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Automation of Energy Conservation for Nodes in Wireless Sensor Networks

Mohammad Umar[a], Mr. Dinesh Babu[b], Dr. K.M Baalamurugan[c], PriyamvadaSingh[d]

[a,d]*B.Tech Student, School of Computing Science and Engineering, Galgotias University*

[b]*Assistant Professor, Department of Computer Science and Engineering, Galgotia College of Engineering and Technology*

[c]*Assistant Professor, School of Computing Science and Engineering, Galgotias University*

Abstract

The two prominent technologies utilized in the Internet of Things are Wireless Sensor Networks (WSN) and Radio Frequency Identification (RFID). In actuality, these two innovations can be seen as the precursors of IoT. WSN is the assortment of installed tiny devices called sensors that have networking potentiality. They are profoundly entering organized frameworks, which incorporate and envelop various sensors in a wireless manner. Even though having incredible amounts of favorable circumstances over individual sensors they have a lot of sending difficulties one of which is Sleep/wake up schedule. The energy of the Wireless Sensor Network is bounded or finite simultaneously they are typical can't be energized. The sole and lone motivation behind utilizing Sleep/wake up schedule is to spare vitality of each node by keeping it in sleep mode as long as pragmatic and plausible which thusly expands their length of life. The author of this exploration paper outlines the sleep/wake up proposes an independent adaptable sleep/wake-up scheduling approach. Different from most existing examinations that utilize the duty cycling technique encounters a tradeoff in packets conveyance postpone along with vitality sparing. In the proposed procedure, confines the work of duty cycling technique, to evade suchlike tradeoff. It is set up on the fortification learning strategy, which allows each node to self-administer and self-decide its activity mode i.e to rest, listen, or to do the transmission in each time allotments in a dissipated and scattered manner. Recreation results display the sufficient execution of the proposed approach in assorted conditions. Ant Colony Optimization (ACO) is the kind of Bio-roused strategy which is a dynamic and trustworthy convention. It wards off system stuffing and keeps from blocking. Further, ACO calculation turns down the utilization of vitality.

Keywords-Wireless Sensor Networks(WSN); Radio Frequency Identification (RFID); Sensor networks; Duty cycling techniques; Ant Colony Optimization (ACO).

1 Introduction

A Wireless sensor system is to be explained as an arrangement of devices that can transmit and receive information assembled from an observed field using wireless connections. The messages are sent and readdressed over various nodes, and gateways, the information is incorporated with different systems similar to remote Ethernet. A wireless network that includes base stations and various nodes additionally called wireless sensors. These systems are utilized to watch and direct states of being alongside ecological conditions for example sound, weight, temperature, and co-operatively pass information by methods for the system to the primary area. Contingent upon the different executions of WSNs they are either used randomly or manually. There is a captivating inexhaustible and limitless capacity in the wireless technology with shifted usage parcel alongside transportation, military, clinical, catastrophic event. The two predominant usages of WSN are monitoring and tracking. The work of particular wireless devices like

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phones, GPS gadgets, PCs, RFID, and so on have gotten progressively normal, conservative likewise assumes a significant job in modernized occasions.

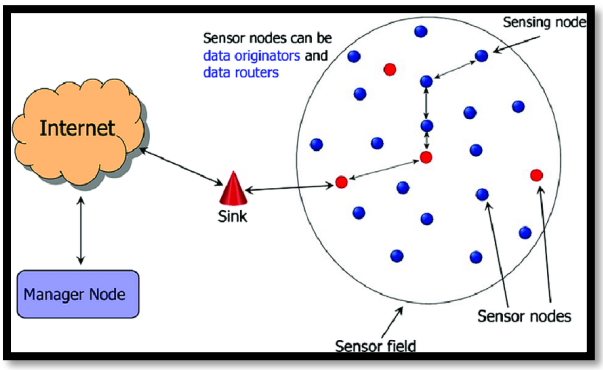

Figure 1- Communication Architecture [1]

1.1 WSN Architecture

Wireless sensor networks are produced using self-ruling sensor nodes positioned in a region working collectively, considered to watch various natural and states of being, for example, development, temperature, load, wavering, sound, or contaminations. One chief reason is the improvement of WSN was military purposes in combat zones in the beginning yet by and by the application space is reached out to extra disciplines including mechanical observing, directing traffic, and wellbeing checking. A Microcontroller, Radio transceiver, and Energy source (battery) are the subsequent components in a wireless sensor node.

