IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-6, June 2018 E-ISSN: 2347-2693

Implementation of Throughput and an Energy Efficient Scheme for Mobile Coordinated Wireless Sensor Networks

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Accepted: 12/Jun/2018, Published: 30/Jun/2018

Abstract:-This paper introduces the throughput and an energy efficient scheme for mobile access coordinated wireless sensor network (MC-WSN) for time-delicate applications. In regular sensor network with mobile access points (SENMA), the mobile access points (MAs) navigate the network to gather data specifically from individual sensors. So energy consumed in regular network structure will be more and also throughput will be low. To resolve this problem, we present the MC-WSN architecture, this provides an efficient solution for time-sensitive information exchange.

Keywords: Wireless sensor networks, SENMA, MCWSN, Mobile Access Points (MAs), Throughput, Energy efficiency.

I.INTRODUCTION

A standout amongst the most vital advances for the twenty-first century is Wireless Sensor Networks (WSN).It has gotten enormous consideration from both scholarly and industry everywhere throughout the world in the previous decades. Wireless Sensor Networks (WSN) comprises of several resource-constrained sensor nodes randomly deployed over a geographic region. These sensor nodes forward tactile information towards a base station (BS). Contingent upon the application type, the BS is found either far from the sensor field or inside the sensor field. Such systems have extensive variety of uses in military and common areas. Some application territories of WSN are as per the following: battle field reconnaissance, target tracking in war zones, interruption location, and post disaster rescue operations , smart home, monitoring and alarming systems for supermarkets, wildlife monitoring systems, and numerous wellbeing and security related applications. In the previously mentioned applications, the sensor nodes generate sensory data from the environment of interest. The sensed information are at long last sent toward the BS for further processing and decision making with regard to the control for meeting the goals of the framework set up. Contingent upon the application, the sensor nodes and the BS can be static or portable. In an ordinary WSN, the sensor nodes are exceedingly resource constrained. The sensor nodes are cheap, dispensable, and anticipated that would last their energy depletes out. In this manner, energy is an extremely constrained asset for a WSN framework, and it should be overseen in an ideal design. Solid and fruitful information conveyance at the BS is wanted. Energy efficiency is a vital part of any application of WSN. Routing of information in WSN is a basic task, and noteworthy amount of energy can be saved if routing can be completed tactfully. Routing is an issue connected to the network layer of the protocol stack of WSN. In multi hop communication, the significant issue might be the determination of the intermediate nodes in the route. The intermediate nodes are to be chosen such that the energy necessity is limited. In the meantime, the information are to be conveyed at the BS reliably and effectively. Alongside late advances in remote control advances, Unmanned Aerial Vehicles (UAVs) have been used in wireless sensor networks for information accumulation and additionally for sensor administration and system coordination.

For proficient and solid correspondence over extensive scale systems, sensor network with mobile access points (SENMA) was proposed. In this paper, mobile access coordinated wireless sensor networks (MC-WSN) design is considered to reduce energy consumption, reliable, and time- data exchange. In MC-WSN, the entire network is divided into cells, each is covered by one MA. The MAs organize the network through deploying, replacing and energizing the nodes. They are also responsible for upgrading the network security, by detecting compromised nodes then replacing them. Data transmission from sensor nodes to the MA goes through simple routing with the cluster heads along a ring or a powerful center cluster head located at the middle of each cell. In the view of dynamic network deployment and topology design, the number of hops from any sensor to the MA is constrained and limited to a pre-determined number. Unlike in SENMA, the delay in MC-WSN relies on the number of hops and the electromagnetic wave speed, and is independent of the physical speed of the MA. For MC-WSN, the energy consumption at the individual sensors is mainly determined by the distance from the closest cluster head, which is one hop away, and is independent of the scope region of the MA and the node density. We exhibit the adequacy of the proposed architecture through reenactment illustrations, which show that the MC-WSN architecture accomplishes higher energy efficiency and orders of magnitude lower delay over SENMA, especially for vast-scale networks.

Rest of the paper is organized as follows, Section I consists of introduction of wireless sensor networks, existing system and proposed system, Section II contains Existing System-Sensor Network with Mobile Access Points (SENMA) and its architecture drawbacks, Section III contains Proposed System-Mobile Coordinated Wireless Sensor Network (MCWSN) and its architecture with brief description,Section IV contains Network operations of MCWSN ,Section V contains The network topology design of MCWSN, Section VI contains Simulation results and Section VII concludes the research work with future scope.

II.EXISTING SYSTEM-SENSOR NETWORK WITH MOBILE ACCESS POINTS (SENMA)

Sensor network with mobile access points (SENMA) is an architecture proposed for low-power extensive-scale sensor networks. As shown in Figure. 1, SENMA consists of two types of nodes: sensors and mobile access points. Sensors are low power and ease nodes that are constrained in processing and communication capacity. Interestingly, mobile access points are equipped with effective processors and refined transceivers, fit for traversing the sensor field with precisely designed trajectory. Examples of mobile access points include manned /unmanned flying and ground vehicles and exceptionally composed light nodes that can hop around the network. They may form a small ad hoc network and perform collaborative information accumulation and post processing including another measurement in the space-time area. In SENMA, sensors communicate directly with the mobile access points.

