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A Review: Distributed Auction-Based Framework v/s Cluster-Based Framework for Auto Scalable IaaS Provisioning in Geo-Data Centers

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***Abstract*—** This research paper proposes a cluster-based framework for Infrastructure-as-a-Service (IAAS) which enables customers effectively hosted intensified performance computing applications and cloud service providers (CSP's) to use their resources beneficially. The solution incorporates the cluster-based framework which handles the geographical data centers grouped logically in clusters. This cluster-based framework overcomes the challenges of traditional centralized provisioning approaches. A. Efficient on-demand IaaS provisioning. B. Auto-scaling of increasing number of IaaS requests. C. Effectively use of Geographical Data center computing resources. D. Maintain Quality of Service parameter requirements for different IaaS requests. Incorporate Vickrey-Clarke-Groves (VCG) mechanism to solve exaggeration and collusion issues. The solution generated extended to host cloud applications based on mobile and how effectively it will work in a changeable environment. To pace the performance of the distributed IaaS framework vs (RCG-IaaS) regional IaaS provisioning model based on an efficient decomposition technique, Column generation as a large scale optimization tool, I use the additional performance metrics as follows: Basic Performance metric: Speedup (Su): Speed gain of using more processing nodes over a single node, Efficiency (E): Percentage of maximum performance (speedup or utilization) achievable (%), Elasticity (El): Dynamic interval of auto-scaling resources with workload variation & Cloud Productivity: QoS of Cloud (QoS): The satisfaction rate of a cloud service or benchmark testing (%), Service Cost (Cost): The price per cloud service (Compute, Storage etc.) provided ($/hour), Availability (A): Percentage of time the system is up to deliver useful work (%).

***Keywords*—**Cloud Computing, VCG mechanism, IaaS, Data Centers, Cluster, Auction, Distributed, Geo (Geographically)

I. INTRODUCTION

IaaS:
An Infrastructure as a Service (IaaS) provider offers you raw computing, storage, and network infrastructure so that you can load your own software, including operating systems and applications, on to this infrastructure (e.g. Amazon's Elastic Computing Cloud (EC2) service).

- This scenario is equivalent to a hosting provider provisioning physical servers and storage, and letting you install your own OS, web services, and database applications over the provisioned machines.
- Greatest degree of control of the three models, resource requirement management, is required to exploit IaaS well.
- Scaling and elasticity are user's responsibility and not the provider's responsibility.

IaaS Provisioning:

The IaaS provider takes responsibility for the hardware and performs all the maintenance to ensure the servers run correctly. Because an infinite number of custom applications can be developed and deployed and run on IaaS, it becomes impossible for a cloud service provider team to manage and troubleshoot all of the software and hardware

Vickrey-Clarke-Groves (VCG) mechanism:
Goal: implement the efficient outcome in dominant strategies.
A general method to do this: VCG
2nd-price auction is a special case
Solution (intuitively): players should pay the "damage" they impose on society. In more details: We can maximize efficiency by: Choosing the efficient outcome (given the bids)
Each player pays his "social cost" (how much his existence hurts the others)
pi =Optimal welfare (for the other players) if player i was not participating - Welfare of the other players from the chosen outcome.

VCG idea in single item auctions
Pi= Optimal welfare (for the other players) if player i was not participating - Welfare of the other players from the chosen outcome
= 2nd-highest value. (When i is not playing, the welfare will be the second highest.)
=0 (When i wins, the total value of the other is 0.)
By VCG payments, winners pay the 2nd-highest bid, and loser pays nothing!
VCG in 5-item auctions:
pi= Optimal welfare (for the other players) if player i was not participating - Welfare of the other players from the chosen outcome
=30+27+25+12+5 The five winners when i is not playing.
=30+27+25+12. The other four winners.
VCG in k-item auctions:
VCG rules for k-item auctions:
Highest k bids win.
Everyone pay the (k+1)st bid.
Truthfulness is a dominant strategy here too.

