Optimized Resource Allocation in Fog-Cloud Environment Using Insert Select

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Abstract. Energy management in modern way is done using cloud computing services to fulfill the energy demands of the users. These amenities are used in smart buildings to manage the energy demands. Entertaining maximum requests in minimum time is the main goal of our proposed system. To achieve this goal, in this paper, a scheme for resource distribution is proposed for cloud-fog based system. When the request is made by the user, the allocation of Virtual Machines (VMs) to the Data Centers (DCs) is required to be done timely for DSM. This model helps the DCs in managing the VMs in such a way that the request entertainment take minimum Response Time (RT). The proposed Insert Select Technique (IST) tackle this problem very effectively. Simulation results depicts the cost effectiveness and effective response time (RT) achievement.

Keywords: Cloud Computing · Micro grid · Fog Computing Macro Grid · Smart Grid

1 Introduction

Cloud Computing (CC) is a large scale user(s) facilitating paradigm which delivers services on the Internet as mentioned in [1]. It provides tremendous chances to Information Technology (IT) industry. There are three Cloud Computing Services (CCS) which play important role. in Cloud Computing Environment (CCE). These CCS are playing an important role in energy consumption techniques on large scales. These are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) as mentioned in [2,3]. CC is used in many industries Vast and most of the use of CC is in IT industry. CC and its architecture for resource allocation is well defined in [4].

CC has emerged as fast grown fragment of IT industry according to [5]. The data on cloud demands for the safety of data on cloud. Major issue of CC is it's security. [5] explains security issues and provides understanding of risks associated with cloud.

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Fog Computing also have security issues but it is preferred over cloud as it is secure as compared to CC. Data is permanently stored at cloud but the processing data is available at Fog. Authors in [6] explains the issues of Fog computing. The main purpose of placement of fog in the CCE is to minimize the load for DSM. There are number of consumers on DS that requests for different amount of energy. The time during which highest amount of energy is consumed by the users is known as Peak Time (PT). The major issue of the energy requirement and it0s management is faced by cloud during PT. In this paper, continents and the peak time considered for continent regions is shown in Table 1.

Table 1. Peak time considered for each continent

Continent	Peak start time (GMT)	Peak end time (GMT)
North America	01:00pm	05:00pm
South America	02:00pm	06:00pm
Europe	03:00pm	07:00pm
Asia	03:00pm	07:00pm
Africa	02:00pm	06:00pm
Oceania	04:00pm	08:00pm

Table 1 shows the continents with our peak start and end time (GMT) which we have assumed. In our assumption, we considered 4 h out of 24 as the peak hours for every continent.

CloudSim tool is used for simulation purpose. Service Broker Polices (SBPs) in the CloudSim manages the routing between DCs and clusters. SBPs described in [8] are: Closest Data Center Routing (CDC), Optimize RT (ORT) or Perfor-

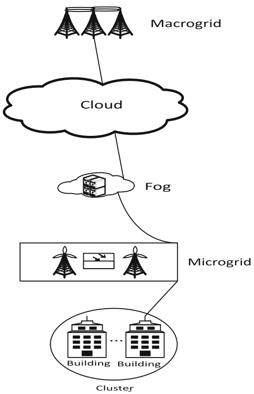

Fig. 1. Proposed system model

mance Optimized Routing, Reconfigure Dynamic Routing (RCD), and Advance SBP (ASBP). Cloud-Fog computing model is shown in Fig. 1

2 Motivation

Cloud and Fog services are used in such a way that all the requests are managed efficiently to allocate the resources to deal with the requests made by users on the system. Earlier, authors use different cloud and fog techniques to optimize the workload in large scale cloud environment by intelligent resource distribution techniques.

Fatima et al. in [2] used RR-algorithm with ASBP to minimize the load in fog environment. Authors in [3] use Particle Swarm Optimization (PSO) Load Balancing Algorithm to balance the load, and helps in maximize the services on cloud and fog. However, we also balanced the load on fog using a proposed IST technique. In our proposed model, we have considered a scenario in which there are 6 regions in a cloud-fog environment. Each region is actually a continent. Users submit tasks and to deal the tasks, VMs are required. IST allocates the task to VMs. The main focus of proposed model is on improving the PT and RT of DCs.