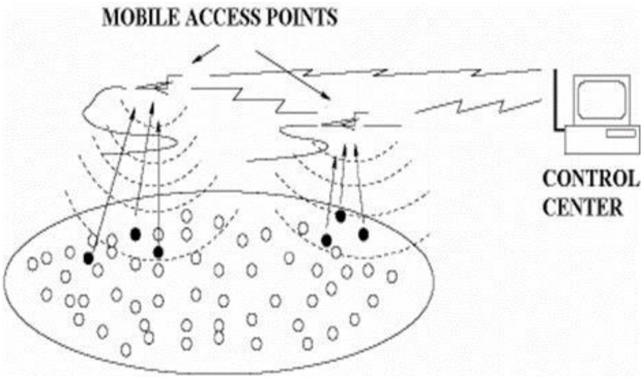

Figure.1.Sensor Network with Mobile Access Points

In SENMA, since sensors impart straight forwardly to the mobile access point without any routing, the energy consumption at the individual sensors altogether diminished over ad-hoc networks. For this to happen, the mobile access point needs to travel complete network to cover all sensors, bringing about a very long mobile access trajectory and subsequently huge delay. The delay relies upon the physical speed of the MA and the length of the MA trajectory, which would increase significantly as the network size increases. In this way, SENMA could be unwanted for time-delicate applications. Persuaded by this perception, we propose a mobile access coordinated wireless sensor networks architecture.

III. PROPOSED SYSTEM-MOBILE COORDINATED WIRELESS SENSOR NETWORK (MCWSN)

In this section, we portray the proposed framework MC-WSN architecture that aims at providing reliable, energy-efficient, and versatile system structure for prolonged-network lifetime and time-sensitive information exchange. We assume the network is partitioned into cells each of radius d. Every cell consists of one mobile access point (MA) and n reliably sensor nodes (SNs) that are arranged into K_{CH} clusters. Each cluster is overseen by a cluster head (CH), to which all the group individuals report their data. CHs then send the information to the MA. A powerful center cluster head (CCH) is employed in the amidst of each cell, and K powerful ring cluster heads (RCH) are put on a ring of radius R_t. The CCH and RCHs can establish direct communication with the MA or with other RCH that are nearer to the MA. All nodes within a distance R_o from the CCH send their information to the MA through the CCH. All other nodes will send their data to the MA through the nearest RCH. If a sensor is within the MA's coverage range, then direct communications will occur. After receiving the information of the sensors, the MA conveys it to a Base Station (BS). The general network architecture is illustrated in Figure 2.

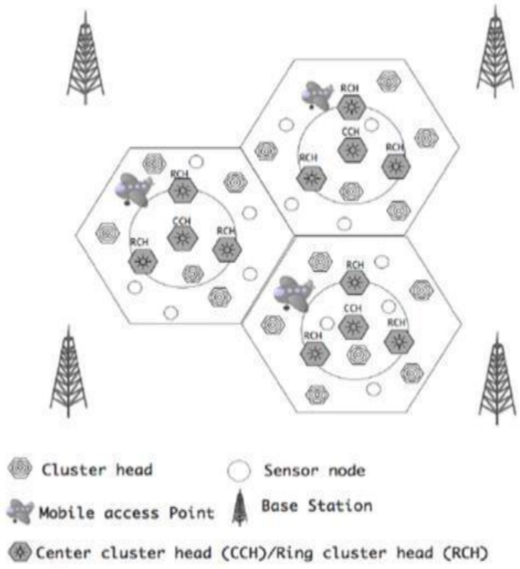

Figure.2. Mobile Coordinated Wireless Sensor Network

Information transmission from any SN to the MA goes through straightforward directing, either with the CCH or the RCHs. Let the communication range of every sensor node and cluster head be r_c and R_c, respectively. SNs will communicate with their CH's only, which then course their data to the MA. CHs have more storage capacity and longer correspondence than SNs, i.e., $R_c > r_c$. To limit the delay in information transmission from the sensors to the MA, the number of hops required in directing ought to be limited. Therefore, we consider partitioning the CHs in the cell into two gatherings based on their region of location. The first gathering contains CHs within the region of radius Ro from the CCH. While the second gathering contains all CHs located outside the radius R_o, where $R_o < R_t$. CHs in the first gathering will send their information to the MA through the CCH, which can convey the information straight forwardly to the MA. While CHs in the second gathering course their data to the MA either straight forwardly or through the RCH. The latter case happens by first sending the information to the closest CH on the ring, then it sends the information in both directions along the ring until it goes the RCH as shown in Figure 3. The RCH then convey the information to the MA. To limit the number of hops, if a CHs in the second gathering is very long from RCH, it can straightforwardly advances its data to the CCH. In the architecture design, we confine the average number of bounces from any SN to its corresponding CH to N_1, and point of confinement the number of hops from any CH to the MA to N_2, where N1 and N_2 are pre-indicated numbers. N_1 is controlled through dynamic system arrangement, while N_2 is controlled through the system topology design (i.e. select the ring radius R_t and the radius R_o).