The resulting remarkable highlights of the Wireless Sensor Networks are as follows: They can be utilized for a gigantic scope. These networks are adaptable; the sole defect is the data transfer capacity of the portal hub. WSN can manage node breakdowns. An extra unordinary highlight is the development of nodes. They can withstand different natural environmental factors. They have viable network topology. Normally, the base station conveys by radio association with other sensor nodes in a WSN. A portion of notable uses of WSN are as per the following

- Environmental/Earth detecting
- Air contamination checking
- Forest fire recognition
- Landslide recognition

Because of current technological headways, the creation of small, low power, minimal cost, and very coordinated sensors have become in fact in addition to monetarily feasible. Those sensors are oftentimes prepared by detecting, information handling, and correspondence segments. Before-mentioned sensors are to be employed to control circumstances, earth walling them in, and afterward recreate certain judgments to signals.

Commonly, an infinite number of sensors the WSN has, that interact including with each other [2]. The vitality of every sensor is confined besides they're conventionally battery-powered, in this manner vitality consumption of individual sensors must be diminished to expand the endurance time of WSNs. Huge reasons for vitality fatigue are unmerited tuning in, impact, catching, and control overhead [3]. Among those, inactive listening could be an ordering segment in most extreme sensor network usage [4]. There are

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interminable techniques to broaden the lifetime of WSNs, productive organization of sensors advancement of WSN inclusion, and sleep/wake-up schedule. Under the aforementioned paper, Sleep/wake-up scheduling proposes to shorten the idle time of listening, which is a state of the basic research inquiries in WSNs [5]. An examination into sleep/wake-up scheduling breaking down the best approach to improve the proportion among dozing time in addition to the conscious time of every sensor in every meeting. Of late, a few sleep/wake-up scheduling procedures are delivered. These systems roughly occur into three classes: On demand wake-up, synchronous.

During each session, nodes synchronize their sleep and wake up time, i.e., managing the duty cycle, where each node remains conscious in some schedule openings while resting in various time allotments. In the suggested independent adaptable sleep/wake-up scheduling strategy, each time node is quickly part of schedule openings in each time allotment, all nodes unexpectedly decide to sleep or wake up. Thusly, in the suggested approach, there is no 'cycle' and record-breaking spaces are independent.

2 Literature Survey

2.1 Tight Performance Bounds of Multi-hop Fair Access for MAC Protocols in Wireless Sensor Networks and Underwater Sensor Networks

Yang Xiao, Miao Peng, John Gibson, Geoffrey G. Xie, Ding-Zhu Du, and Athanasios V. Vasilakos [9]

This forming dissects the speculative prerequisite fringes of medium access control (MAC) conventions for specific multi-ricochet, RF-based remote sensor systems, and undersea sensor systems. A critical component of this assessment is the showing of a real passage decide that demands sensors to have a proportionate degree of undersea edge move to the base station. The criticalness of as far as possible and lower limits is two-overlay: Primary, they languish over all vague MAC conventions under both single-channel including half-duplex radios; following, they are likely right. For undersea sensor systems, following demonstrated conditions, it deduces a strong upper bound toward arrange use and shows a significant reality that the utilization in systems with expansion delay is greater than that in systems with no spread deferral. The deterrent of this endeavor with respect to undersea sensor systems wins in the point that the proliferation defers sway on undersea sensor systems is mind boggling to appear.

2.2 Distributed finite-time tracking of multiple non-identical second-order nonlinear systems with settling time estimation

Yu Zhao, ZhishengDuan, Guanghui Wen and Guanrong Chen [10].

Here the record separates the flowed restricted time consent following request for an arrangement of autonomous executives addressed by various non-unclear second-demand nonlinear systems. Mostly, a variety of scattered restricted time shows is proposed subject to the close to position and relative speed ends. Next, an exceptional course of action of spectator based counts is created to explain the restricted time consent following difficulty apparently utilizing relative speed estimations. The primary upgrade of this creating is that, by registering the estimation of the Lyapunov work at the basic point, the quantifiable settling time can be resolved for second-demand multi-master exercises with the proposed control shows. Convincingly, the sufficiency of the specific outcomes is decorated by use in low - Earth circle transport headway flying.