Recently, cloud computing has emerged as a paradigm that provides both compute and storage resources and network resources in the form of Infrastructure-as-a-Service (IaaS). This can be modeled as a Virtual Network (VN): a set of virtual nodes and a set of virtual links with Quality of Service (QoS) requirements. As a result, many evolving applications requiring efficient IT/Network infrastructures can be hosted. Examples include data-intensive search engines [1], high-performance scientific and grid computing, like climate modeling and high-energy physics [2]. Cloud computing reduces the investments required to establish new infrastructures and encourages more and more Over-the-Top application providers (such as NetFlix, Skype and Facebook) to move their platforms to a cloud infrastructure, Cloud Service Providers (CSPs) are challenged by the exponential growth of the demand for IaaS. The challenge increases when CSPs seek to extend their coverage and maximize their long-term profit. To meet the challenge, CSPs have begun to deploy their Data Centers geographically distributed (Geo-Data Centers) [3,4,5,6]. By doing so, they increase the availability of their resources and can even take advantage of electricity prices that may be lower in some locations. However, this new architecture, called Geo-Data Centers, still uses a centralized controller which may result in an inefficient use of computing resources [7,8,9,10,11,12].

Rest of the paper is organized as follows, Section I contains the introduction of IaaS, IaaS Provisioning, VCG mechanism, Cloud Computing, CSP. Section II contain the related work of distributed auction-based framework, Section III contains Comparative study of distributed auction-based framework and proposed cluster-based framework, Section IV contain the architecture and essential steps of framework, Section V describes the comparative study of VCG mechanism for removing the issues of exaggeration and collusion. Section VI concludes research work with future directions.

II. Related Work

In this section, I survey the literature and describe the previous research works in the field of IaaS provisioning, networked clouds and virtualized Data centers

IaaS provisioning

A number of approaches have been proposed to handle the main challenges of IaaS provisioning: scalability and increased computational complexity. Both affect the quality of the solution. Most proposals [7,8,9,10,11,12,13] have focused on a Two-phase, centralized provisioning approach, first mapping the virtual nodes, and second, assigning virtual links to routing paths. All incoming requests are collected in one central hub. The main drawbacks of this centralized, sequential approach are as follows.

- Two-phase node and link provisioning may result in a high number of blocked requests and less efficient resource use, thereby reducing the profit for CSPs.
- A non-scalable heuristic approach increases response time, which may result in IaaS provisioning and QoS that are less than optimal.

Houidi et al. [9] proposed a heuristic mapping algorithm based on a multi-agent framework. Their approach assigned an agent to each substrate node to carry out the mapping algorithms. However, they evaluated the performance and the scalability of their proposal with a medium-scale experiment only. Scaling up the algorithm to work with thousands of substrate nodes caused additional communication overheads that impeded efficiency.

Chowdhury et al. [10] proposed a solution called PolyViNE that coordinates the VN embedding process across participating Infrastructure Providers (InPs). Each InP enforced its local resource allocation policy in its own network before forwarding the un-embedded nodes and links to a neighboring InP. The process continued recursively until the whole request was embedded. The authors mentioned issues inherent to PolyViNE: the scalability, the response time, and the computation overheads. A decentralized framework addresses all these issues more effectively.

Louati et al. [14] proposed a centralized approach using a max-cut flow algorithm and an ILP model to split IaaS requests across multiple InPs. Their proposal uses a centralized approach, which may result in scalability issues. In addition, splitting IaaS requests may cause inefficiency that is unsuitable for many recent applications.

Networked Clouds

Networked Clouds are especially useful in scaling networks as they grow, by increasing flexibility and tightening security. Most research in cloud networking has addressed the IaaS provisioning problem on a distributed cloud architecture. However, most proposals, including those presented below, adopt a centralized controller with heuristic Twophase IaaS provisioning. This may result in an inefficient use of computing resources as well as scalability and computation time issues.

Papagianni et al. [5] addressed the integration of computing and networking resources with Networked Cloud Mapping (NCM). They defined NCM as the efficient mapping of user requests for Virtual Resources (VRs) (denoted as VN requests) onto a shared substrate connecting isolated islands of computing resources. They formulated the optimal NCM as a MIP problem. To tackle the problem, they proposed a heuristic mapping methodology. However, their solution is still centralized, which affects its scalability. Even with a relaxed MIP, it still cannot handle large numbers of requests. Kantarci et al [11] proposed a novel virtualization scheme for an inter-Data Center network over an IP on an optical backbone. Since the inter-Data Center network needs to be reconfigured in polynomial time to grant Time-Of-Use-Awareness (TOUA) of cloud user traffic, the authors propose a simulated annealing heuristic. They claim that significant Operational Expenses (OPEX) savings can be achieved while demands can be provisioned with low energy consumption in the Data Centers and network equipment.

