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Structured Deployment using Clustering Mechanism for Improving the Performance of the RFID Network

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Abstract— RFID is one of the most suitable technologies for today's world. RFID technology is mainly focused for tracking and locating the objects. The objects may be either moving or immovable. Normally RFID communication is based on the RFID Tag and the Reader permutations. The Readers were deployed in different locations for the better communication between the tag and reader. This paper is focused on the structured deployment of RFID readers to form a network using clustering mechanism. The performance of the network will be analyzed by various network attribute such as throughput, Accuracy, Missing tag ratio, Read Rate and Delay. For an efficient communication, the structured deployment of the RFID Reader's is most important. The clustering method is used for the proper deployment of RFID readers for efficient communication. Cluster is the grouping of RFID readers based on the geographical locations. Every cluster has a cluster head (CH) and these Cluster heads are responsible for every transaction between the cluster to cluster communications. This cluster head have selected according to their energy level and the centrality of the adjunct. This paper detailed how the RFID readers and tags are communicated using the clustering mechanism and performance of the RFID network is analyzed and discuss the results.

Key words: Cluster; Deployment; Energy; Reader; RFID

I. INTRODUCTION

RFID Technology is mainly used for automatically identifying the objects with high efficiency. By using RFID system we can tracking the objects whichever moving or stable. We can have an exact value of the objects where it is located by using the RFID network. RFID technology is used for medical, data collection, vehicle tracking, defense, indoor positioning system, supply chain etc.

In the Shanghai city, the HERO (Hierarchical Exponential Region Organization) protocol was used for tracking the vehicles in real time. RFID readers were deployed in various locations by using region organization. RFID tags emit the radio frequency signal and this signal carries some information about the objects. The emitted signals are captured by the readers when the tag roaming inside the reader's coverage area. If we want to track a vehicle, just inject the query to the reader and this reader process the query. The reader gathers the information from the RFID network and produces the exact information of the tracking vehicles using query routing algorithm (**Zhu et al., 2009**).

Lot of RFID systems are conceived for tiny projects only. If we want to increase the RFID readers and tags the network traffic is high and the performance is become very less. The unstructured RFID reader's positioning is the reason for the low performance of the network. If the query is enriched, the traffic also increased between the reader to reader communications. The proposing method is to arrangement of the RFID readers in a structured manner by splitting the readers into group by groups. The groups were exchanged by the Clusters. The cluster carries the RFID readers and Cluster head. The cluster head is not a stagnant one, it may varied dynamically based on their energy **(Thurai Pandian et al., 2013)**.

In the Intelligent Public Transportation System (ITPS), keeps the passengers behaviors every time. For assemble the passengers in a single location we need to tracking the passengers. RFID readers are equipped with in the bus door for identifying passengers. RFID tags are secure with their pockets, hands, wallets. The reader reads the tags information when the passenger moves towards the door. The RFID tags were surrounded and composite in plastic cards (**Oberli et al., 2010**). There are various category of RFID tags are present in the market. The RFID readers range is (**Zuo et al., 2010**),

LFR (Low Frequency Range) =124-135 KHz
HFR (Higher Frequency Range) = 13-56 MHz
UHF (Ultra High frequency) = 860-960 MHz

There are lots of RFID applications are available to provide the accurately locating objects without any direct contacts between them (**Wang et al., 2012**) (**Garfinkel et al., 2005**) (**Tan et al., 2008**). Research and growth in RFID have made different domains such as person identification (**Nikolaos Konstantinou et al., 2012**), trading stores and assert tracking etc. (**Lee CH et al., 2011**) (**Kang et al., 2011**).

Nowadays lots of tiny RFID projects are available (**Civilis et al., 2005, Kalansuriya et al., 2013**) but these tiny projects were accompanying with minimum tags and Readers only.

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The unstructured deployment of the readers are support the good efficiency in this type of tiny projects.

But when we go for the large scale RFID system; the unstructured deployment is not support for proficiency. So we need to construct a structured deployment of the RFID readers. In this paper, a new innovative method clustering mechanism is introduced. Clustering is called group of readers are deployed in a structured manner.

Every cluster has a cluster head and the cluster head is responsible for all the communication from one cluster to another cluster. Finally the query routing algorithm (**Zhu et al., 2009)** is used for track the objects. We can inject the query in the cluster and the query is routed to some other cluster for track the objects. The cluster head is responsible for transmitting the query from one to other cluster.