3 Problem Statement

As we are aware that there are several problems that may occur in CCE. Dealing with these problems is a challenging issue which is discussed in this section. The major problems that occurs in CCE are: First problem in cloud environment that occurs is to handle the coming requests from the user to the DCs in such manner so that the response time does not exceed too much so that there is a large delay in fulfilling the user request. User demands are the most important things in any system. Second problem that occurs in CCE is to check the status of resources i.e. whether available or busy. If any resource is busy then job to be done by VM is shifted to some other VM which is available and capable to perform the task. IST model works in such a way that it deals with the problems mentioned above very conveniently.

4 Related Work

For resource distribution, A cloud-fog based model is presented in [2] where authors use RR-algorithm and the SBP used here is Dynamic Service Proximity Service Broker Policy.

Valle et al. in [8] describes the use of PSO in power systems for solving non-linear optimizing problems. They use PSO and its variants for optimization of power system.

Wang et al. in [9] presented three layered model for traffic management. These techniques are implemented in CCE in such a way that they provide flexibility and reliability to the users as well as the system. Dehghanpour et al. in [10] uses a hybrid of Cuckoo Optimization algorithm and linear programming algorithm for dealing the overlays of Micro-grids (MGs).

In [11], Bogaraj et al. proposed ANFIS system for managing micro-grids. It is used for HRES. For implementation, MATLAB is used. There are many other techniques that are used for optimization in different prospectives.

Zachar and Daoutidis in [12] explains the scheduling of MGs. The focus is on minimizing the operational cost and surety of exchange of commitments.

Huld, Moner and Kriston in [13] presents a GIS-based model for estimating the mini grid system performance. Geo-spatial analysis and output energy mapping is the main methodology for GIS-based model. In [13], authors analyze small scale model which is based on photo-voltaic mini grid system.

Authors in [14] uses Enhanced Bee Colony Algorithm for minimizing the load on MGs. The analysis for such purposes is done in large as well as small scale system models.

Tumuluru, Huang and Tsang in [15] presents demand amount estimation model. The main purpose is to fulfill DS power request.

In [16], authors presents a framework for cloud data centers (DCs). This framework is named as StarCube. It is first system that handles fat-tree networks by allocating and de-allocating the requested services.

Earlier, the focus was on energy generation, but now the main focus is on minimizing the energy wastage in existing energy generation system. Author in [18] uses Genetic Algorithm for balancing the load in the CCE.

Nguyen, Thoai and Nam in [17] uses genetic algorithm for allocating VMs in private cloud and authors in [18] also uses GA for load balancing in cloud environment.

In [19], authors describes the importance of balancing the load in cloud environment and describes the survey made by the author. Authors also explain the challenges in cloud environment and techniques to overcome the load. Authors in [20] uses Dragon Fly Algorithm (DFA) for load management. The main purpose for DFA is to reduce the un-necessary and vague behavior in binary search problem.

Smart Grid (SG) concept uses the same technique of load balancing in Energy Management System (EMS) mentioned in [21].

Author in [22] also explains about the tools that are used for the analysis of performance.

Sahni et al. in [23] proposed heuristic scheduling Technique for handling the workflows that occurs in cloud environment. Monitor-control-loop manage the workflow in cloud environment in such a way that cost and time requirements are monitored continuously. They proposed a JIT-C algorithm which itself has 3 different algorithms for different tasks.

Wang, Zhang, et al. proposed a system FDALB which is described in [24]. Centralized and distributed load balancing techniques are used together in the proposed technique. Long and short both flows are scheduled differently in FDALB. Distributed switches handles the short flows.

Wang and Gelenbe in [25] proposed Task Allocation Platform (TAP) technique for tasks dispatching in cloud. TAP supports both dynamic and distinct static schemes. It provides solution to analytical models. Islam et al. in [26] proposed a model to conserve water for DCs. For such purpose they used GLB and Power proportionality techniques.

