

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

A Framework for Data Utility Cost Reduction in Internet of Things Employing Vehicle Nodes

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ABSTRACT: Currently, internet of Things (IoTs) has populated as new model with an increasing number of things to be adhered to an internet. Unlike from the traditional models, in internet of things the data computing mechanism is needed to systematically collect and offer the data which give sensing service. Though, an existing method of data computing are unfavorable which require the consolidated and incentive-consideration to decrease the data collection cost and motivate maximum participants for collaboration. In this paper, a utility based data-computing system has been proposed, which permits the vehicles to integrate the mobile data/information in non rural area, in a manner to furnish sensing system using IoT. Initially a Game-theory based data computing algorithm has been designed, which improves the computation cost. Secondly an algorithm for “RSUs”, “RSBs” and mobile nodes in a IOT model has been developed, later the mathematical modeling for the proposed algorithm is discussed. Finally the performance efficiency of the proposed framework through simulation results have been measured. The experimental results have proved that the designed framework can effectively upgrade the sensing system using IoT with minimum cost.

KEYWORDS: Data Computing, IoT, Sensing Service, Game-Theory.

I. INTRODUCTION

“Internet of Thing” is a trending technology in current networking system. With rapid growth of advanced intelligence system and network, the IoT has appeared a new technique to give the services; like Iaas, Paas, and Saas. [15] With comparing of traditional networking system, IoT contains the power to change existing world. An IoT offer the sensor data to people on demand. Also, instead of data collection in a fixed location, there is improving of number of devices connected with internet, the sensor devices in an IoTs would provide the energetic data in various locations where the diversity of information can be acquired. Thus can be forecast that an IoTs will be extensively used in our day to day lives in upcoming days.

With increasing of importance of data-computing stems from different advance technologies increasing the major role of IoT performance. Several sensor devices in IoT can play as mobile sources where the data-computing system is required to identify more information, such as traffic-density, temperature and noise in non rural area. Like example; forecasting of traffic ranking and the advice of route depends on the sensor-data in IoTs will help to give drivers with data information for safe driving. From the collection of data computing system, it is possible to minimize traffic, can plan for driving and can predict upcoming events in various regions.

Nevertheless, the current data-computing systems cannot be methodically utilized in the IoT with succeeding reasons. Firstly, in present architecture of IoTs, the data contributor and receiver both are dependent on each other. Hence it needs meshed architecture which helps data-contributor and receiver work correctly. Secondly, the collection of sensor data services are not charge less, the data-collection pricing scheme will help the data-contributor to minimize its cost and acquire profits.

To resolve the above challenges, in this work, a utility based data computing framework required to be designed to give sensing service in IoT. First, propose the design architecture which permits the vehicle to accumulate the mobile data in non rural area, in the manner to acquire sensing services in IoT. Hence we introduce the Road side Buffer (RSB) where every RSB contains the sink-node to accumulate the sensing information from vehicles and acquire sensing service. Next, with consideration of power and time-cost, making the survey of utilities in data-computing system, incentives can be provided depends on utilities. Finally, the concept of Game-theory is utilized to scheme the interaction to decide an optimum range to acquire profit at the grouping of sensor-data. The main contributions are:

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- Design architecture for IoT hiring the “RSBs” which help the RSU to accumulate the sensor-data. The designed architecture is a united solution for data collection in IoTs.
- Depends on the survey of utilities in data-computing system, the Game-theory based data-computing algorithm is designed which improve the computation cost.
- Finally, formulate the mathematical modeling which perform the numerical-computing and simulation of data-computing framework. And evaluating the performance efficiency through simulation results.

The entire paper work is organized as; section-ii presents the project background work. section-iii highlights the review of survey. Section-iv represents the problem-statement. Section-v exhibits the methodology of proposed system. Section-vi contains the implementation-part. Section-vii examines the performance of proposed simulation results and section-viii ends with paper conclusions.

II. BACKGROUND

The traditional architecture of IoT support the combination of RSB and road side units in IoT which collects the sensor information through vehicular mobile-data. The fig.1. Exhibits the mesh architecture of IoT in collective data-collection from diverse mobile-nodes.