II. EXPERIMENTAL METHOD

Overview

Every RFID technology has RFID Tag and reader and these two components will play the major role. The RFID tags released the Radio frequency signals, these signals are individually identified. A tag carries the info about the objects where it was located. Perhaps the RFID tags range is 46m (**Ilie-Zudor et al., 2006)**. The Active tags were communicating their signals using chips circuit of broadcast to all other readers. The active tags range is 300m (**Ni et al., 2011**). The different types of tags were passive tags. This kind of tags has tiny in range and its properly working until the battery power is shutdown.

Framing cluster and cluster head (CH)

The RFID technology has implemented in different environments. There is no proper deployment structure is followed in RFID system. Large scale RFID systems have needs to proper deployment structure for improving the efficiency and performance. The small scale RFID systems are inadequate in scalability. All the readers were communicated one to other. So the energy is losses due to lengthy distance transmission also traffic occurred. For this kind of causes the performance will less. By forming the clusters we have a better performance than the past technology.

By the Space division method the readers are deployed in various locations depends upon the coverage area of the readers. According to the geographical distance and the readers rage the clusters were formed. Every cluster has a cluster head (CH) for transfer the information with other clusters. The cluster head can communicate between the clusters and the neighbor cluster nodes.

Most wanted node and the higher energy level node is selected for cluster head. According to the energy level of the cluster head is high. All the information's were collected and updated in the server by the cluster head only. The readers are read the information from the RFID tag and it's transferred to the server data base. By using this cluster mechanism the nodes were deployed structured manner and reduce the network traffic also.

Let {C1, C2, C3….Cn} is the different clusters were deployed in the overlay structure. Within the cluster which node has more links and high energy level, that node is treated as cluster head (CH).

Algorithm

Step 1: select Tx cluster head (CH)
Step 2: check energy (E) level of each node (N)
Step 3: if E (N) >Tx
Step 4: E (N) is CH
Step 5: send this data within its cluster and other cluster heads.
Step 6: Repeat step 2 to 4 at time interval t

Select the high energy node as a cluster head (CH) and checked the energy level [E] for the entire nodes of its cluster. If any of the nodes have a high energy level more than the cluster head, that specific node is changed as a cluster head and up-to-date to other cluster heads this validation is made in the certain time period (t).

Figure (1) shows the connection of clusters and the cluster heads. The readers can read the information from the RFID tags and it's transferred to the cluster head. The cluster head will leads the information and transferred to the server. The entire nodes are group together and interconnected with each other. All the received data is updated periodically and it transmits the information to CHi-1and updated to the database. CHi-1 is the former cluster head situated before the server. The DSR (Dynamic Source Routing) protocol is used for the path identification and routing.

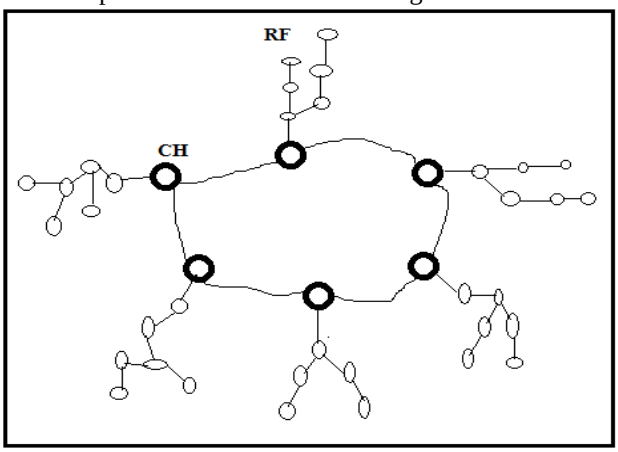

Fig.1. Forming of clusters and cluster heads

III. EXPERIMENTAL RESULT

This Research work is well appropriate in the vehicle tracking system continuously and furthermore well suitable to the huge deal RFID frameworks. The HERO convention is utilized to actualize the tracking system. In any case, when the readers are expanded, the general efficiency of the system is diminished. To conquer this issue we need to proceed onward the refreshed strategy as clustering. The tag data is gathered from the readers and sends to the nearby server by utilizing the cluster head. The gathered data are aggregated in the database and refreshed in the specific timespan. This work was executed in the java with SQL server database. This system was giving the better QoS in tracking vehicles progressively. Different parameters are taken for simulation result.

In this simulation, six groups are conceivable in the stipulated geological region. This exploration could simulate in Net Beans IDE7.4 version. The below table will demonstration of the simulation settings

Table 1. Simulation setting

No of readers	25
No of tags	1000
Coverage range	2.5 meter
Read rate	10 per sec
Cluster Count	6
Geographical size	1000 * 1000 meters

We can give the different simulation inputs and get various results. We have to modified the reader's rate as 20, 30, 40… etc. and the geographical location may also be change based on the reader's rate. When the distance is high we have to inbuilt more number of RFID tags. We can scale up the system by increasing the clusters and the RFID readers.