Virtualized Data Centers

Virtualized Data Centers has been proposed as a distributed Infrastructure allowing more flexible provisioning of IaaS requests with stringent QoS requirements. We surveyed some work in the area.

Amokrane et al. [7] introduced Virtual Data Centers (VDCs) as an adapted VN with VMs as end-points. The authors proposed a resource management framework called Greenhead for embedding VDCs across geographically distributed Data Centers. Their approach had two phases. The first phase is to divide VDC requests into partitions. In the second phase, each partition is assigned to a Data Center based on electricity prices, power usage, the availability of renewable resources, and the carbon footprint. Greenhead also relies on a centralized model where all incoming VDC requests are submitted to a central hub for allocation. This significantly impacted the scalability of the proposal. Alicherry and Lakshman [13] proposed a centralized resource allocation scheme for geo-distributed clouds to minimize the service delay among selected servers. A Two-phase heuristic algorithm uses a sub-graph selection to divide the requested resources among the chosen servers.

III. COMPARATIVE STUDY OF RESEARCH

In this section I have demonstrated the previous research work and proposed research work comparison on behalf of my view point with respect to cluster-based framework for IaaS provisioning that is auto scalable. In which I want to explore that the IaaS provisioning will be distributive and can be done on behalf of clusters rather than regions.

Table-1: Comparative study of previous work & proposed work

Sr.No	Previous Work	Proposed Work
1	Proposed a cloud infrastructure-as-a-service (IaaS) framework that allow customers to have their high-performance computing applications hosted efficiently and cloud service providers to use their resources profitably. [15]	This thesis proposes a cluster-based framework for Infrastructure-as-a-Service (IAAS) which enables customers effectively hosted intensified performance computing applications and cloud service providers (CSP's) to use their resources beneficially.
2	The solution introduces a distributed architecture that manages geo-data centers logically grouped into regions. [15]	The solution incorporates the cluster-based framework which handles the geographical data centers grouped logically in clusters. This cluster-based framework overcomes the challenges of traditional centralized provisioning approaches.
3	This framework overcomes the following:[15] A. Efficient provisioning of IaaS demand. B. Scale w.r.t. growing no. of IaaS requests. C. Efficient use of geo-data center computing resources. D. Guarantee of the stringent QoS	Proposed framework overcomes the following: A. Efficient on-demand IaaS provisioning. B. Auto-scaling of increasing number of IaaS requests. C. Effectively use of Geographical Data center computing resources.

	requirements of IaaS requests.	D. Maintain Quality of Service parameter requirements for different IaaS request.
4	Not Done	Incorporate Vickrey-Clarke-Groves (VCG) mechanism to solve dynamic changes in the outcome and collusion issues.
5	Not Done	The solution generated extended to host cloud applications based on mobile and how effectively it will work in a changeable environment.
6	To quantify the performance of the RCG-IaaS model vs Two phase IaaS heuristic provisioning approaches, they used the following performance metrics:[15] A. Acceptance Ratio: The ratio of accepted IaaS requests to the total submitted requests at each period B. Data center resource utilization: The ratio of the resources used (CPU, memory, storage, and bandwidth) to their total capacity in the data center A. C. CSP's Net profit: The accumulated profit of each RC in each region. Profits calculated based on the bids collected from the successful requests, less the cost of the network resources and the VM's calculated by the model. [15]	To pace the performance of the distributed IaaS framework vs (RCG-IaaS) regional IaaS provisioning model based on an efficient decomposition technique, Column generation as a large-scale optimization tool, I use the additional performance metrics as follows: 1. Basic Performance metric: • Speedup (Su): Speed gain of using more processing nodes over a single node • Efficiency (E): Percentage of maximum performance (speedup or utilization) achievable (%) • Elasticity (El): Dynamic interval of auto-scaling resources with workload variation 2. Cloud Productivity: • QoS of Cloud (QoS): The satisfaction rate of a cloud service or benchmark testing (%) • Service Cost (Cost): The price per cloud service (Compute, Storage etc.) provided ($/hour) Availability (A): Percentage of time the system is up to deliver useful work. (%)

IV. THE ARCHITECTURE AND ESSENTIAL STEPS OF PROPOSED FRAMEWORK

In this section, I provide a cluster based-framework that can host any extensive applications with demanding quality of service requirements.