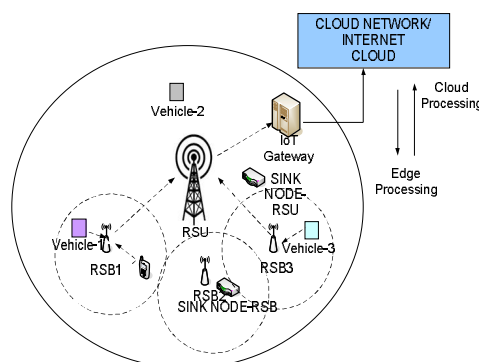


Fig 1. “Traditional IoT enabled Data-Computing Paradigm”

The traditional model of IoT integrated with multiple sensor-nodes, “RSBs”, “RSUs” with sink-node.

The design framework has been presented which gives the optimum cost during the process of data-computing using IOT enabled sensing-system. The mathematical outcomes of proposed paper show that the design framework for data-computing guarantees systematic and trustworthy data-communication with optimum cost of resource utilization.

III. LITERATURE REVIEW

This section demonstrates an explicit new review study towards predictable data computing standard into the IoT. There are some important studies has illustrated about the information pertaining to the conceptualization of various IoT enabled data computing methods.

The work done by Zu et al [1] frequently analyzed different “*Distributed Complex Event Processing (DCEP)*” methods and also intended an integrated design for smart grid Internet of Things (IoT) examining. As per numerical model performance study is not proposed however the performance efficiency has been calculated from view point of theoretical.

Another work proposed by M.Gio et al. [2] an “*Energy efficient target tracking protocol*”, which reduces the energy utilization by reducing of the sensors which is utilized in tracking of target and as well as decreasing quantity of the data being sent to the cluster head (CH). In this paper two major algorithms is demonstrates by authors which are- a) “*Reduced Area Reporting (RARE-Area)*” and b) “*Reduction of Active Node Redundancy (RARE-Node)*”. The major role of “*RARE-Area algorithm*” is to decrease the sensor nodes and it’s utilized for tracking by investigating an

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amount of the data. And the significant role of “**RARE-Node**” algorithm is reduces the superfluous data amount in the network by study the spatial data in between nearby sensors.

The paper work illustrates by G.Han et al 2.16 [4] a new of “**Green Routing Protocols (GRP) for Wireless Multimedia Sensor Networks (WMSNs)**”. The routing-protocol can handle the tradeoff between network and “**Quality of Sensor (QoS)**” conditions. The authors have demonstrated review study of routing protocol for WMSNs which categories into two parts: - a) Single Layer and b) Multi Layer. It is depend upon network structure.

Another work carried out by Z.Su and Y.Hui 2017 [5] a design of “**Content centric vehicular networks (CCVN)**”. The component of content centric is able to exchange the information among one vehicle to another and controlled based on its identification record. To transfer the information for vehicles using integrated algorithm.

A.Mehrabi and K.Kim [6] have using mobile sink have illustrated “**Energy harvesting sensor-networks**”. The authors mostly demonstrated over issues on data-collection over “**Energy-Harvesting**” sensor networks by using of mobile sink with jointed mobility prototype that may shift over direct path. To exploit the Network throughput, a technique is applied to choose the nmbr of time-slots to entire “**sensor-node**”.

Authors M.Zhao and C.Wang [7] of the “**Three-layered framework for mobile data gathering in the “WSN”**”. For an example a) **Sensor-Layer**, b) **Cluster head-Layer**”, and c) **Sen-Car” Layer**. The planned structure utilizes the “**Distributed load-balanced Clustering**” with double data-uploading, which is followed to as “**LBC-DDU**”.

S He et al, [8] demonstrated an algorithm for “**Location dependent task in crowd-sensing**”, initial they discovered the allocation issue assignment. After that they considered the apportion location dependent task issue by allowing the environmental characteristics and spatial movement qualities of the mobile customers.

The study done by X.Li et al. [9] using a new technique called Vehicle based MSNs for monitoring of Traffic. Here, use of vehicle sensor data is for traffic monitoring. To save the communication cost and avoid network congestion by using these sensor nodes which generally set with long periods.

In X Duan et al [10] have illustrated the distributed-algorithm to execute “**Walrasian-Equilibrium**” into “**Mobile-Crowd Sensing (MCS)**”. This structure optimizes the pricing and distribution task by finding the “**Walrasian-Equilibrium**” which attains the social-welfare maximization.