5 System Model

In this section we will discuss about our proposed system and its working. In this cloud-fog computing model, region 1, 2 and 6 are North America, South America and Oceana respectively. It comprises 3 clusters. Region 3, 4, and 5 are Europe, Asia and Africa respectively and they have 1 cluster in them. All of the 6 regions contains 1 fog in them hence there are 6 fogs i.e. F1,F2, ... , F6. There

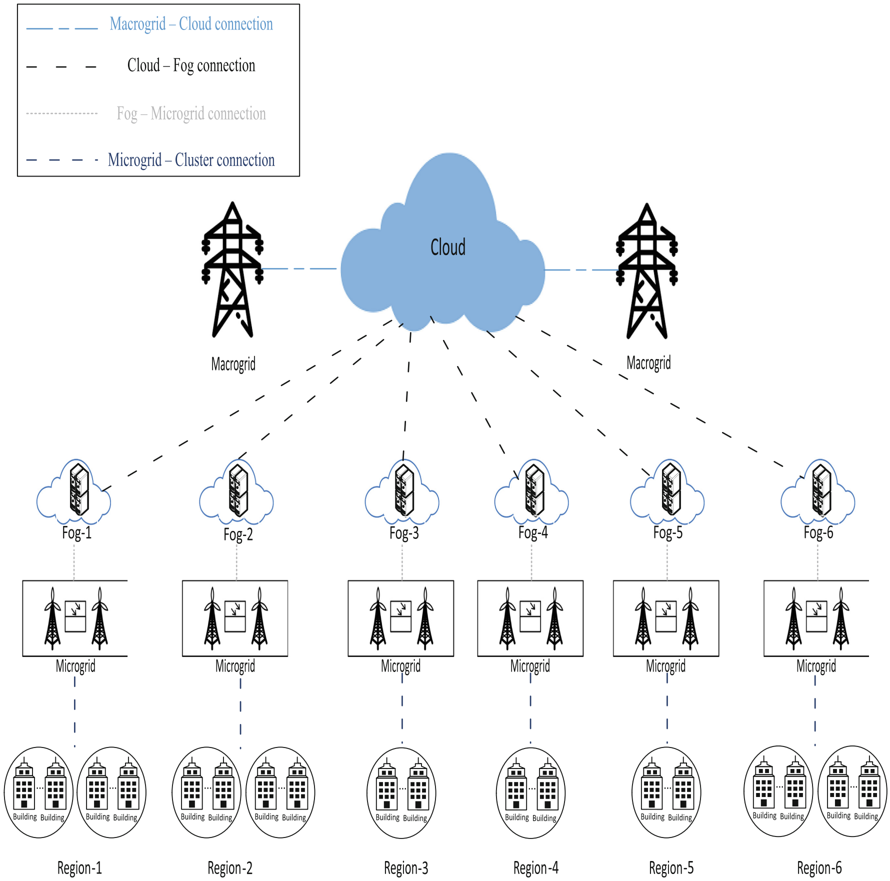

Fig. 2. Proposed system model

are total 9 clusters. They are C1, C2, ... , C9. Each cluster contains 50 buildings. Micro-grid provides electricity to the DS. VM allocation is done using IST.

The proposed scheme uses a Fog-Cloud based system which deals the users requests. Conferring to the system, there are 50 buildings considered in each cluster. Each building has 10 number of homes and 6 regions are divided into nine clusters. In this model, clusters are consist of group of buildings. Requests from consumers side are received at fog end, after this fog communicates with MGs. MGs deals with the requests and fulfill them, if not, fog contact with cloud which responds these requests. In this way, the proposed model operates. The simulation of presented technique is done in CloudSim (Fig. 2).

6 Algorithm and Working of Algorithm

This section describes the IST algorithm and its working. Working or IST is shown in the Fig. 3

6.1 IST Algorithm

Algorithm 1 IST Algo

$vmStatesList \leftarrow dataCenterController.getvmStateList()$
$getNextAvailableVM()$
$finalArray \leftarrow vmStateList.keySet()$
$doInsertionSort(finalArray)$
$whileN \leq finalArray : Length()do$
$ifvmStatesList.get \neq vmState.Busythen$
$returnfinalArray$
$endif$
$endwhile$

6.2 Working of IST Algorithm

Firstly, IST evaluates the status of VMs. If a VM is busy then the IST algorithm does not assign job to that VM. Tasks are assigned only to the idle VMs which are firstly added to the list of available VMs. A task queue is maintained. Keeping the queue under consideration, allocation of feasible resources is done and VMs handles the respective tasks.

