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VIRTUAL MACHINE MIGRATION: A COMPARATIVE STUDY

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Abstract: Usage of virtualization in cloud computing is acquiring more significance because of the lack of appropriate usage of resources, inappropriate load balancing of executing nodes, level of fault tolerance in VMs for increasing the nodes portability and to increase the physical server cost effectively. Therefore, migration is considered as one of the significant features of VM technology. VMM is the migration of VM from single host to other. It is generally executed by post-copy and pre-copy migration. This paper dealt with the reviewing the concept of virtualization following its types. There are different VMM techniques that are also discussed with its comparison. There are challenges, like low bandwidth, fault network, the memory state among clusters. For the enhancement purpose, different optimization as well as classification algorithms has been discussed. Number of authors has worked in the field of virtualization in cloud computing. Few of that are given in the review.

Keywords:cloud computing; virtualization;virtual machine migration; service models

1. INTRODUCTION

Cloud computing is used to provide services to the users that are connected through internet [1]. The services are accessed by the user from the data that is stored into the server which is generally known as Cloud. Cloud helps to resolve the problems related to network connections and online services [2].Cloud computing can be categorized as a new paradigm for the Dynamic configuration that supports computing services which is usually supported by the data center along with virtual machine [3].Cloud computing provides infrastructure, platforms,and software (application) as available on the paid instant mode. These services are in the industry known as the infrastructure as a service (IaaS), the platform as a Service (PaaS) and software as a service (SaaS) [4]. Many computing service providers include Google, Microsoft, Yahoo, IBM's rapid deployment of data centers at diffeyrent locations providing cloud computing services worldwide [5]. Below table is depicting the service models following its paradigms, features, advantages as well as disadvantages.

Table1.Comparison of service models in cloud computing

Service model	***Paradigm***	***Features***	***Advantages***	***Disadvantages***
Infrastructure as a Service (IaaS)	Infrastructure as an resource	Platform independent	Scalability	The efficiency and productivity of the business mainly depends upon the vendor's ability
		Less infrastructure cost	Nil investment in hardware	
		Less SLA	Pay per costing	
			Position independent	Long term cost
				Require new centralization
				Various security measure
Platform as a Service (PaaS)	License purchasing	Depend on cloud infrastructure	Scripting environment on server side	No control over the VM thus increasing security risk
		Used by Agile project management methods	Database management system (DBMS)	Time consuming as the updating and upgrading of application is done on time
			Storage Network access	Less cost effective than SaaS
Software as a Service (SaaS)	Software as an resource	Provide a complete platform to the user	Administration is easy	No control over the data

		Services are provide for end users over the internet	Updates automatically	processing as the software is used by a large number of users
			Compatible	
			Global accessible	Less control over the software parameters

The main technology behind cloud computing is virtualization. Virtualization makes pooling resources which help to utilize resources efficiently with reasonable cost to users.

A. Virtualization

Virtualization is software that provides a mean to run many operating system (OS) and applications on a single server at same time [6]. Virtualization helps to reduce IT cost and thus, increasing the efficiency of the computer hardware. The technology behind virtualization is called a virtual machine monitor (VMM) or a virtual manager that separates the computing environment from physical infrastructure. Virtualization are mainly categorized into four types namely hardware virtualization, operating system virtualization, server virtualization and storage virtualization [7]. Below figure is showing architecture of virtualization.