IV. METHODOLOGY

To develop a framework for analysing the data collection cost using a IOT architecture employing RSBs, RSUs and Vehicular nodes by measuring the utility of these components. Using the utility factor a game model is developed for increasing their participation in data collection and optimizing the data collection cost. The utility based data-computing framework performs the succeeding operations. i. “**RSU**” deployment, ii. RSB and vehicular-nodes deployment, iii. Accomplish cooperative communication, iv. Cost-estimation by game theory and v. execution analysis.

A. Proposed system model

The conceptual design model of proposed utility based IoTs assisted cost-effective data-computing scheme to allow the sensing-services.

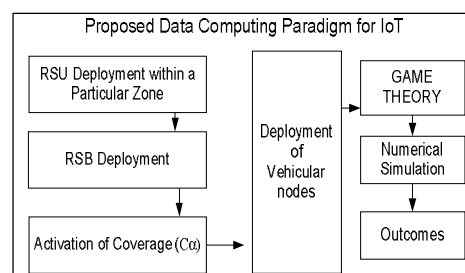


Fig.2 designed system-model

In proposed system-model, motivation based Game-theory has been proposed which acquire the optimum cost through data-computing operation of IOT based sensing-services as shown in fig.2. The mathematical outcomes of

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proposed paper show that the design framework for data-computing guarantees systematic and trustworthy data-communication with optimum cost of resource utilization.

B. Flow design for “Game-Theory” based mathematical simulation.

Fig.3, exhibits the needed procedure to implement for the reason of simulating the designed sensor based and IoT entitled data-computing system. And also exhibits how the designed model incorporates the estimation-cost for both RSUs and RSBs. The Game-Theory scheme ensures the utility metric along with framework performance efficiency.

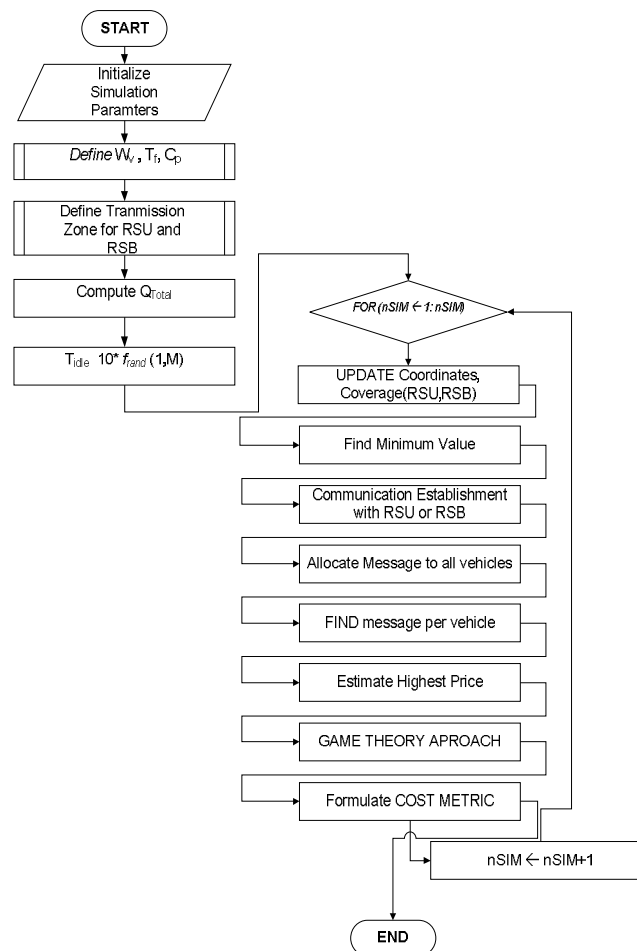


Fig.3 Flow design for “Game-Theory” based mathematical simulation

V. IMPLEMENTATION

The proposed system implementation is divided into following sections as described below:

A. Deployment of ROAD SIDE UNIT (RSU).

“RSU” module describes the deployment strategy of transmission factors. The RSUs transmission radius initializes and localized the coordinates x,y both are allocated as transmission radius (Tr.). the band-width factor is allocated as transmission-rate for zones. And the further RSU with zone visualization is accomplished.