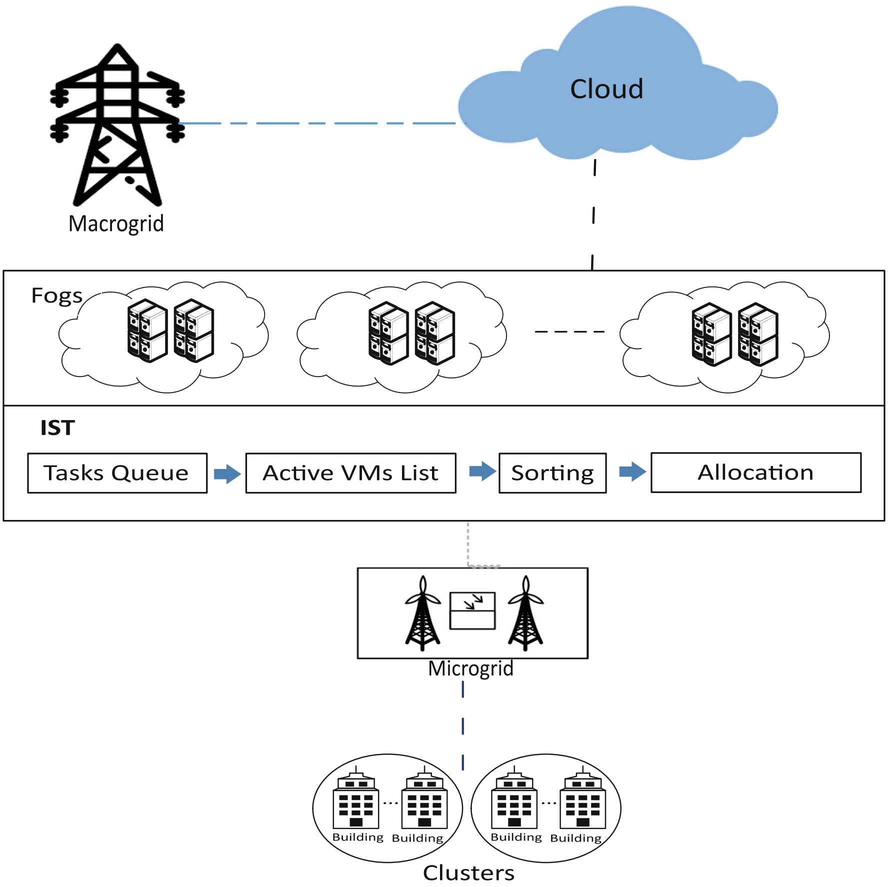

Fig. 3. Working model of IST

7 Problem Formulation

In this section, the problem formulation is discussed. As in this model, the main focus is on minimizing RT. For doing so, the whole mechanism for computing it, is it's formulation (Table 2).

The problem is given by:

$$P : \min\{RT\}$$
$$VM_{status} = \begin{cases} 1 & \text{if } VM = Available \\ 0 & \text{if } VM \neq Available \end{cases} \tag{1}$$

$$RT = \omega_{ftime} - \omega_{ftime} + \omega_{dtime} \tag{2}$$

Table 2. Notations and their meanings

Notations	Meanings
RT	DC response time
ω_{ftime}	Finishing time of the task
ω_{stime}	Starting time of the task
ω_{dtime}	Transmission delay time
Nt	Number of tasks
Nv	Number of VMs

8 Performance Evaluation

In this section, the performance of the proposed system is discussed. In this paper, plots of RR-algorithm and IST are shown which are generated using CDC routing (SBP).

Table 3. System specifications on which simulations performed

Processor	Intel Core i3
CPU	1.7GHz
System type	64bit-OS
Windows	Microsoft Windows 8.1 Pro
RAM	4GB
Hard Drive	500GB

Table 4 shows the DC RT using RR-algorithm.