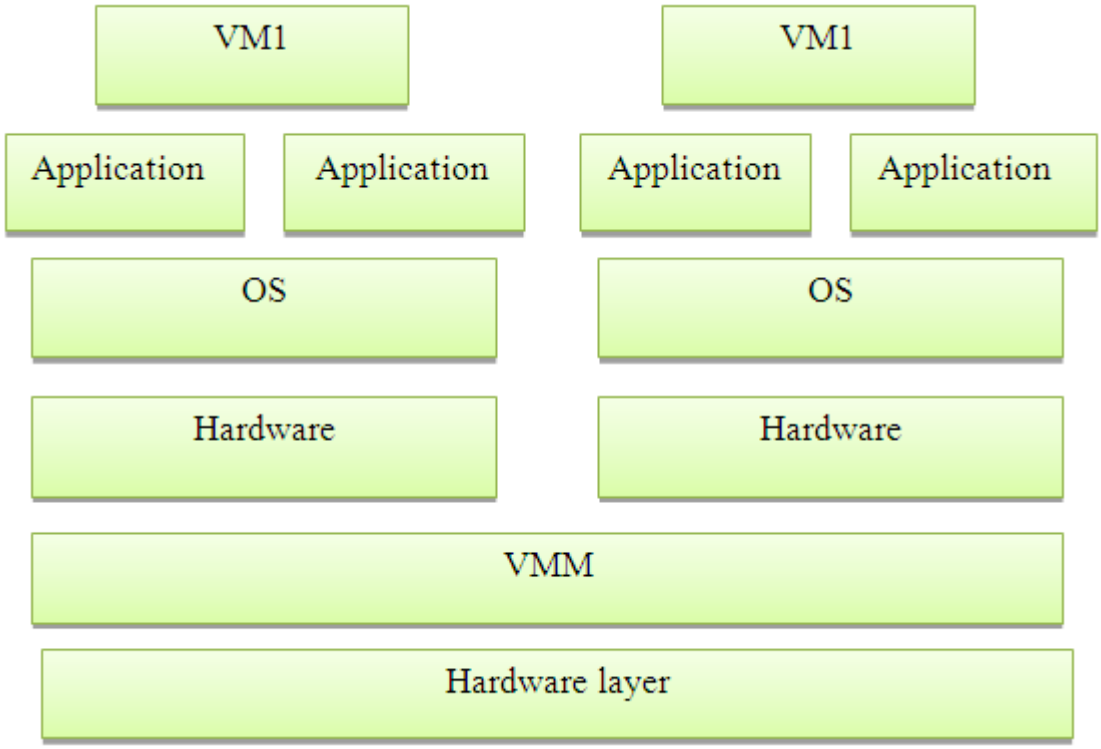

Figure.1.Virtualization Architecture

Virtualization has number of types, namely, hardware, operating system, server virtualization and storage virtualization. The table is depicting the description and the applications [8].

Table 2. Types of Virtualization

Virtualization types	***Definition***	***Applications***
Hardware virtualization	Virtual machine software and VMM are directly implemented on the hardware	Mostly used for the server platforms, because to control a virtual machine is easier than a physical machine
Operating system virtualization	Virtual machine software and VMM is implemented on the Host OS	Used for testing the applications on various platform of OS
Server virtualization	Virtual machine software and VMM is implemented on the server system	Since the physical server is divided into many small servers as per the demand of the user thus for load balancing server virtualization is used

Storage virtualization	A number of network storage devices are integrated to form a single storage device	Mostly used for backup and recovery

