Real Time Resource Scheduling Framework for Smart City

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Abstract. Smart City plays a vital role in social development. Real time scheduling of different tangible and intangible resource in distributed environment in smart is challenging problem. The different disaster management tasks smart city applications such as floods, earthquake, pandemic, fire, disaster relief, and control of hazardous area, major accidents, control of terrorism and other attacks require real time emergency resources scheduling. The existing techniques uses for smart city resource management are suffering from low resource utilization and high response time, migration and preemption overhead. This work paper presents cluster based real time resource scheduling framework for emergency situation in smart city. The edge computing resources are group into cluster. The proposed framework increases resources utilization and reduces response time, migration, preemption overheads. The emergency tasks are scheduled to these computing cluster are allow to migrate within the cluster to ensure to reduce migration, switching overhead, response time and increase resource utilization and success rate.

1. Introduction
The smart city improves the leaving standard of life. The resource scheduling is used to manage and optimize the different smart city resources such as energy, transportation infrastructure, health, environmental and human etc. in smart city. There is requirement to schedule these resources in such way that improve resource utilization and reduce response time. Lot of research work has been done in the past on emergency response systems[1]. The resource scheduling for fire disaster management using dynamic model, resource allocation model under time constraint[2], resource management under multiple disaster places[3][4]. Real time resource scheduling in distributed environment is still open research problem[5]. Different resource management techniques for edge computing survey are represented by Tang [6]. The adaptive algorithm for smart city resource management is presented by Zhang[7]. Fog and mobile computing resource management and development in real time resource management in fog computing is done[8]. The different challenges face in smart city resource management is describe by Law[9]. Real time application in smart city and its requirement and scheduling techniques is represented by Gasco[10]. Optimal job shop scheduling techniques is mentioned by Liu M[11]. The workflow scheduling approach is used in edge computing data centre is described [12]. Energy efficient resource scheduling in cloud computing data centre is described [13]. Dynamic service migration mechanism in edge computing is developed[14]. Resource task scheduling with low cost for mobile edge computing is presented in some research work [15]. The smart city
application tasks scheduling for edge computing is presented using multi-server techniques [16]. This paper proposed real time resource scheduling by grouping edge computing resources into cluster to ensure real time actions in emergency situations with high resource utilization, success rate and reduce migration, preemption overheads as shown in Figure.1.

The objectives of this research work are as follows:

1. To propose cluster based real time resource scheduling framework for distributed environment in smart city
2. To implement proposed scheduler using edge computing to ensure real time response and increase resource utilization
3. Analysis and Performance measure of proposed scheduler with benchmarking.

![Cluster Based Resource Scheduling Framework](image)

**Figure.1. Cluster Based Resource Scheduling Framework**

2. **Methodology**

The cluster based real time tasks scheduling model consist of set of processing nodes P and T as real time emergency smart city application tasks set.

\[ T = \{T_1, T_2, T_3 \ldots T_n\} \]  \hspace{1cm} (1)

The task is characterized by \( Ti(ei,di,pi) \) where

- \( ei \): Tasks \( Ti \) worst case execution time
- \( di \): Tasks \( Ti \) deadline
- \( pi \): Tasks \( Ti \) period

The tasks utilizations represented as

\[ U = \frac{ei}{pi} \]

The implicit deadline tasks model is used where deadline of task is equal to period of the tasks

\[ di = pi \]. The set of computing resources are as mention in equation 2.

\[ P = \{P_1, P_2, P_3 \ldots P_m\} \]  \hspace{1cm} (2)
The scheduling of tasks to processing nodes is a global scheduling problem where the set of tasks is maintained in one global run queue and tasks scheduler dispatch tasks to any free processing nodes. The maintenance of long run queue is difficult as the number of tasks in common run queue increases as shown in Figure 1.

2.1. Cluster Formation
Cluster based resource scheduling groups the processing nodes into cluster. The propose scheduler assigns a number of processing nodes in each cluster and create m/c number of cluster as shown in equation 3.

\[ C_1, C_2, C_3, \ldots, C_{(m/c)} \]  

![Figure 2. Global Tasks Scheduling](image)

3. Implementation Details
Implementation of proposed algorithm presented as follows.

3.1. Cluster Based Resource Sharing Algorithm
The Cluster based resource scheduling consist of two steps:
Cluster Tasks Assignment: Task assignment assigns the tasks to cluster based on worst fit tasks assignment techniques.
Cluster Tasks Scheduling: It schedule the order of execution of tasks executed on the processing nodes as shown in Fig.3.
Algorithm: Cluster Based Real Time Resource Scheduling

*Initialize Tasks Set T = \{T1,T2,T3,\ldots,Tn\}*

*Initialize Processing Nodes P = \{P1,P2,P3,\ldots,Pm\}*

*Initialize Size of Cluster c = 2^i \text{ for } i\in\{1,2,3,\ldots,k\}*

*Create Clusters Set C = \{C1,C2,C3,\ldots,C(c/m)\}*

for each cluster C1 to C(c/m) do

  for each task From Ti from i = 1 to n do

    if U(Ti) \leq c then

      c = c - U(Ti)

    else if U(Ti) > c

      Select next C

    else

      Tasks not Schedulable

    end if

  end for

end for

4. Results and Discussion

The performance analysis of proposed cluster based real time resource scheduler is done using simulation for real time tsunami disaster management system on edge computing platform. Tsunami disaster management system consists of two part detection of tsunami and prevention measure after tsunami. The detection of tsunami includes the real time alert tasks for citizens, government agencies, rescue team, hospitals teams, wave tracking and identification tasks, ocean monitoring tasks. Tsunami disaster prevention includes tasks for emergency healthcare, tracking of living things in affected area, transpiration etc. The different tasks involved in detection and prevention of tsunami disaster management system are processes on edge computing cluster to provide real time response. The
simulation result shows that the proposed cluster based real time scheduler increase resource utilization and reduces response time as compare to global scheduling as shown in Table 1.

| Performance Parameters       | Global Scheduling | Cluster Scheduling |
|------------------------------|-------------------|-------------------|
| Resource Utilization (%)     | 83                | 96                |
| Migration Cost (%)           | 93                | 57                |
| Preemption Cost (%)          | 81                | 67                |
| Success Rate (%)             | 74                | 91                |
| Response Time (%)            | 56                | 36                |

![Figure 4. Performance Analysis of Cluster Scheduling](image)

The proposed scheduler increase resource utilization and success rate by approximately 14% and 22%. The response time using proposed scheduler reduces by 55%. The migration and preemption overhead with proposed scheduler is reducing by approximately 63% and 20% respectively.

5. Conclusions
Smart city plays an important role in urban and social development. Emergency resource management is challenging tasks due to new requirement of smart city such as real time response, distributed recourses and self organization. The propose cluster based real time resource scheduling group the edge computing nodes into cluster and different disaster management tasks scheduled on these cluster computing nodes for real time response. Cluster scheduling ensures the efficient scheduling of emergency applications tasks. The proposed cluster based real time scheduler increase resource utilization and reduces response time. Cluster based real time scheduler reduces migration, preemption
and response time. The tasks acceptance rate that is success rate is increased in proposed resource scheduling algorithm for smart city applications.

In future the proposed resource sharing framework applicable in other application areas such as defense, agriculture, etc for efficient resource scheduling.

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