From the simulation results we can analyze the attributes of the RFID system. The attributes are throughput, Delay, Read Rate, Accuracy, No. of missing Tag. We can plot the graph based on the analysis of the simulation results. The Attributes are determined from the simulation results. The attributes are described below.

Throughput

Throughput is the rate of successful perused tag and is determined utilizing the following equation.

$$\text{Throughput} = \sum_{l=1}^{n} \text{read}(l)$$

Where l is the successful read tags. Concerning various Cycles (C) are tried by including increasingly number of tags in a group. In this work five Cycles (C) are executed. The various arrangements of Cycles are marked as {C1, C2, C3, C4, and C5}.

Table 2 uncovers 1000 tags had been included per cycle in a solitary cluster and most extreme throughput had been accomplished in the initial two emphases as 32 and 26. Third and fourth accomplishes throughput of 18 and 16. The fifth cycle accomplishes the throughput as 8 which is the base throughput.

Table 2 Throughput

Sl No.	Tags	Throughput (Tags Per second)
1	1000	32
2	2000	26
3	3000	18
4	4000	16
5	5000	8

The graph X axis is denoted the tags count in the different cycles and the Y axis is measured the various throughput values of the different cycles. Based on the results the geographical area is enlarged the throughput may decreased. The X axis value is increased by 1000 at every cycles but the Y axis value is decreased based on the throughput measured. The figure (2) is determined the throughput values derived from the Clustered RFID system.

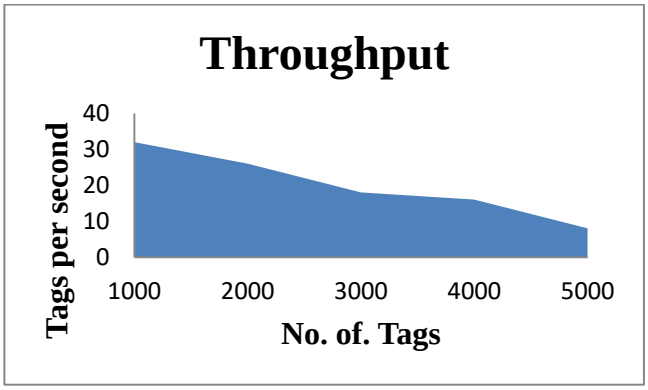

Fig.2. Throughput

Delay

According to the simulation, we can analyse the results and plot the graph and it can be notified the RFID using clustering mechanism is consuming less delay only. From the graph, X axis is the Delay and the Y axis is measured the different cycles. It is a transmission delay. It is the measure of time required to send the tags and is determined utilizing the accompanying condition.

$$\text{Delay} = T1 - T2$$

Where, T1 – Transmission Time, T2- Reception Time.

By investigating the various emphases C1, C2, C3, C4, and C5 it tends to be seen that RFID utilizing clustering mechanism creates less delay.

Table 3. Delay

Sl No.	Tags	Delays (S)
1	1000	2.1
2	2000	4.7
3	3000	6.8
4	4000	14.2
5	5000	20.6

From the Table 3 the delay of the Clustered mechanism is depicted in the different emphases. The delay measures the seconds in qualities.

The primary emphasis of cluster component devours an ideal delay of 2.1 seconds as it were. While expanding the cycles of the delay is also expanded. The delay created in second and third cycles is 4.7 and 6.8 individually. When utilizing the fourth and fifth cycles the delay is 14.2 and 20.6 in a moment. The delay had been multiplied when expanding the emphasis.

The graph appeared in Figure (3) expressly brings up the delay of RFID tracking system utilizing clustering mechanism while expanding the quantity of emphases. The x axis is signified as tags count and the y axis is meant as mean delay. The delay is expanded while expanding the readers and the tags in the specific geological zone (cluster).

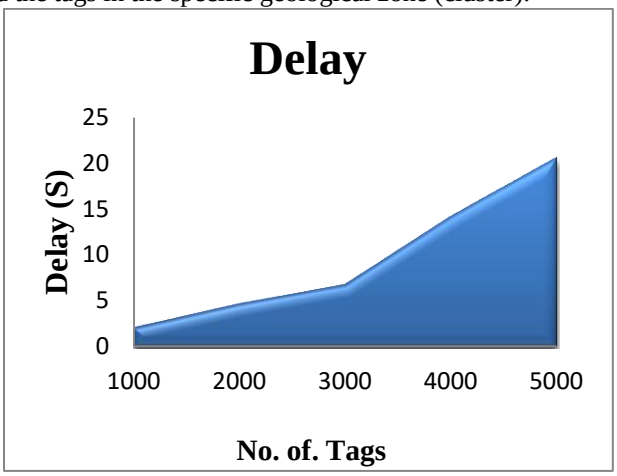

Fig.3. Delay

Read Rate

Read rate is estimated by RFID reader that can read the tags at the specific timespan. The read rate esteems are determined by the reader's capacity to read the tags at specific timeframe.