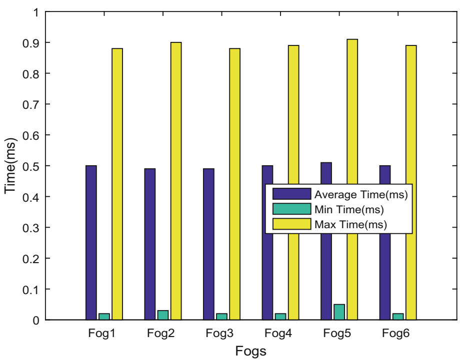

Fig. 4. DC RT using RR

Table 4. DC RT using RR

DC	Avg. (ms)	Min. (ms)	Max. (ms)
Fog1	0.5	0.02	0.88
Fog2	0.49	0.03	0.9
Fog3	0.49	0.02	0.88
Fog4	0.5	0.02	0.89
Fog5	0.51	0.05	0.91
Fog6	0.5	0.02	0.89

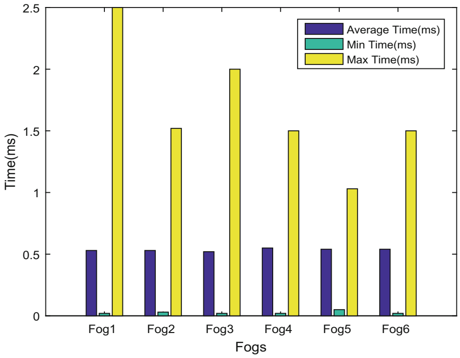

Fig. 5. DC RT using IST

Table 5. DC RT using IST

Fog	Avg. RT (ms)	Min. RT (ms)	Max. RT (ms)
Fog1	0.53	0.02	2.5
Fog2	0.53	0.03	1.52
Fog3	0.52	0.02	2
Fog4	0.55	0.02	1.5
Fog5	0.54	0.05	1.03
Fog6	0.54	0.02	1.5

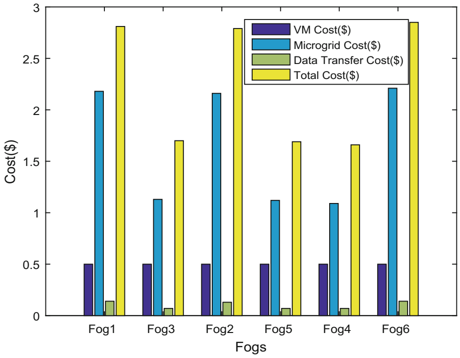

Fig. 6. Fog cost using RR

Table 6. Total fog cost using RR

DC	VM cost ($)	MG cost ($)	DT cost ($)	Total cost ($)
Fog1	0.5	2.18	0.14	2.81
Fog3	0.5	1.13	0.07	1.7
Fog2	0.5	2.16	0.13	2.79
Fog5	0.5	1.12	0.07	1.69
Fog4	0.5	1.09	0.07	1.66
Fog6	0.5	2.21	0.14	2.85

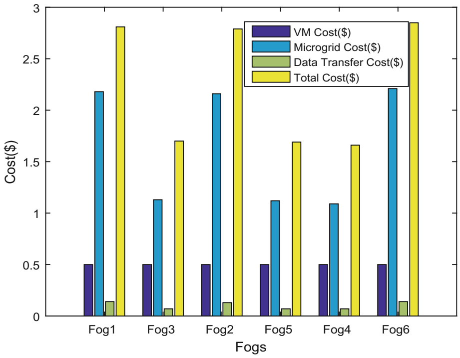

Fig. 7. Fog cost using IST

Table 7. Total cost using IST

DC	VM cost ($)	MG cost ($)	DT cost ($)	Total cost ($)
Fog1	0.5	2.18	0.14	2.81
Fog3	0.5	1.13	0.07	1.7
Fog2	0.5	2.16	0.13	2.79
Fog5	0.5	1.12	0.07	1.69
Fog4	0.5	1.09	0.07	1.66
Fog6	0.5	2.21	0.14	2.85

Table 5 shows the results of DC RT using IST. The average DC RT is 0.53ms
Table 6 shows Total Fog Cost using RR-algorithm.
Table 7 shows the Total Cost of Fog using IST.