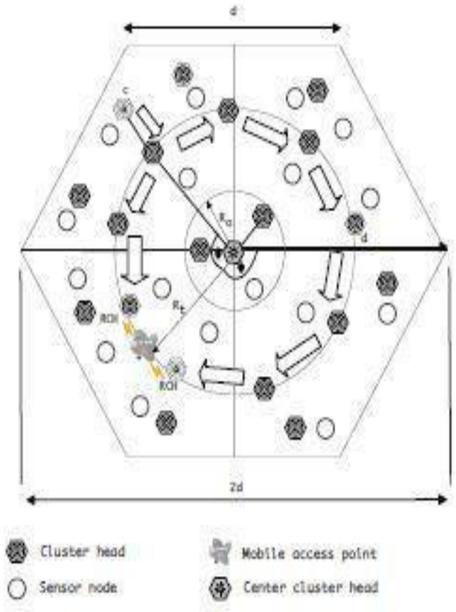

Figure. 3. The topology used in the MC-WSN architecture. Here CH c has a packet to deliver to the MA.

The main features of the MC-WSN architecture are:

- *Minimize the delay:* Unlike in SENMA, where the information collection delay relies upon the physical speed of the MA, in MC-WSN the delay relies upon the number of hops and the electromagnetic wave speed, and is independent of the physical speed of the MA. Therefore, the delay is significantly lower than that in SENMA. The delay is further reduced by minimizing the number of hops required to reach the MA; this is achieved through network topology design and active network deployment.

- *Provide high energy efficiency:* The SNs have the most limited resources in wireless sensor networks. In the proposed MC-WSN, SNs will only communicate with their closest CHs, and are not engaged in any inter-cluster routing. Also, in contrast to SENMA, SNs in MC-WSN do not need to receive the beacon signal from the MA.

- *Enhance network resilience, reliability and scalability:* The MC-WSN is a self-healing architecture, where the CCH and RCH represent two options for relaying the data to the MA. Each option can act as an alternative for the other. In the case when the routing paths do not work, the MA can traverse its cell for data collection. Overall, MC-WSN is a resilient, reliable and scalable architecture.

IV. NETWORK OPERATIONS

In this section, we illustrate the network procedures utilized in MC-WSN.

A. *Network Set-Up*

We assume that the CHs and the MAs are furnished with Global Positioning System (GPS) to acquire their area information. The network set-up is built up through the accompanying advances:

1) Cluster formation: All CHs will send Hello messages containing their IDs and areas. Every SN recognizes it's closest CH, to which it sends a Request to Join (RTJ). After getting the message RTJ, then CH will send Confirm to Join (CTJ).

2) Ring set-up: The MA moves along the cell in a circular ring of radius R_t broadcasting Start messages to the CHs in its scope

region. Indicate the set of CHs that are along the ring and inside the MA scope region as χ. The CHs in χ get the Start message,
and answer to the MA with an ACK.

3) Discover links to the ring: Communicate InitCH message to all their neighboring CHs. The InitCH message will consists of the ID and area of the sender CH. At the point when a CH gets the InitCH, it will communicate InitCH to its neighbors. This will occurs until all CHs gets at- least a single InitCH message. Affirmation is made in reverse through similar connections.

4) Discover links to the CCH: CCH also communicate a reference signal to all its nearest CHs. The Reference signal is sent by CHs, utilizing a similar way talked about above, until the point that it comes to the CHs on the ring.

5) Establish the links to the ring or the CCH: CHs at that point build up connections with the CCH as well as the nearest CH on the ring by sending Request to Connect (RTC) message. The procedure is finished when the intended receiver replies with Confirm to Connect (CTC).

B. Sensing and Collecting

Data sensing and collecting is performed periodically, where the individual sensors monitor the environment and report their data to the CHs. When TDMA is utilized inside clusters, every SN reports to its relating CH an information message in its allotted time slot. To reduce the interference between clusters (inter-cluster interference), Direct Sequence Spread Spectrum (DSSS) can be utilized, where the nodes of the diverse clusters use distinctive spreading codes. Likewise, information transmissions from SNs to CHs, between CHs, from CHs to the MA, and from the CCH to the MA are made over various frequencies
its scope zone. If a CH gets the beacon signal, at that point it can react specifically by sending its information to the MA. If the information is gotten correctly, the MA reacts with an ACK. It is noticed that the information, a CH sends to the MA can be data from its own particular cluster members, or from different clusters that transfer their information through it.

V. THE NETWORK TOPOLOGY DESIGN

In this section, we will get the optimal radius Ro and the ring

radius R_t that will reduce the number of hops from any CH to the MA. Considering θ as the smaller angle between the MA position and the CH on the ring that initially got the information; as shown in figure.4.