Read rate = tags can read at specific time period

The tags moving towards the reader and the tags were caught by the reader as per the reader's effectiveness. Here the readers can catch 10 tags at any given moment. On the off chance that the tags count is expanded, the read rate will be naturally diminished. By expanding the quantity of tags that are gone through a specific reader, the read rate of the clustered RFID framework is diminished.

Table 4 demonstrates the real read rate of the clustering systems in the different emphases of C1, C2, C3, C4 and C5. In the primary cycle the read rate of the reader is archives 81% among the 1000 readers in the network. In the second cycle the tags count had been expanded by 2000 and the read rate of the frameworks accomplishes 63%. In the third cycle the tag count is expanded by 3000 any place the read rate of the framework is 52%. By including 4000 tags in the fourth cycle the read rate of the framework accomplishes 36% as it were. In like manner in the fifth cycle, including 5000 tags the framework can accomplish 15% read rate as it were.

Table 4 Read Rate

Sl No.	Tags	Read Rate (%)
1	1000	81
2	2000	63
3	3000	52
4	4000	36
5	5000	15

Table 4 demonstrates the real read rate of the clustering systems in the different emphases of C1, C2, C3, C4 and C5. In the primary cycle the read rate of the reader is archives 81% among the 1000 readers in the network. In the second cycle the tags count had been expanded by 2000 and the read rate of the frameworks accomplishes 63%. In the third cycle the tag count is expanded by 3000 any place the read rate of the framework is 52%. By including 4000 tags in the fourth cycle the read rate of the framework accomplishes 36% as it were. In like manner in the fifth cycle, including 5000 tags the framework can accomplish 15% read rate as it were.

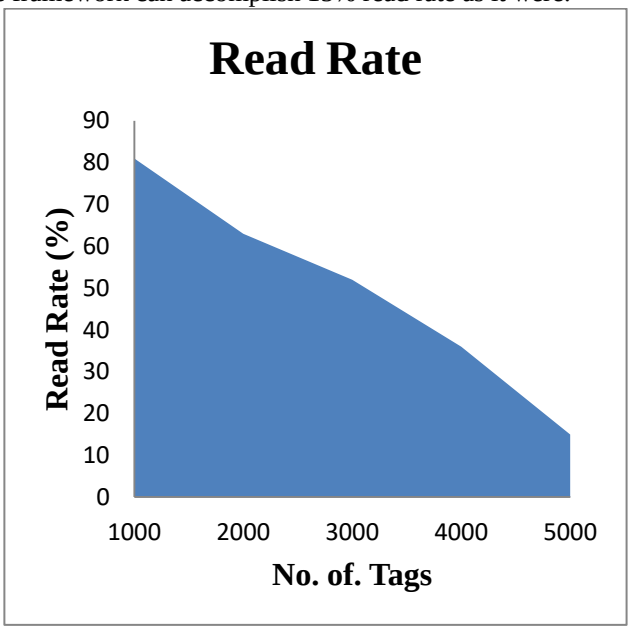

Fig.4. Read Rate

When we increase the number of tags and pass through the particular reader, the reader of the clustered RFID technology can read the tags as very fast. The read rate of the simulation result is clearly analysed and plot the graph. The number of tags is increased dramatically; the read rate of the clustered RFID system performance is decreased. The X axis is the number of tags. The tag count is increased by 1000 in every cycle. The Y axis is measured the read rate of different cycles. Figure (4) is determined the read rate of the RFID tags which is captured by the readers.

Accuracy

Accuracy is a proportion of helpfulness of a system. It relies on the quantity of effectively received tags, and is determined utilizing the accompanying condition.

$$\text{Accuracy} = \frac{\text{Missing Tag Count}}{n} \times 100$$

n – Total tags.

The accuracy of the system is regularly expanded when the tag is low. At the point when the tag is expanded the accuracy of the system is likewise diminished naturally.

Table 5 demonstrates the accuracy of the clustering system with five emphases. In the primary cycle the proposed RFID framework can accomplish 100 % accuracy when the tag count is 34 at once. In the second cycle the accuracy of the system is 92.3% when the tag count is 136 at any given moment. In the third cycle it accomplishes 49.5% of accuracy when the tag count is 568. Similarly in the fourth and fifth cycles the accuracy of the system is 21.2% and 11.4% just when the tag count is 2128 and 4192.