The master stakeholder, the IaaS customer, owns extensive distributed applications and wishes to have a well-founded infrastructure on which to host them. The second stakeholder, the Cloud Service Provider (CSP), owns the cluster distributed framework and is responsible for providing that well founded infrastructure in order to accommodate the customer's requests.

My proposed architecture consists of various multiple Data Centers deployed in different geographical area's and arranged in groups forming clusters. The connectivity among Data Centers is achieved through a backbone network owned and managed by the same Cloud Service Provider (CSP).

Figure 1 illustrates the Data Centers and clusters (East, West, North, South, for example) of the proposed architecture.

Two main entities are defined, the central Master Cloud Service Provider (CSP) and a set of Cluster Coordinators (CCs) that represents the clusters in upper-level decision-making at the Master Cloud Service Provider (CSP). Periodically, an election algorithm in each cluster endorse the Data Center with the maximum resource use to be the CC of that cluster.

The recipient CC can choose whether to allocate the requested resources within its cluster (distributed approach) or to forward the requests to the Master Cloud Service Provider (CSP) for a decision (hierarchical approach). The Master CSP is capable of solving any allocation issues that arise from additional constraints such as resource outages or customer location.

Physical servers adopt virtualization techniques (such as partitioning) to form a set of Virtual Clusters (VCs) or Virtual Machines (VMs) following various QoS classes [16]. The capacity of VRs from QoS class q in cluster c denoted by Cg q is defined as the total number of VRs available at the cluster resource pool. The aggregated value for the Intra-Data Center bandwidth in cluster c denoted by Bc is calculated based on the oversubscription values [17]. The term "oversubscription" is defined as "the practice of connecting multiple devices to the same switch port to optimize switch use. However, because ports are rarely run at their maximum speed for a prolonged period, multiple slower devices may fan in to a single port to take advantage of unused capacity" [17].

For example, an oversubscription of 1:1 indicates that any host is able to communicate with any other host at the full bandwidth of their network interface. Many Data Center designs introduce oversubscription as a means to lower the total cost of the design. Typical Data Centers network designs are oversubscribed by a factor of 2.5:1 (400 Mbps) to 8:1 (125 Mbps), i.e., each server in the Data Center is connected in the Data Center network by a 400 Mbps link. Collecting various granularities of VRs from all the regional Data Centers constitutes the regional virtual resource pool denoted by Vg, this pool also includes Intra and Inter-Data Centers networks.

An IaaS request k ϵ N is represented by a graph Ik = (Vk; Bk; Pk), where, Vk represents the number of required VMs, each VM characterized by its CPU, memory, and storage requirements. Bk represents the bandwidth requirements between each pair of VMs, and Pk represents the price that customers are willing to pay.