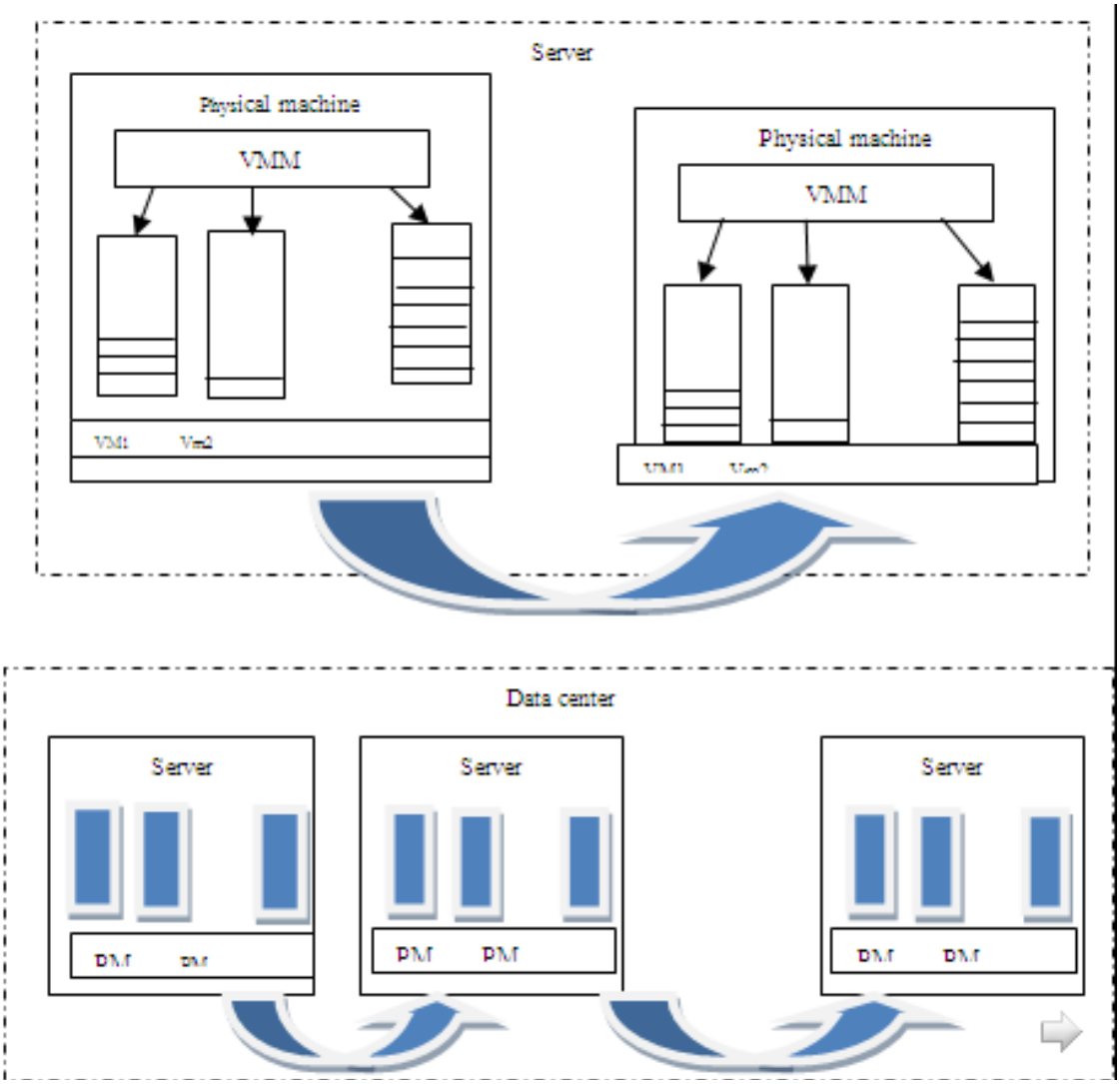

Figure 2. Virtual machine migration in cloud computing

B. Virtual machine migration

It is the process to migrate virtual machines from one physical machine to another without disconcerting the services provided to the user [9]. It is mainly categorized into two types [10]:

a) Non-Live Virtual Migration: It is also known as off line virtual migration. In this migration process, the VM's on source side is paused and forwarding all the states to the destination and finally, stopped the operation of virtual machine at the target host. The main disadvantage of VM migration is that the downtime is usually higher.

b) Live Virtual Migration: In this migration process, Virtual machines are transferred from one node to another node without disturbing the service.

The live virtual machine migration is mainly divided into two types namely, pre-copy memory migration and post copy memory migration.

- *Pre copy memory migration:* In this process, memory is transferred initially and then execution is transferred. In this process, memory is transferred from source to destination node over a number of iterations. It mainly works in two phases, namely, warm up phase and stop and copy phase [11]. In warm up phase if the copied page required some changes, then the page is copied again and again until the reduplication rate is less than the moving page rate. In stop and copy mode, the VM's are stopped at the source node, and the left data will be forwarded to the destination node.