Table 5 Accuracy

Sl No.	Tags	Accuracy
1	34	100
2	136	92.3
3	568	49.5
4	2128	21.2
5	4192	11.4

Based on the simulation results the graph can be eminent that the accuracy of clustering mechanism of RFID system. The X axis is denoted by the number of tags and the Y axis is the accuracy. In the graph clearly show the accuracy of the clustering RFID system. When the tags count increased the accuracy will become low. Figure (5) is determined the accuracy values of the RFID readers reading value.

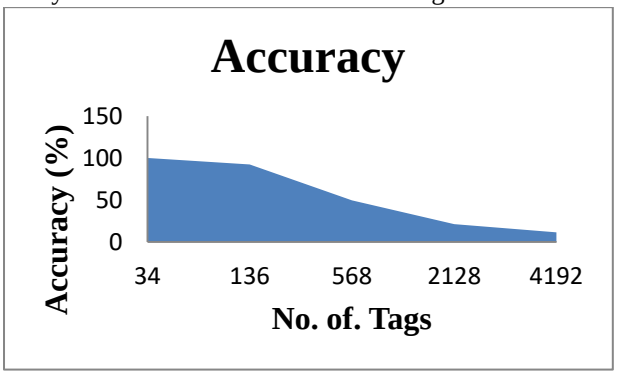

Fig.5. Accuracy

No.of missing tag

When the objects are moving very fast, there is a chance to miss that fast moving objects in the RFID system due to over load. The RFID network detected tags as it has the capability for catching more tags irrespective of speed. The number of missing tag is calculated based on the time in seconds.

Table 6. No of Missing Tags

Sl No.	Time in Seconds	No of Missing Tags
1	1.3	1
2	2.18	4
3	3.48	7
4	4.56	10
5	6.28	13

Table 6 demonstrates the quantity of missing tags esteems at the different time frames. The five time frames are connected at the five cycles in the clustered RFID system. The 1000 tags are included at every time cycles. In the initial time sequence 1.3 seconds the missing tag worth is 1.

In the subsequent cycles is by including 2000 tags in the time sequence 2.18 seconds the missing tag worth is found as 4. In like manner the quantity of missing tag esteems in the third, fourth and fifth cycles are 7, 10 and 13.

The graph is clearly depicting the missing tag values. The X axis is determined by the time in seconds value is increased by every 1000 tags adding in the RFID network. The Y axis is determined by number of missing tags value derived from the various time sequences. Figure (6) determined the missing tag values of the clustered RFID system derived from the simulation results.

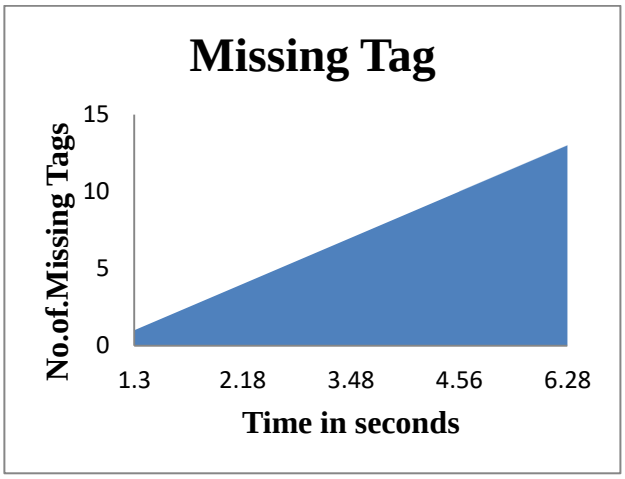

Fig.6. Number of Missing Tags

Generally the overall performance of the RFID system using clustering mechanism is outstanding. The simulation result has been measured with different cycles and the output result was analyzed in an articulate manner. Finally the figure shows the attributes (Throughput, delay, Accuracy, Read rate, No.of missing tag) of the clustering RFID system. The graphs of the different attributes are clearly determined and examined.

IV. CONCLUSION

The RFID technology is used in the many real world applications like tracking, IoT, etc. This proposed method is highly braved and inventive techniques to be used. The construction of cluster and cluster head process of the RFID system is reduce the complexity of the real world applications. It is used for large scale RFID system for tracking the objects in flexibility pacification and the performance also enhanced. The accuracy with high QOS is accomplished by deploying the RFID readers in a structured manner throughout the world. This RFID clustering mechanism research work is useful for the future work of the RFID system.

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