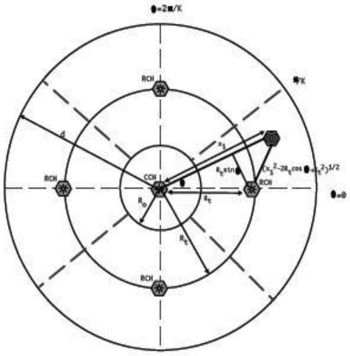

Figure.4. MCWSN Topology

The PDF of θ is $f_\theta(\theta) = \frac{1}{\pi}$. Assume that two cluster heads isolated by a separation $2R_{CH}$ will communicate each other. Then, for a given θ, routing along the ring requires $[\frac{\theta \mathrm{Rt}}{2RCH}]$ hops to reach the RCH. While, the routing from the ring to the CCH requires$[\frac{\theta \mathrm{Rt}}{2\mathrm{RCH}}]$hops. Therefore, to reduce the number of hops for nodes outside the ring, the routing over the ring is made by the condition that $\theta < 1$, i.e., $\theta < 57.3°$. If this condition is not fullfilled, nodes reach the MA mainly through the CCH. Nodes in the region between R_o and R_t route their information through the ring if $\frac{\theta \mathrm{Rt}}{2\mathrm{RCH}}+\frac{\mathrm{Rt}-\mathrm{x}}{2\mathrm{RCH}} < \frac{x}{2\mathrm{RCH}}$. That is, if $\theta < \frac{2x}{\mathrm{Rt}} - 1$, the nodes at distance $R_o \le x < R_t$ route their information to the RCH. Else, they route the information to the CCH. We assume that CHs along the ring can evaluate θ from the beacon signal they receive. The RCH will informs the nodes in the region between Ro and R_t that are connected to it. In the event that the nodes in this region don't get a notification from the RCH, at that point they forward their information to the CCH.
Assume N_{hops} be the average number of hops required to direct the information from any CH in the network to the CH that can communicate with the MA directly, i.e., the CCH or the RCH. Note that the number of hops to reach the MA is
$N_2 = N_{hops} + 1$.

N_{hops} is given by:

$$N_{hops}=\frac{1}{2RCH}[\int_{o}^{Ro} xfX(x)dx + \int_{x=Ro}^{Rt}\int_{\theta=\frac{2x}{Rt}-1}^{\pi} xfX(x)f\theta(\theta)d\theta dx + \int_{x=Ro}^{Rt}\int_{\theta=0}^{\frac{2x}{Rt}-1}(Rt-x+\theta Rt)\, fX(x)f\theta(\theta)d\theta dx + \int_{x=Rt}^{d}\int_{\theta=1}^{d} xfX(x)f\theta(\theta)d\theta dx + \int_{x=Rt}^{d}\int_{\theta=0}^{1}(x-Rt+\theta Rt)\, fX(x)f\theta(\theta)d\theta dx\ ], (1)$$

Where x is the distance from any CH to the center of the cell, $f_X(x)$ is the PDF of x and can be approximated by $f_X(x) = \frac{2x}{d2}$ assuming that the CHs are uniformly distributed in a circle of radius d.

By setting $\frac{\partial Nhops}{\partial Ro} = 0$, we obtain the optimal $R_o = 0.5\ R_t$. Then, we substitute in (1) with the optimal R_o, and obtain the optimal R_t by setting $\frac{\partial Nhops}{\partial Rt} = 0$. We get $R_t = 0.686$ d; it then follows that $R_o = 0.343$ d.

Proposition: To reduce the information collection delay in MCWSN, the following conditions should be met.

(1) The CHs within a distance $R_o = 0.343$ d from the center of the cell will send their information to the MA through the CCH.

(2) Nodes at a distance x from CCH, where $R_o \le x < R_t$, will send their information to the MA through the ring if $\theta < \frac{2x}{Rt} -1$, or through the CCH if $\theta > \frac{2x}{Rt} -1$.

(3) Other nodes at a distance $x \ge R_t$ from the CCH, will send their information to the MA through the ring if $\theta < 1$, or through the CCH if $\theta > 1$. The ring radius is $R_t = 0.686$ d. The delay is proportional to the number of hops required for directing the information to the MA. The average distance traveled Corresponding to N_{hops} is $2R_{CH}N_{hops}$; therefore, the delay in packet delivery is $D_M \propto \frac{2RCHNhops}{VEM}$, where $V_{EM} = 3 \times 10^8$ m/s is the electromagnetic wave (EM) propagation velocity.

VI. SIMULATION RESULTS

In this section, we are going to compare the Energy and Throughput of SENMA and MCWSN through simulation results as follows:

A.Throughput:

The throughput, is defined as the average number of data packets received effectively from all groups per unit time. Here we evaluate the overall average per-node throughput of the MC-WSN and compare it to that of SENMA.We are taking different sensor nodes at different timings, and we are comparing it with the SENMA. For throughput graph on x-axis we are taking time (msec) and on y-axis we are taking throughput. For N=100 sensor nodes we are taking throughput values at different timings.