2.3 Distributed Optimal Consensus Filter for Target Tracking in Heterogeneous Sensor Networks

S. Zhu, C. Chen, W. Li, B. Yang, and X. Guan Published in IEEE Trans. Cybern., vol. 43, no. 6, pp. 1963–1976, Dec. 2013[11]

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The record is included including the impediment of filter plan for spot following across sensor networks. Particularly of various current tasks towards sensor networks, this article examines the composite sensor networks with two classes of sensors going in preparing capacities. In any case, issues of how to manage the heterogeneity of sensors besides how to create a filter for a target following over such sort of networks dwell chiefly uninvestigated. The paper proposes a dispersed accord filter to tackle the objective following issue.

2.4 An Energy-Efficient MAC Protocol for Wireless Sensor Networks

Wei Ye, John Heidemann, Deborah Estrin

Published in Proc. IEEE INFOCOM, New York, NY, USA, Jun. 2002, pp. 1567–1576[12]

This creating proposes S-MAC, a medium-(MAC) convention got ready for WSN. WSN's use of battery-worked handling notwithstanding identifying contraptions. A system of those devices will work together for a standard help like environmental checking. It is dependent upon that sensor systems to be used in a business hoc way, with unequivocal hubs languishing inactive over broad stretches, then again changing over rapidly unique when something is found. These properties of sensor systems and use drive a MAC that is confined from ordinary remote MACs in every way that matters each structure: imperativeness accumulating and self-configurations are prime targets, while per-center fairness and latency are humbler. S-MAC uses three novel ways to deal with reduce imperativeness use and guide self-configurations. To lessen essentialness use in watching an empty channel, hubs purposely rest. Neighboring hubs structure virtual bunches to auto-synchronize on rest plans.

3 Methodologies

This examination of sleep/wake-up schedule concentrates on the best way to adjust the ratio among sleeping time in addition to the awake time of each node in every period as appeared in Figure 2.

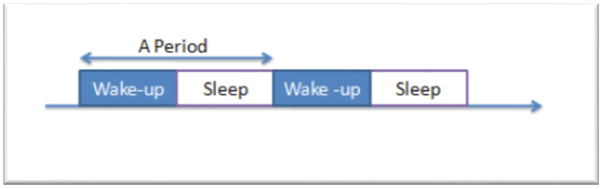

Figure 2-Formulation of the Problem [13]

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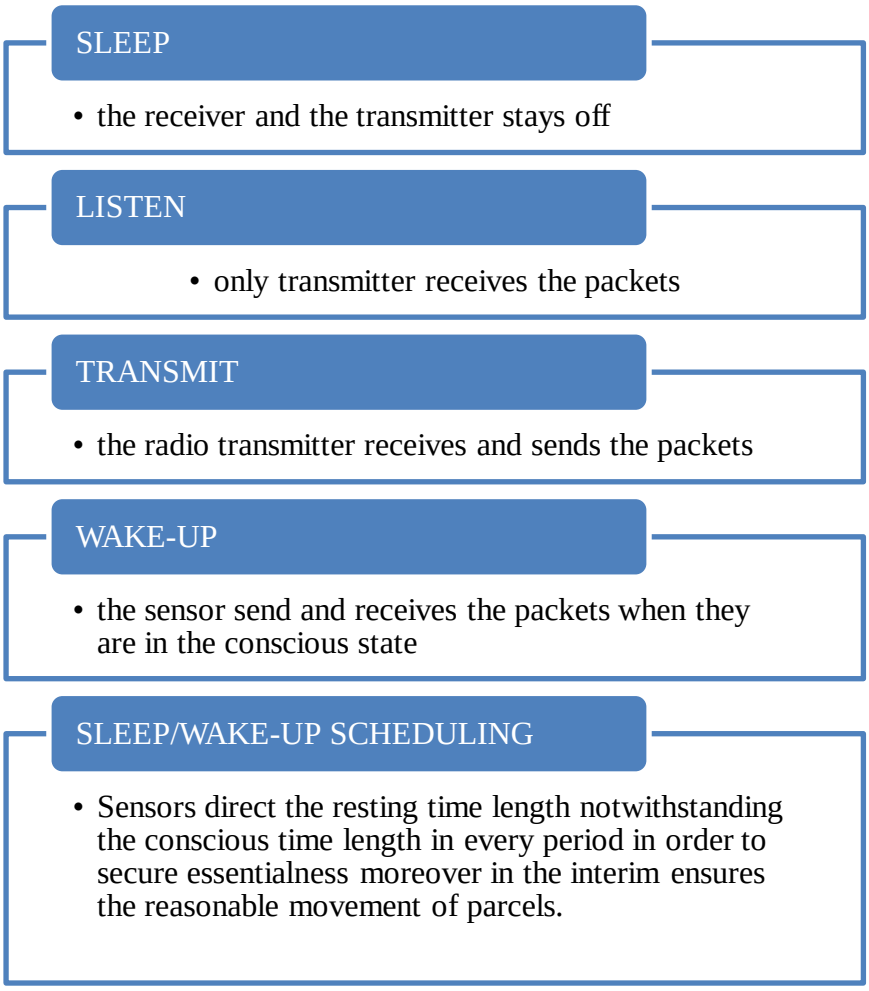