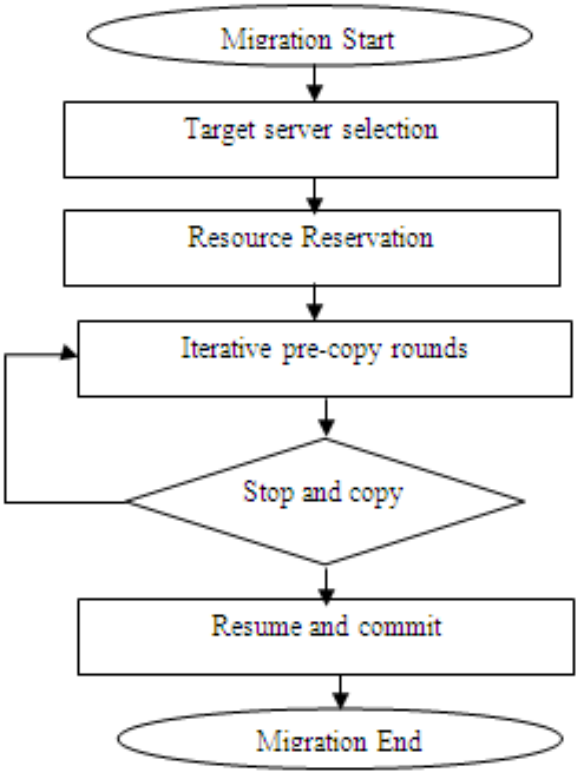

Figure 3. Pre-copy migration

- *Post copy*: In the post-copy approach, if migration fails, the VM is stopped at the source host and switches the execution states at destination host to resume the VM. After that, copy the memory pages via network links. The VM at destination host start responding immediately [12].

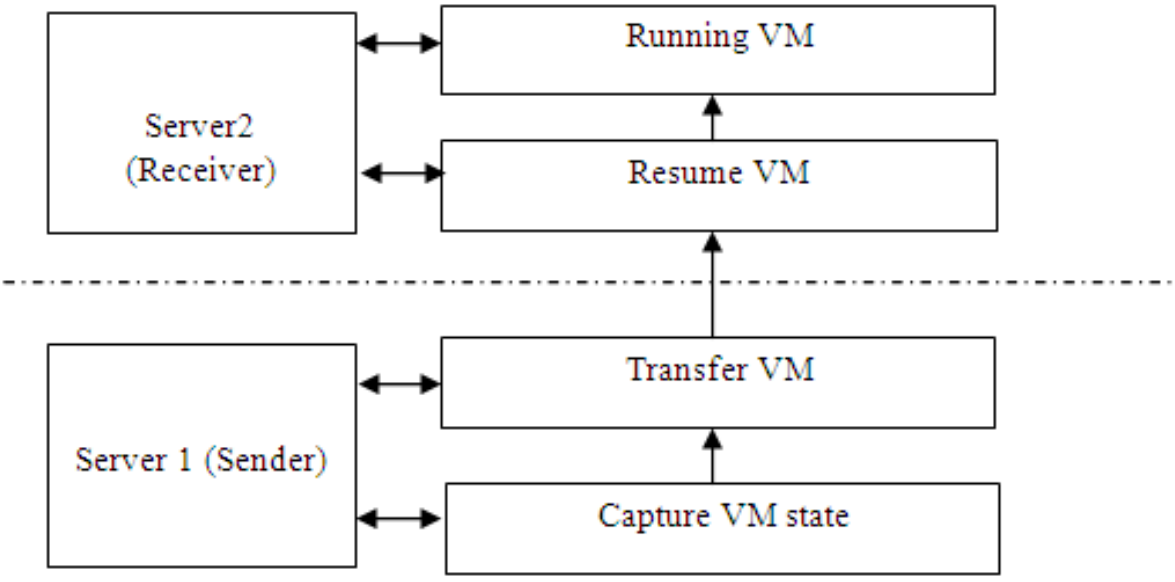

Fig.ure 4. Post copy Migration

- *Hybrid algorithm:* Firstly, at source, required memory pages migrated in pre-copy phase, then the execution states will be interchanged and VM resumed at destination host. After that, the remaining memory pages will be processed by post-copy algorithm via network link [13]. Fewer numbers of pages need to be accessed from the source, thus, this leads to increase the performance. Total migration time is also better than pre-copy and post-copy approach. It divides mainly into five phases as shown in fig below.