For N= 100 at t=20 msec

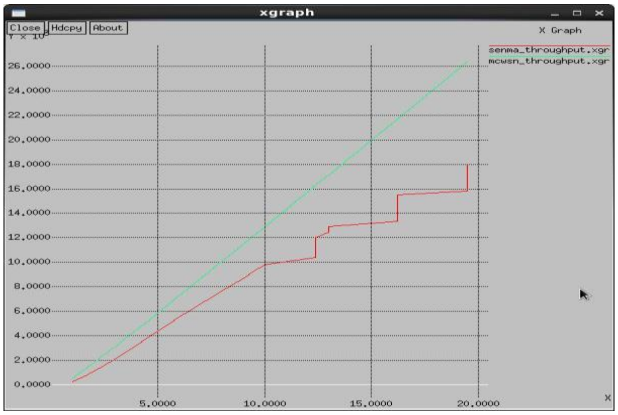

Figure.5.Throughput for 100 sensor nodes at t=20msec

For N= 100 at t=25 msec

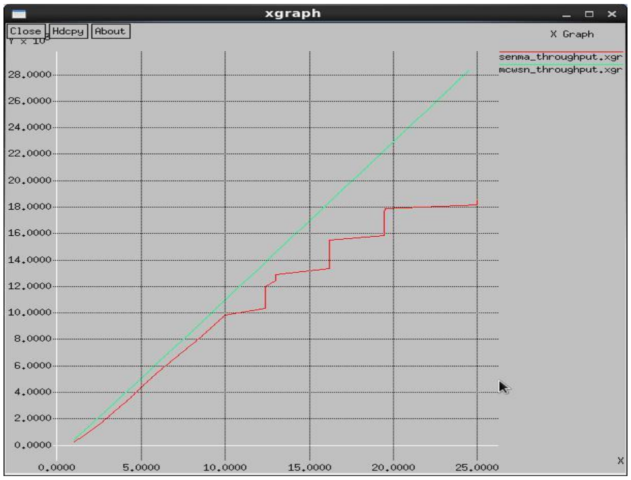

Figure.6.Throughput for 100 sensor nodes at t=25msec

For N= 100 at t=30 msec

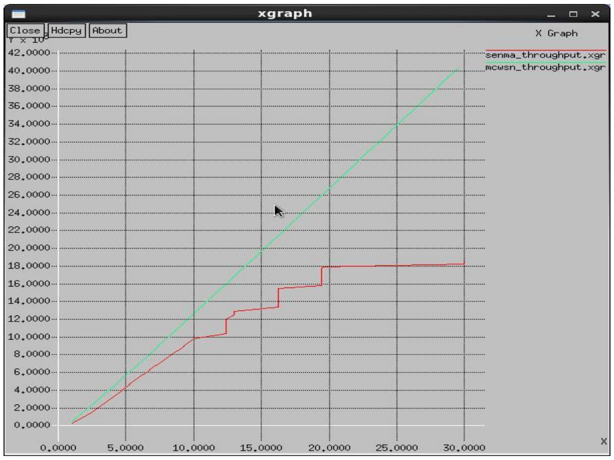

Figure.7.Throughput for 100 sensor nodes at t=30msec

For N= 100 at t=35 msec

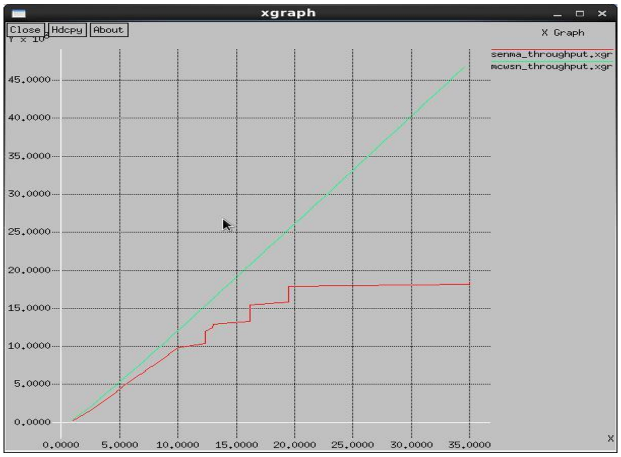

Figure.8.Throughput for 100 sensor nodes at t=35msec

For N= 100 at t=40 msec

Figure.9.Throughput for 100 sensor nodes at t=40msec

Comparison of Throughput for 100 Sensor Nodes at different Timings:

Comparison of throughput for both SENMA and MCWSN for 100 sensor nodes at different timings is shown in below:

Table.1.Throughput comparison for 100 Sensor Nodes at different Timings

TIME(msec)	SENMA	MCWSN
20	288.21	702.80
25	288.21	589.21
30	288.21	714.09
35	288.21	712.31
40	288.21	469.73

From this we observe that if we increase the time value we are getting the enhanced throughput .So now we are increasing the sensor nodes and taking the throughput value at t= 20 msec

