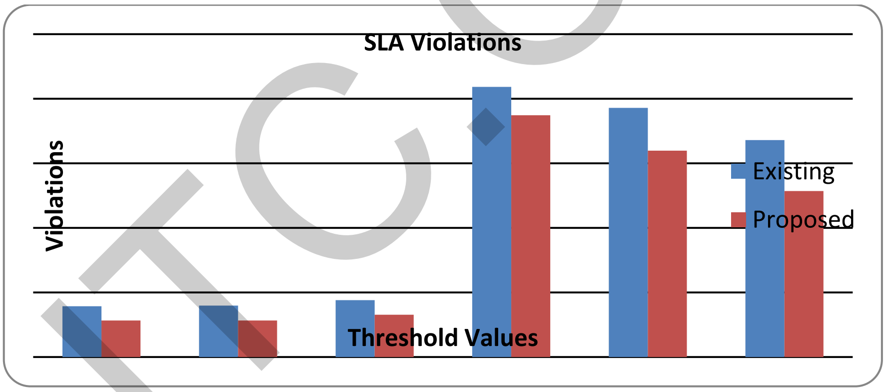

Fig. 3: SLA Violations

Execution Time

Execution Time is the time to execute tasks within specific time. It is also defined as the difference between ending time and starting. Figure 4 shows the execution time of proposed algorithm and existing algorithm where each threshold value of proposed system is less than existing system.

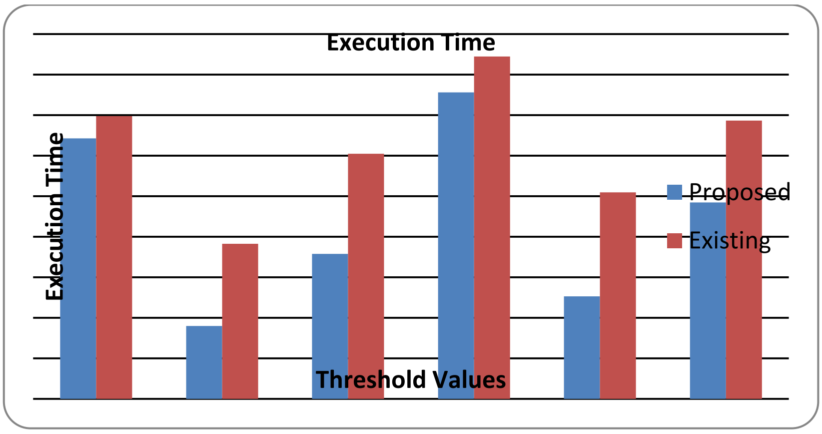

Fig. 4: Execution Time

At threshold value 0.2 the execution time of proposed algorithm is 1.797561mille seconds and existing system has 3.825784 mille seconds. Similarly each threshold value shows proposed algorithm has less execution time than existing system.

VI. CONCLUSION AND FUTURE WORK

Multiple parameter based Resource allocation is one of the most challenging issues in Cloud Computing. Many of the researchers have proposed various algorithms and techniques to provide the resources to users from Cloud and this thesis also proposed a technique by which number of users and number of providers can send their requests and offers to the auctioneer for resources with their multiple parameters. So, the resources that are allocated to Cloud users based on the parameters such as cost, time, quantity and type of resource. The proposed technique calculates the price of the resources online and users can get the discount on the basis of requested time for the resources. If they order resources more than three days then user can get the discount and here is also a penalty check the for defaulter providers. The selected Providers should be penalized if they failed to provide required resources to users. It is economically beneficial model because users can get the multiple resources at a time. It also reduced the VM migrations, SLA Violations and Execution Time.

- **Future Directions:**

(a) In the current thesis, results are compared with Random overlap, but in future, the results can be compared with existing Auction based models.
(b) It can be implemented to schedule multiple tasks at the same time during resource allocation.
(c) Automatic discount policy would implement according to number of requested resources.
(d) More QoS parameters can be included in future.

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