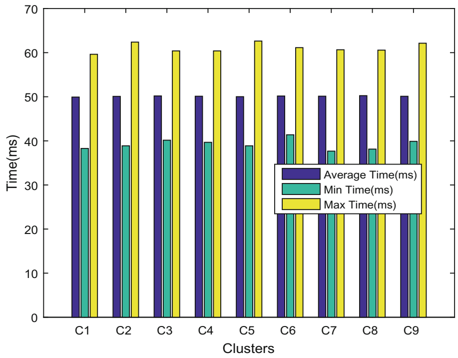

Fig. 8. RT by region using RR

Table 8. RT of region using RR

Cluster	Avg. RT (ms)	Min. RT (ms)	Max. RT (ms)
C1	49.93	38.28	59.63
C2	50.09	38.88	62.39
C3	50.19	40.15	60.4
C4	50.12	39.67	60.4
C5	50.02	38.88	62.63
C6	50.17	41.38	61.14
C7	50.13	37.67	60.66
C8	50.25	38.13	60.57
C9	50.11	39.89	62.14

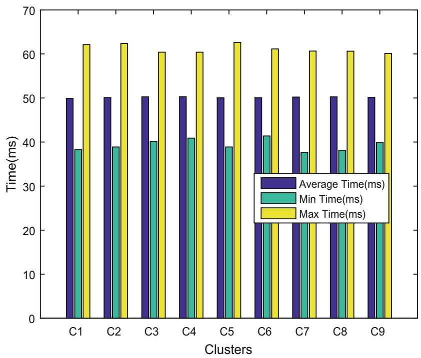

Fig. 9. RT of region using IST

Table 9. RT of region using IST

Cluster	Avg. RT (ms)	Min. RT (ms)	Max. RT (ms)
C1	49.93	38.28	62.14
C2	50.11	38.88	62.39
C3	50.26	40.15	60.4
C4	50.28	40.89	60.4
C5	50.04	38.88	62.63
C6	50.06	41.38	61.14
C7	50.21	37.67	60.66
C8	50.26	38.13	60.63
C9	50.16	39.89	60.13

Fog Cost for both the algorithms is same. Total VM cost is 3.00 ($), total MG cost is 9.88 ($) and total Data Transfer (DT) cost is 0.62 ($) (Table 8).

The graphs in Fig. 8 shows the RT of regions (clusters) using RR-algorithm. Table 9 shows the regions RT for IST.

The above Figures shows that the simulation results using IST and RR-algorithm are nearly equal.

9 Simulation Results

In this section, there is a discussion about simulations and their outcomes. For the simulation results, there are some considerations of price scheme, data and memory storage. Assumed cost per hour for VM at each fog is 0.1$. Storage cost per second considered is 0.1$. Memory cost per GB assumed is 0.1$. Data transfer cost per GB is 0.1$. 1 Physical hardware unit is placed at each fog. 10 users can be treated simultaneously. Instruction length of request is 100 bytes. Number of

VMs at each fog are 5. Image size is 10000 bytes. Bandwidth considered is 1000. Fog memory is 20GB. Number of processors in each fog are 4. Time shared VM policy is used.

The proposed IST technique is compared with RR-algorithm using different SBPs to evaluate the performance of proposed system. The simulations are performed in cloudsim using a system comprising hard drive capacity of 500 gigabytes (GB) and RAM of 4GB memory size. Further details of system are mentioned in Table 3. The outcomes of IST are shown in the plots and tables above which justify that performance of IST is satisfactory and nearly closer to the RR-algorithm which is further able to be improved. RT of DC for RR-algorithm is shown in Fig. 4 and RT of DC using IST is shown in Fig. 5. Overall cost of fog using RR-algorithm is shown in Fig. 6 and overall fog cost using IST is shown in Fig. 7. Figure 8 shows the RT of regions using RR-algorithm and Fig. 9 shows the RT of regions using IST.

Evaluating the results, it is obvious that the cost is almost the same for IST but the RT of IST is greater than that of RT calculated using RR algorithm. The RT of the DCs and Regions can further be minimized by making changes in the proposed scenario like we can introduce a new SBP and compute the performance using IST.

10 Conclusion and Future Work

In this paper, a resource allocation in cloud-fog environment have been discussed. The proposed technique, IST, efficiently allocate the resources to DCs and fulfill the DS requests. In this paper, the focus is on allocation of VMs to DCs. The efficiency of IST is computed by comparing the RT and Cost. It can be seen from the concluded results that the cost of the fog and cluster is almost the same. The RT of IST is also similar to the RT of RR algorithm. Low cost and RT shows the reliability of this system.

The proposed technique has the ability to provide even better results by making small changes in it. In future, we plan to hybrid RR and IST to compute the performance of present scenario and also after making changes in the current one as well. We also plan to compute the performance of IST using some other SBP(s) in future.

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