For N= 200 at t=20 msec

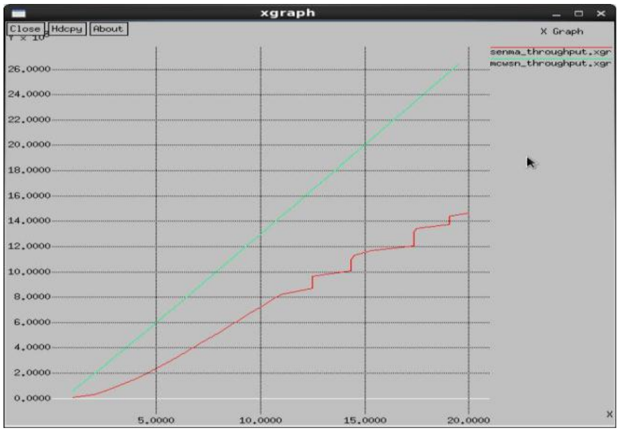

Figure.10.Throughput for 200 sensor nodes at t=20msec

For N= 300 at t=20 msec

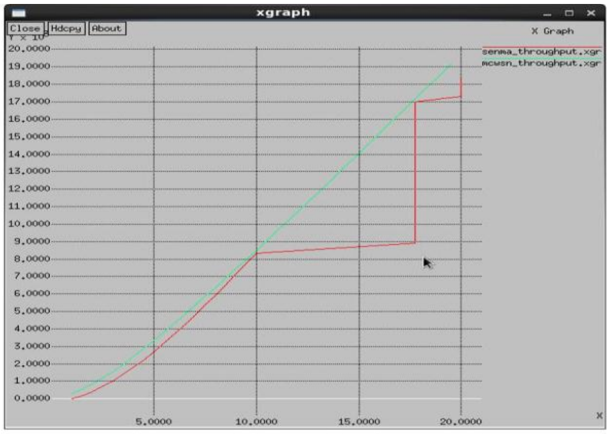

Figure.11.Throughput for 300 sensor nodes at t=20msec

For N= 400 at t=20 msec

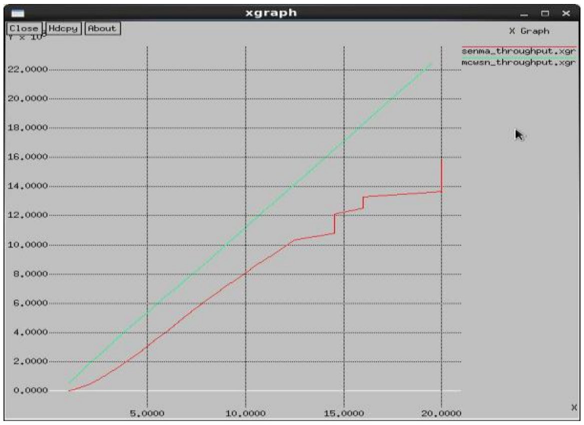

Figure.12.Throughput for 400 sensor nodes at t=20msec

For N= 500 at t=20 msec

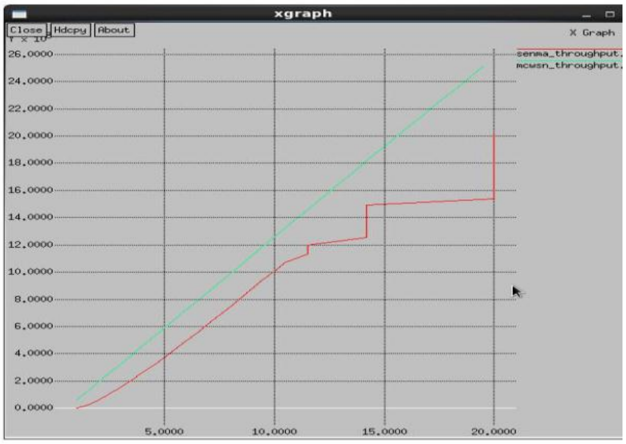

Figure.13.Throughput for 500 sensor nodes at t=20msec

Comparison of Throughput for different Sensor Nodes at different t=20 msec:

Comparison of throughput for both SENMA and MCWSN for different sensor nodes at t= 20 msec is shown in below:

Table.2.Throughput comparison for different Sensor Nodes at t=20 msec

NUMBER OF SENSOR NODES	SENMA	MCWSN
100	288.21	712.86
200	293.02	710.40
300	336.26	570.89
400	361.06	565.53
500	480.76	432.60

B. Energy Consumption: Energy efficiency is a essential worry in wireless sensor networks because of the restricted power asset of the individual sensors. The hierarchical node deployment in MC-WSN enables the sensors to communicate with their closest CHs only, and hence we will get the low energy consumption at the individual sensors, which is significantly more efficient than the conventional SENMA architecture. In SENMA, all sensors inside the scope territory of a MA gets a beacon signal from the MA, which is utilized to notify sensors of the nearness of the MA and to show which sensor can transmit. The periodic reception of beacon signals from MA in SENMA contributes essentially to the power utilization at the individual sensors. We evaluate the energy consumption of the MC-WSN and compare it to that of SENMA. We are taking different sensor nodes at different timings, and we are comparing it with the SENMA. For energy graph on x-axis we are taking number of sensor nodes and on y-axis we are taking energy consumption (Joules).

For N=100 sensor nodes we are taking energy consumption values at different timings.