3.1 GAME THEORY

The laws in mathematical games are sterner and assign what is allowed and what isn't. Game theory [14], a segment of arithmetic gives the apparatuses to analyze the conditions in parties, called players; they are self-governing and settle on their own choices. All through dynamic, there might be a state of appearance of contention, and furthermore players may concur on specific things. These contentions are effectively demonstrated by utilizing Game Theory which is utilized in this composition to manage the rest/wake-up booking snags in Wireless Sensor Networks.

The game here is determined by a combo of payoff matrices-

$$P=\begin{bmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \\ p3 & p_{32} & p_{33} \end{bmatrix} \text{and } Q=\begin{bmatrix} q_{11} & q_{12} & q_{13} \\ q_{21} & q_{22} & q_{23} \\ q_{31} & q_{32} & q_{33} \end{bmatrix}$$

The game here is resolved here, P and Q assign the adjustments for the row players in addition to the column players. For each couple of comparing players, the subsequent three activities are conceivable for example to transmit, listen, and sleep. The aggregate activity of the players finishes up their payoffs as indicated by their result matrices a combo of payoff matrices. The line player's and sections players expected result is-

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$$\mathbf{P_p}=\sum_{1\le i\le 3}\left[\sum_{1\le j\le 3} \boldsymbol{p_{ij}x_iy_j}\right]\ldots.(1)\mathbf{P_q}=\sum_{1\le i\le 3}\left[\sum_{1\le j\le 3} \boldsymbol{q_{ij}x_iy_j}\right]\ldots(2)$$

Assign actions 1–3 indicate *transmit*, *listen*, and *sleep*, individually. If the successful transmission of the packet occurs, the payoff of either transmitter or receiver is the energy utilized to transmit or receive the packet, along with a positive constant *U* where *U* = 98. The payoff for action *sleep* is −0.003, the negative sign indicates that the energy is being consumed. In every time slot, the individual node is in one of the various states which means the situation of its buffer. A node's buffer can save three packets: *s*0–*s*3. Furthermore, the node produces three actions: transmit, listen, and sleep, signified as 1–3, sequentially. The policy of the node can be expressed with the help of the following matrix-

$$\Pi=\begin{bmatrix}\pi(s_0,1) & \pi(s_0,2) & \pi(s_0,3)\\ \pi(s_1,1) & \pi(s_1,2) & \pi(s_1,3)\\ \pi(s_2,1) & \pi(s_2,2) & \pi(s_2,3)\\ \pi(s_3,1) & \pi(s_3,2) & \pi(s_3,3)\end{bmatrix}$$

Originally, as the node doesn't possess any information, all-action is estimated to be uniformly relevant in all states.