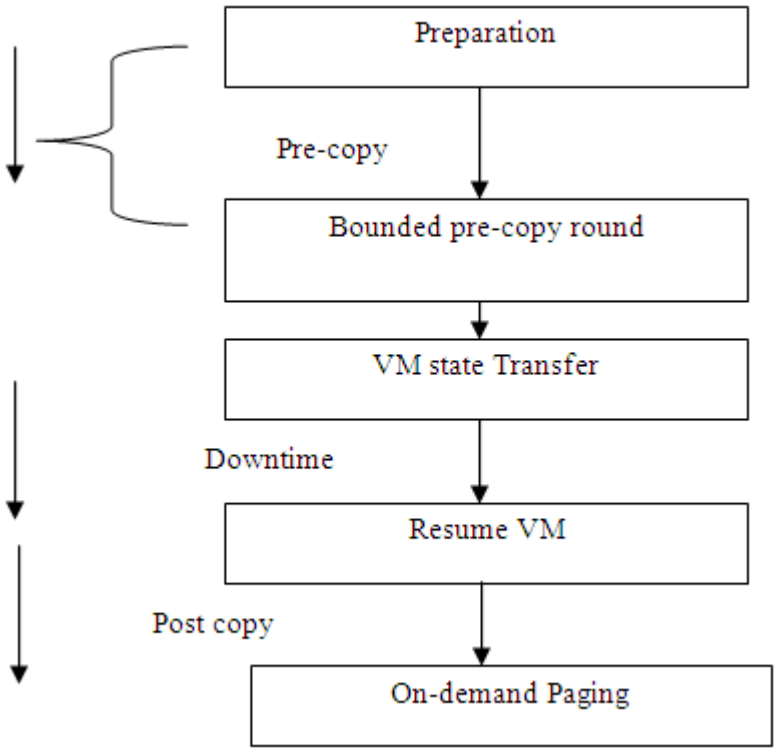

Figure 5. Hybrid VM Migration

i. *Preparation phase***:** In this phase, system resources are reserved at the target host.
ii. *Bounded pre-copy rounds:*Identify the delimiter pre-copy phase and transfers the virtual machines from the sender's server to the recipient's server.
iii. *VM resume phase:*It launches the transferred state at receiver side.
iv. *On demand paging:*As per the user requirement it sends the application.

The parameters that are considered during the VM migration are [14]:

i. *Downtime:*It is defined as the time below which no service is available to virtual machines.
ii. *Migration Time:*It is the total time required to transfer a virtual machine from source to destination without any disturbance to the network.
iii. *Preparation time:*The time between the starting of migration process and virtual machine (VM) processing state is transferred to the destination host, during which the virtual machine run regularly and creates page faults is known as preparation time.
iv. *Application Degradation:*During the migration process of virtual machine from one node to another, the performance of the services is degraded that is executed at that virtual machine.

Table 3. Comparative analysis of different Virtual machine migration techniques

VM migration	***Techniques***	***Advantages***	***Disadvantages***
Non-Live	Stop VM at source node and then transfer to destination	Simple and easy to use	Require more down time
	Pre-copy method	Downtime is less than a second	Copied transmission overhead
		Migration is totally transparent to the application, OS and remote customers.	
	Adaptive rate limiting method	Service downtime is low <60ms	Total migration time is low
	Post –copy method	Every memory page is transmitted only at once	Downtime is more as compared to pre-copy
		Less overhead	

Other approaches	CPU scheduling and recovering system	It works on CPU scheduling and recovering system	Does nr work well in more complex system
		Decrease the downtime as well as total migration time when compared with pre-processing techniques	
	Check pointing/recovery and trace/ replay approach	VM migration is fast and transparent	This technique is used only when the replay rate is larger than the log growth rate
		The migration and down time of the system are decreased totally	

2.CHALLENGES IN LIVE VIRTUAL MACHINE MIGRATION

Live migration has number of challenges as shown in table 4. The challenges considered are; Low bandwidth, Fault network, Memory intensive applications, memory state between clusters and security [15].

Table 4. VMM challenges

Challenges	***Description***
Low bandwidth	To transmit the images with large size VM need large bandwidth to allocate the images
Fault network	In post copy technique, when VM tried to fetch pages from destination node that are not being transferred, it moves back to the source host thus creating network faults by suspending the VM at source node
Memory intensive applications	Decrease the overhead of post copy migration method
Memory state between clusters	It become a challenge to transfer the control of memory and CPU between the host system
Security	The external attack such as Denial of service (DoS) directly affects the VM manager.

3. ALGORITHMS USED IN THE EXISTING WORK

In this section, we are discussing the algorithms and techniques used in the existing works for virtual migration in cloud computing [16]. The algorithms are GA, PSO, ACO, ABC, ANN and Fuzzy Logic.