For N= 100 at t=20 msec

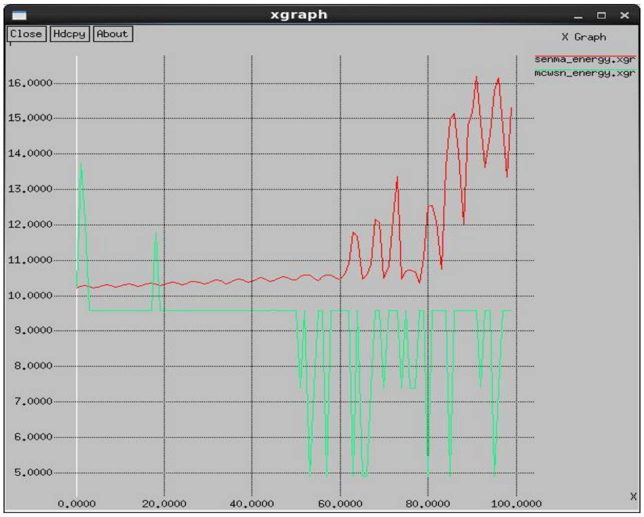

Figure.14.Energy Consumption for 100 sensor nodes at t=20msec

For N= 100 at t=25 msec

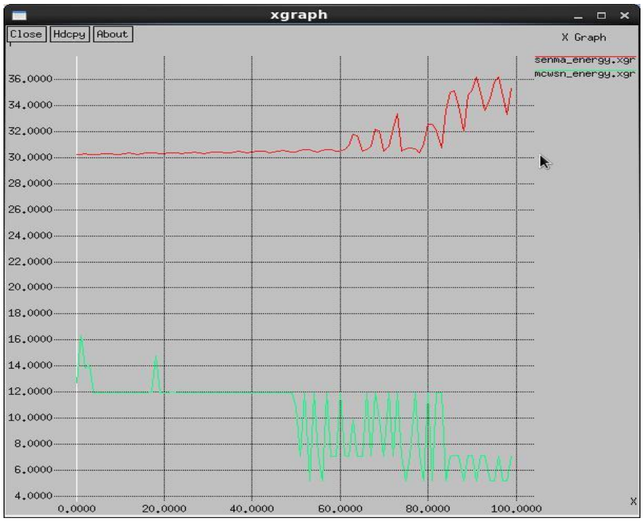

Figure.15.Energy Consumption for 100 sensor nodes at t=25msec

For N= 100 at t=30 msec

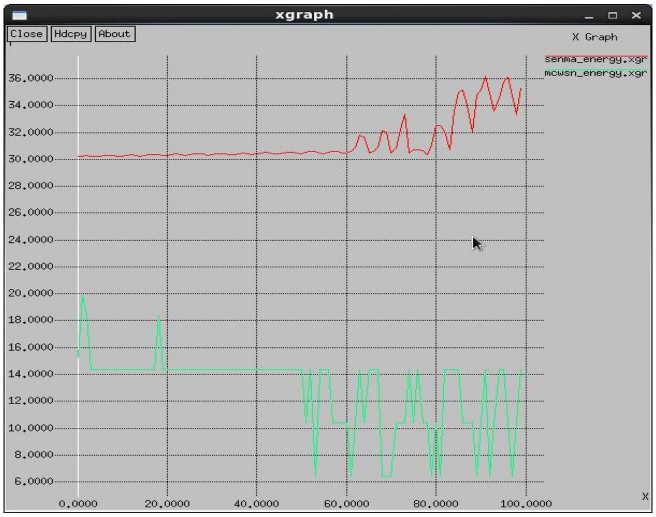

Figure.16.Energy Consumption for 100 sensor nodes at t=30msec

For N= 100 at t=35 msec

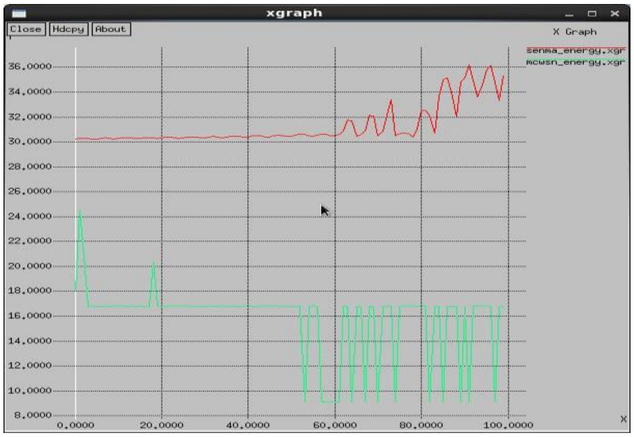

Figure.17.Energy Consumption for 100 sensor nodes at t=35msec

For N= 100 at t=40 msec

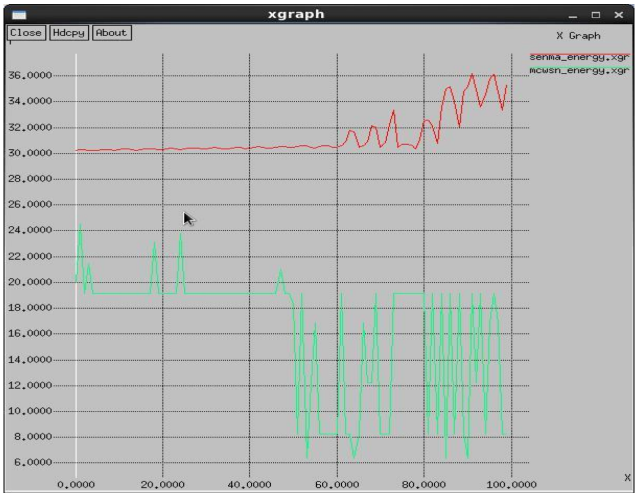

Figure.18.Energy Consumption for 100 sensor nodes at t=40msec

Comparison of Energy Consumption for 100 Sensor Nodes at different Timings:

Comparison of energy consumption for both SENMA and MCWSN for 100 sensor nodes at different timings is shown in below:

Table.3.Energy Consumption comparison for 100 Sensor Nodes at different Timings

TIME(msec)	SENMA	MCWSN
20	3128	964.721
25	3128	1044.73
30	3128	1289.19
35	3128	1580.37
40	3128	1636.79

From this we observe that energy consumption of SENMA is more than MCWSN. Now we are increasing the sensor nodes and taking the energy consumption at t= 20 msec.