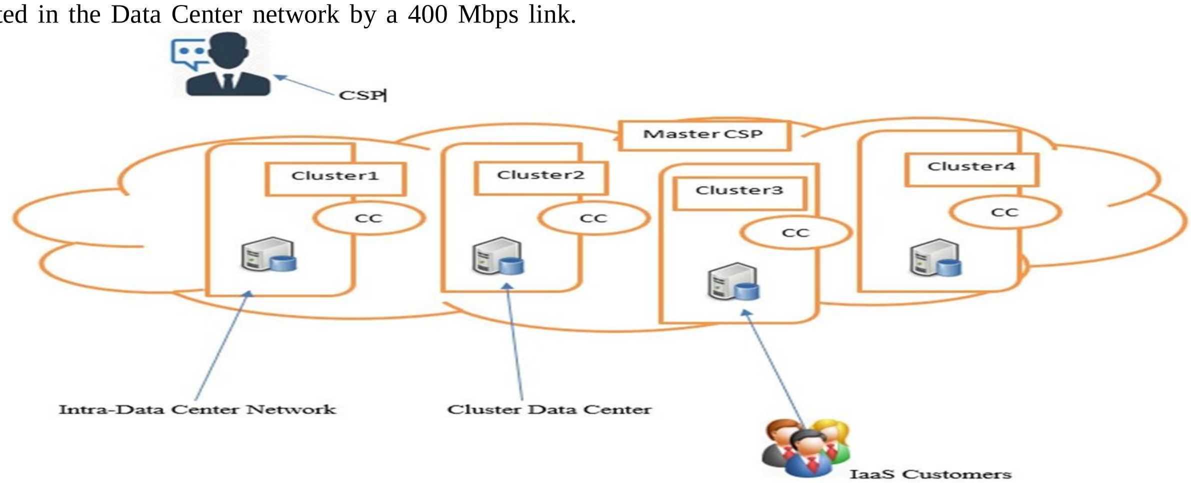

Figure 1: Proposed Cluster-based Framework

V. COMPARATIVE STUDY OF VCG MECHANISM

The main purpose of this section of Comparative study of VCG mechanism is that the issues which arises in previous research work done by others, they have not solved the issues of exaggeration and collusion Therefore, in this review paper, I just want to initiate a comparative study of these VCG-mechanism, in advance by which, I can solve the issues of exaggeration and collusion. And at the end I just want to say that I will correlate the different VCG mechanism and find which one is best in my next implementation-based research paper.

Table-2: COMPARATIVE STUDY OF VCG MECHANISM

Sr. No.	Topic	Work Done	Year	Journal/Symposium/Conference
1	Vickrey-clarke-groves mechanism [18]	The VCG Mechanism is an example of a combinatorial auction. In the VCG Mechanism a bid is a valuation. The VCG mechanism then implements an efficient allocation taking the bids at face value. That is, goods are divided among bidders so as to maximize the sum of reported valuations.	September 3, 2010	Optimal shill bidding in the VCG mechanism, Itai Sher University of Minnesota

2	An incentive mechanism such as the Vickrey-Clarke-Groves (VCG) Mechanism [19]	we can also prevent manipulation through the misreporting of preferences. However, in many practical settings it is hard to bound the problem so that such a central authority is feasible.	Jackson, 2000	Jackson, M. O. (2000). Mechanism theory. In the Encyclopedia of Life Support Systems. EOLSS Publishers.
3	Sealed-bid (Vickrey) auction [20]	It is a simple example of a mechanism: each agent makes a claim about its value for an item to an auctioneer, who allocates the item to the highest bidder for the second-highest price. The Vickrey auction is useful because it is non-manipulable, in that the weakly dominant strategy of each agent is to report its true value, and efficient, in that the item is allocated to the agent with the highest value.	Krishna, 2002	Krishna, V. (2002). Auction Theory. Academic Press.
4	The Vickrey-Clarke-Groves Mechanism [21]	Since the VCG mechanism is the only mechanism that I Make truth telling a dominant strategy I Implements the utilitarian rule and since the VCG mechanism yields a budget deficit, There is no budget balanced, efficient mechanism for this social choice problem. Ok then, the “first-best” is not attainable. What’s the best we can do with a budget-balanced mechanism? (The “second-best.”)	Jeffrey Ely, July 8, 2009	work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License.
5	Vickrey-Clarke-Groves Mechanisms [22]	Two items A and B. Bidder values A at 200, B at 100, budget of 150. Can’t bid true values and be assured of staying within the budget. A “straightforward” bid might be 150 for A, 100 for B, and 150 for the pair. But the mechanism will interpret this as saying that the bidder has zero value for B if it is awarded A. Example of a more general problem: complex to bid with a budget in a Vickrey auction.	Jonathan Levin, Paul Milgrom’s Winter 2009	Economics 285, Market Design

VI. CONCLUSION AND FUTURE SCOPE

The main conclusion of the study is that every IaaS provisioning is major cause in any infrastructure where compute resources are shared across different channels and customer want that infrastructure where the compute resources are shared across the channel without any failure means must not be any more time to wait for opting the compute resources and must not any problem while enhancing these compute resources. Therefore, I have compared various VCG mechanism and for best resource allocation I have proposed a Cluster-based framework. In future I will implement these concepts via some cloud computing tool and compare the results of my research to other previous researches done and prove that my work done is better than others in performance perspectives and for allocation of compute resources in cloud environment.

VII. ACKNOWLEDGMENT

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