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Algorithm for Road Side Unit Deployment

Input: T_r

Output: RSU with Zones

Start

Initialize: T_r

$[X_{rsu}, Y_{rsu}] \leftarrow T_r$

$T_{rate} \leftarrow BW[]$

Visualize \rightarrow RSU, Coverage of RSU, RSU Zones

End

B. Deployment of RSB

This module describes the process involved into deployment of RSB unit. In this, the radius (R_{rsb}) transmission is initialized for the reason of RSBs localization. Below algorithm represents the step by step procedure to follow the respective operations.

ALGORITHM: Deployment modeling of an RSB

Input: R_{rsb}, M

Output: RSU deployment within a particular Zone (Z), Activation of coverage (Co)

START

Initialize R_{rsb}, M

Initialize $T_{r(rs b)}$

$T_{r(rs b)} \leftarrow TR[]$

Compute the area of deployment

$(A) \leftarrow 2 \times T_r$

Process Node Localization

$i \leftarrow 1$

WHILE 1

$i \leftarrow i+1$

Generate new Coordinates

$[t_1, t_2]$

$\leftarrow \sum ((R_{rsb} + (A - 2 \times R_{rsb}) * f_{rand}(1)))$

Compute, RSU distance

$d_{rsu} \leftarrow \sqrt{(t_1 - X_{rsu})^2 + (t_2 - Y_{rsu})^2}$

IF $d_{rsu} < R_{rsb}$

Continue;

END

$[X_{rsb}, Y_{rsb}] \leftarrow [t_1, t_2]$

Break

END

Generate other coordinates

$i \leftarrow 0$

IF $M > 1$

WHILE 1

$i \leftarrow i+1$

Generate new coordinates

Current

Distant = $\sqrt{(t_1 - X_{rsb})^2 + (t_2 - Y_{rsb})^2}$

$d_{rsu} = \sqrt{(t_1 - X_{rsu})^2 + (t_2 - Y_{rsu})^2}$

IF

$\sum (Currentdis) : t < 2 \times R_{rsb} \Rightarrow 1 \parallel d_{rsu} < R_{rsb}$

$X_{rsb} \leftarrow [X_{rsb}, t_1]$

$Y_{rsb} \leftarrow [Y_{rsb}, t_2]$

$T_{r(rs b)} \leftarrow T_R[]$

END

END

END

END

C. Numerical simulation

The designed framework additionally performs 50-rounds for extensive simulation and produces an survey on distinct cost oriented parameters; like cost of RSBs, cost of RSUs, RSBs utility and RSUs utility etc. the below algorithm exhibits the step by step numerical simulation procedure for the proposed model.

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STEPS FOR NUMERICAL SIMULATION

Input: Total Data (Q_{Total}), Total Round (T_R)

Output: Simulation

START

Initialize simulation parameters

Define W_v, T_{fs}, C_p

Define transmission zone in RSU and RSB respectively

Define D_{rsu}, D_{rsb}

Compute Q_{Total}

Generate Idle Time

$T_{idle} \leftarrow 10 * f_{rand}(1, M)$

FOR ($nSIM \leftarrow 1: nSIM$)

UPDATE Coordinates

Formulate Coverage of RSU, RSB

Define $T_{r(rsu)}, T_{r(rsu)}$

Measure vehicle capacity

Compute size of the data

$DATA_{SIZE} \leftarrow 0.1 + 0.9 f_{rand}(1, Q_{Total})$

Initialize Connect_{ID}

Compute the distance between vehicle and all the other respective RSB

$$d \leftarrow \sum_{i=1}^{length(X_v)} \sqrt{(X_{rsb} - xv_i)^2 + (Y_{rsu} - yv_i)^2}$$

FIND Minimum value

IF MINval $\leq R_{rsb}$

Plot Connection with RSB

ELSE

Plot connection with RSU

END

END

Highlight vehicles serving to rsb

Allocate message to all vehicle

FIND message per vehicle

ConnID, get vehicle ID, RSB, RSU ids

GET $T_{r(rsu)}$

Compute Cost_(rsu,rsb)

ESTIMATE **highest price offered by buyer**

APPLY GAME THEORITICAL APPROACH

Compute Cost of RSB, RSU and Utility of RSB, RSU

Visualize Outcome

End.