For N= 200 at t=20 msec

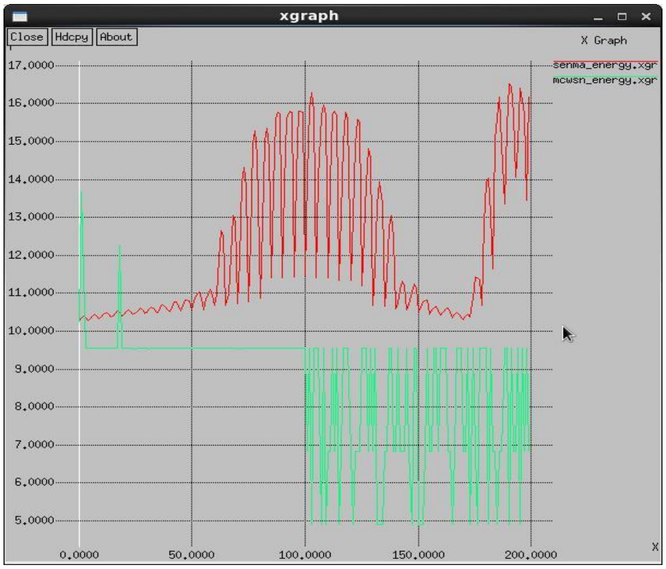

Figure.19.Energy Consumption for 200 sensor nodes at t=20msec

For N= 300 at t=20 msec

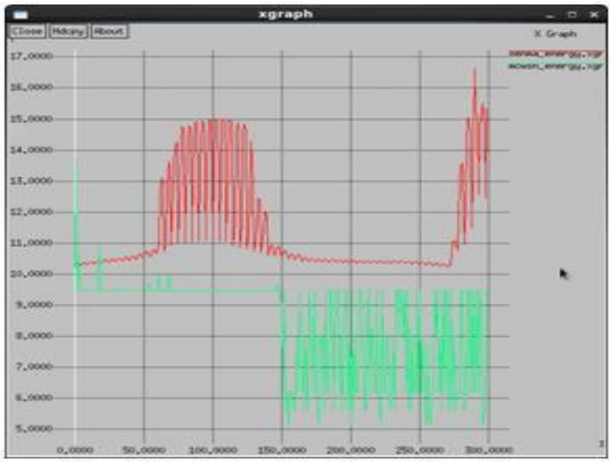

Figure.20.Eergy Consumption for 300 sensor nodes at t=20msec

For N= 400 at t=20 msec

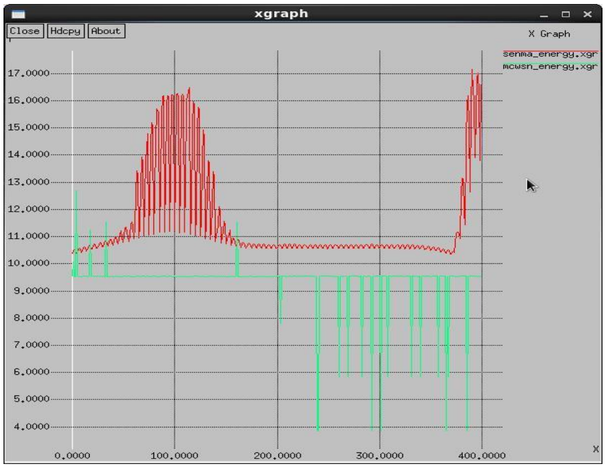

Figure.21.Energy Consumption for 400 sensor nodes at t=20msec

For N= 500 at t=20 msec

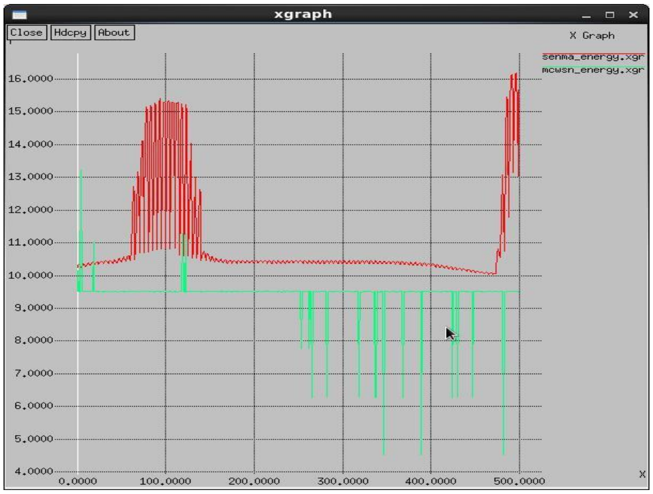

Figure.22.Energy Consumption for 500 sensor nodes at t=20msec

Comparison of Energy Consumption for different sensor nodes at t=20 msec:

Comparison of Energy Consumption for both SENMA and MCWSN for different sensor nodes at t=20 msec is shown in below

Table.4.Energy Consumption comparison for different sensor nodes at t=20 msec

NUMBER OF SENSOR NODES	SENMA	MCWSN
100	288.21	911.028
200	293.02	1731.14
300	336.26	2528.95
400	361.06	3758.69
500	480.76	4718.79

Review of results:

From these comparison tables i.e. Energy and Throughput tables we can say that MCWSN is more efficient than SENMA.

VII. CONCLUSION AND FUTURESCOPE

In this paper, a mobile access coordinated wireless sensor networks (MC-WSN) architecture was proposed for reliable, efficient, and time-sensitive data exchange. The hierarchical and heterogeneous structure makes the MC-WSN an exceptionally flexible, solid, and adaptable design. We gave the ideal topology configuration to MC-WSN with the end goal that the number of hops from any sensor to the MA is limited. We dissected the execution of MC-WSN as far as throughput. It was demonstrated that with dynamic system sending and hop number control, MC-WSN accomplishes considerably higher throughput and energy effectiveness over the customary SENMA. Our investigation additionally showed that with hop number control, network analysis becomes more tractable. In addition, putting MC-WSN in the master plan of network design and improvement, we gave a unified framework for wireless network modeling and portrayal.In future we can extend this one by providing adaptive scheduling to each node.

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