Table 5. Comparative analysis of algorithm used in VM migration

Algorithms	***Description***
Genetic Algorithm (GA)	GA is inspired from the fitness function via evolution.
	There are chromosomes that can be represented in the form of elements known as genes.
	It generally works with the chromosome (solution) arbitrary population.
	General parameters used for the simulation in GA are: Number of general, cross over, population size and mutation.
. Particle Swarm optimization (PSO)	It is evaluated from the social behavior of birds mitigating flock for reaching the destination which is not known.
	'Particle' is the bird's flock for every solution.
	In this, every bird finds a definite solution/direction from the local region.
	This process needs social intraction as well as intelligence.
Ant Colony optimization (ACO)	ACO is developed by Dorigo by considering the fact that Ant are able to find the shortest path from source to destination node.
	In ACO ants generates n number of processes.
	Every Ant is evaluated by using an objective function
Artificial Bee Colony (ABC)	It is a swarm inspired algorithm
	It mainly comprises of three components: Employed bee, onlooker bee, and Scout bee.
	Employed Bee is responsible for searching the food from the hive.

	Onlooker bee is responsible for increasing the quality of the food
	Scout Bee is responsible for utilizing employed bee
Artificial neural network (ANN)	It is based on the biological function in whch the relation between input and output are determined.
	It works by observing the data sets and provide a better solution.
	ANN considered a random data rather than the whole data set
	It comprises of three layes namely input, output and hidden layer that are interconnected with each other.
	In the hidden layers weights are attached that modified the results as per the requirement
Fuzzy logic	It is an extension of multilogic function
	It works on If and Else statement
	It uses membership function to input all fuzzy values
	Execute the rules and then provide output by using De-fuzzification
	Membership function is used to minimize Boolean logic

4 . RELATED WORK

A comparative analysis has been given in below table. The table covers environment, techniques used, advantages as well as disadvantages of the work done previously by number of authors.

Table 6. A glance of existing techniques

References	***Environment***	***Techniques used***	***Advantages***	***Outcomes***
Beloglazov	CLOUD SIM	MBFD (Modified Best Fit Decreasing), MM (Minimization of Migrations	Less energy consumption Cloud computing reduce the storage of data center, Load of CPU, disk has been balanced	The parameters like SLA, number of VM migrations has been evaluated
M. S. Pilavare [56, 2015]	CLOUD SIM	Genetic algorithm	Make spam decreases Performance increases	Priority has been determined on the basis of different algorithm such as Round Robin, FCFS and GA.
M. F. Akbar et al. [58, 2016]	CLOUD SIM	Median Deviation based Task Scheduling (MDTS),	Reduce makespan High Quality performance is obtained	Performance parameters like make span, SLR, speedup, efficiency and number of better quality solution haven been measured. MDST algorithm perfrom well than all other existing algorithms
Gao	JAVA	A binpacking and a MMAS (max–min ant system) algorithm, Ant clony optimization	The proposed system is more efficient and reliable than other existing algorithms	The performance parameters such as Power consumption, resource wastage, With respect to correlation coefficient has been measured
Han	CLOUD SIM	RUA (Remaining Utilization Aware), PA (Power aware)	These algorithms are sued in hybrid for completing the VM task in cloud data centre	Prevent server from overload Reduce SLA violations
Tsakalozos	CLOUD SIM	VM migration, Priority based algorithm	Load sharing Increase utilization of physical amchine High consumption of task scheduled during less load	The performance parameter like SLA violation has been measuredCost driven policy
Zhang,	CLOUD SIM	VM migration, Clustering algorithm	Effective VM migration in cloud media Total internal traffic in cloud media decreases	The parameters such as total migration time, total data transmission, the average packet exchange frequency

				are determined
Borhani,	CLOUD SIM	Energy aware VM migration, MBFD	Minimize SLA violation Less energy consumption	The proposed algorithm achieved SLA violation up to 73% and energy consumption up to 81%.

5. CONCLUSION

This paper dealt with the current research evaluation on virtualization for the effective utilization of the resources following its categories. VMM is necessary for different reasons, like, energy reduction, load balancing, dynamic resizing as well as enhancing availability. The VM migration assists the effective utilization of having different objectives of resource management. Usually, VMM procedure thoroughly provides the application performance until and unless it is being attended by enhanced optimization techniques. A comparative analysis of work done by number of author has been provided in the review.

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