VI. RESULTS

The obtained outcomes from the system are given here. The system is processed by using MATLAB.

A. RSU Deployment

The RSU deployment is represented in communication area segmented as seven zones. The green rectangle area is the deployed RSU.

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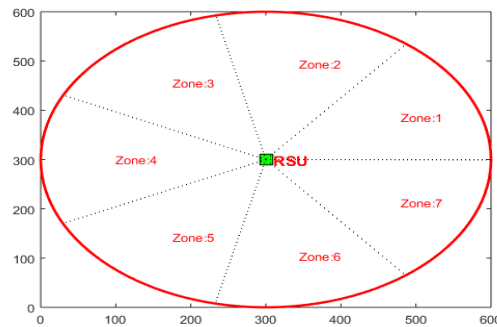


Fig 4. Deployment of RSU with seven zones

B. RSB Deployment

The RSB Deployment results are as shown in fig.5-fig.8 with the varying values of number of RSB and the radius.

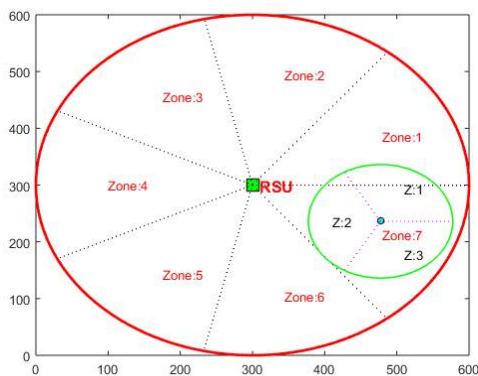


Fig.5. Deployment RSB with $r=100$ and $N=1$

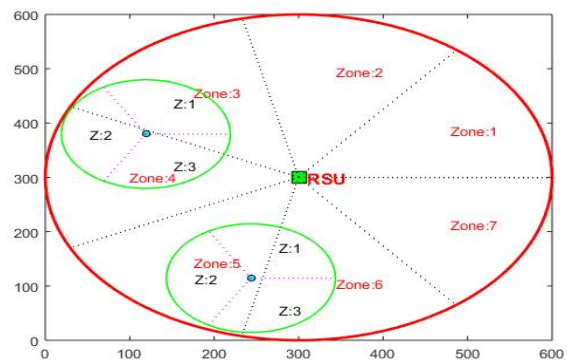


Fig.6. Deployment of RSB with $r=100$ and $N=2$

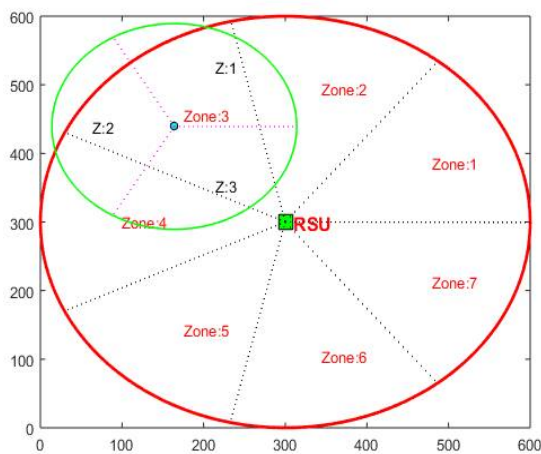


Fig. 7. Deployment of RSU with $r=150$ and $N=1$

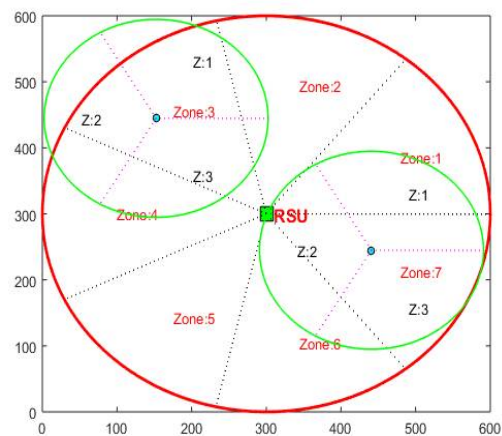


Fig.8. Deployment of RSU with $r=150$ and $N=2$

C. Vehicular Node Deployment

The vehicle deployment results with density values of 5 and 10 with number of vehicles 40 and 80 respectively are as shown in fig. 9.

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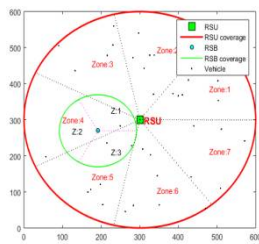


Fig.9(a) Density=5 and vehicles=40

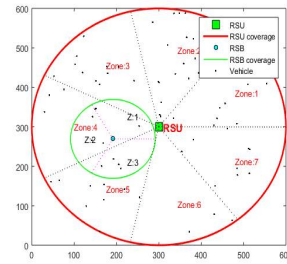


Fig.9(b) Density=10 & Vehicles=80

D. RSU & RSB Cost VS Density

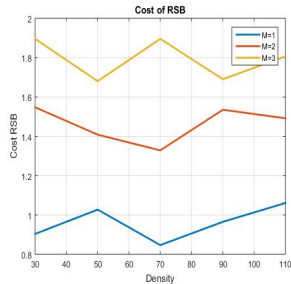


Figure 10(a) RSB cost vs density

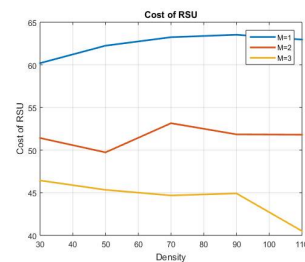


Figure 10(b) RSU cost vs density

E. RSU & RSB cost VS Number of data

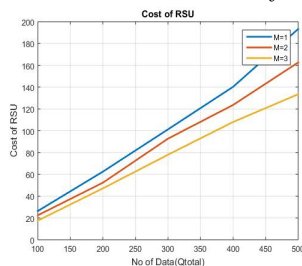


Fig.11(a) RSB cost vs Data

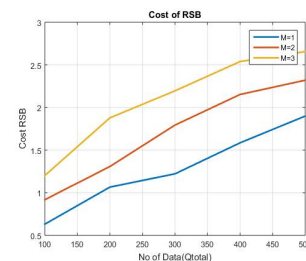


Fig.11 (b) RSU cost vs Data

F. Utility of RSU & RSB with Density

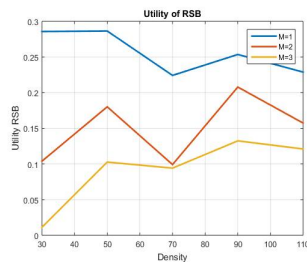


Fig.12(a) RSB utility vs Density

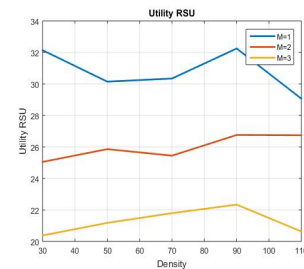


Fig.12 (b) RSU utility vs density

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G. Utility of RSU Vs Data

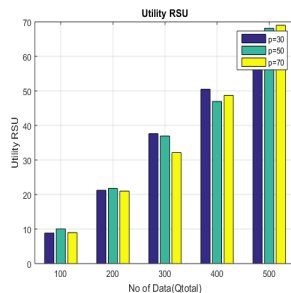


Fig.13 (a).RSU utility vs Data with M

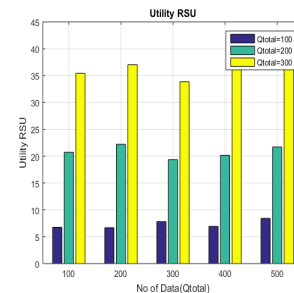


Fig. 13(b).RSU utility vs Data with Q

VIII. CONCLUSION

The proposed work develops the utility based data-computing framework, which is additionally deployed in “IoTs” to consolidate the sensing services. The proposed system initially visualizes an consolidated environment by applying of RSBs to accumulate the sensor information/data from vehicles utilizing of sink-nodes. Furthermore, implements the timing-cost and power-cost at the computation time of framework and analyse the performance and examine the utilities in data-computing system. More, it incorporates an approach of “Game-Theory” to decide the optimum cost of sensing systems. The analysis of pricing model gives the confirmation, which employ the proposed model in IoT of data-computing can enhance the communication and sensing service meanwhile acquiring less-cost computation.

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