- *TRACO-MAC:* In TRACO-MAC, two radios are applied, where one is concerned with waking up neighbors and the other is towards transmitting packets. Unlike conventional on-demand strategies, in TRACO-MAC, during the time a node has a packet to broadcast, it does not wake up its complete neighborhood only selectively wakes up numerous neighbors which have beforehand involved in communication over rate estimation. To the theory of optimization, Ant colony optimization is introduced here to obtain the most precise and shortest path in Kthe network.
- *DWACO-MAC:* DWACO-MAC is a synchronized duty cycle MAC protocol, where every cycle is classified in three periods: a) sync; b) data; and c) sleep. DWACO-MAC ought to synchronize the clocks inside sensor nodes systematically through the sync period. DWACO-MAC later sets up a one-to-one equivalent mapping connecting a data period including the subsequent sleep period. To the theory of optimization, Ant colony optimization is incorporated here to achieve the quickest route in the network.
- *EMACO-MAC:* In EMACO-MAC, every node applies a pseudorandom number generator: $Xn+1=(aXn+c) \bmod m$ to measure its wake-up times In aforementioned simulation, $m = 65536$, each node's *a*, *c* and *X n n*+1 are individually appointed following the policies proposed by Knuth [50]. EMACO-MAC does not necessitate synchronization however it wants nodes to switch data ere nodes can perform foresight. To the idea of optimization, Ant colony optimization is introduced here to obtain the most precise way in the network.
- *ASACO-MAC:* In ASACO-MAC, nodes rise systematically to accept packets. Neighboring nodes ought to communicate regularly to swap data about wake-up schedules to evade long preambles at the commencement of transmission. Besides, we also distinguish SAACO-Mech. with its synchronized variant, SA Mech.-Syn. Within SAACO-Mech.-Syn, it is believed that a sink node rhythmically broadcasts an unusual packet to the complete network to synchronize the nodes' clocks. The purpose of adding SAACO Mech.-Syn for separation is to test how the initiation of synchronization will influence the execution of SAACO-Mech. To the notion of optimization, Ant colony optimization is incorporated here to achieve the shortest route in the network.

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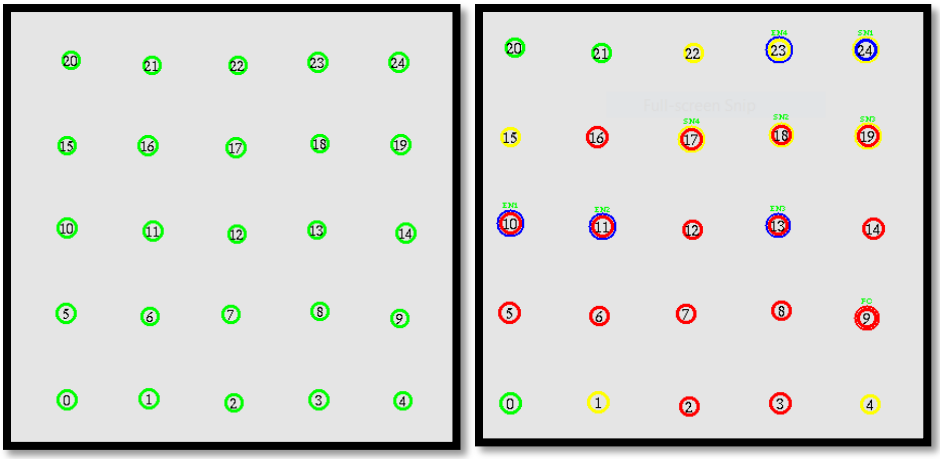

Figure 3Animation depicting the states of the nodes A-before and after application of algorithm

The animation here explains the functioning of the model, originally, 25 nodes are exercised in the grid format upon which the self-adaptive sleep/wake is implemented and the stimulation is being played. All the nodes are green initially which explains that their energy is full moreover abundant. Whereas blue, yellow, and red present source, destination, and FC (final controller). All the nodes are green originally after a particular duration of time when the nodes begin expending their energy they switch their color from green to yellow and then subsequently to red which confirms that the nodes are dead. This occurs to all the 25 nodes one by one, on increasing the time cursor we saw that that the end nodes were of the red color which signifies that the nodes were dead. By applying the various analysis commands for example Packet Drop Calculation of the network, Packet Delivery Ratio Calculation of the network, Throughput Calculation of the network and Routing Overhead Calculation of the network.

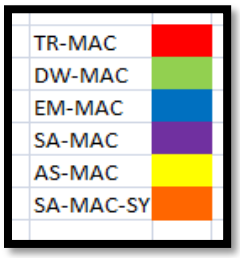

Figure 4Shows the working of graph

- **Packet drop calculation of the network**

Packet loss occurs in the event that at least one packet of data advancing over a PC network collide with show up at their end. Packet loss is either made by mistakes in information transmission, across wireless networks, or network blockage. Packet loss is assessed as a level of packet lost concerning packet sent. [16] The Transmission Control Protocol (TCP) recognizes packet loss retransmissions to ensure authentic informing. Packet lossin a TCP association is also utilized to sidestep blockage moreover shows an intentionally diminished throughput for the association.

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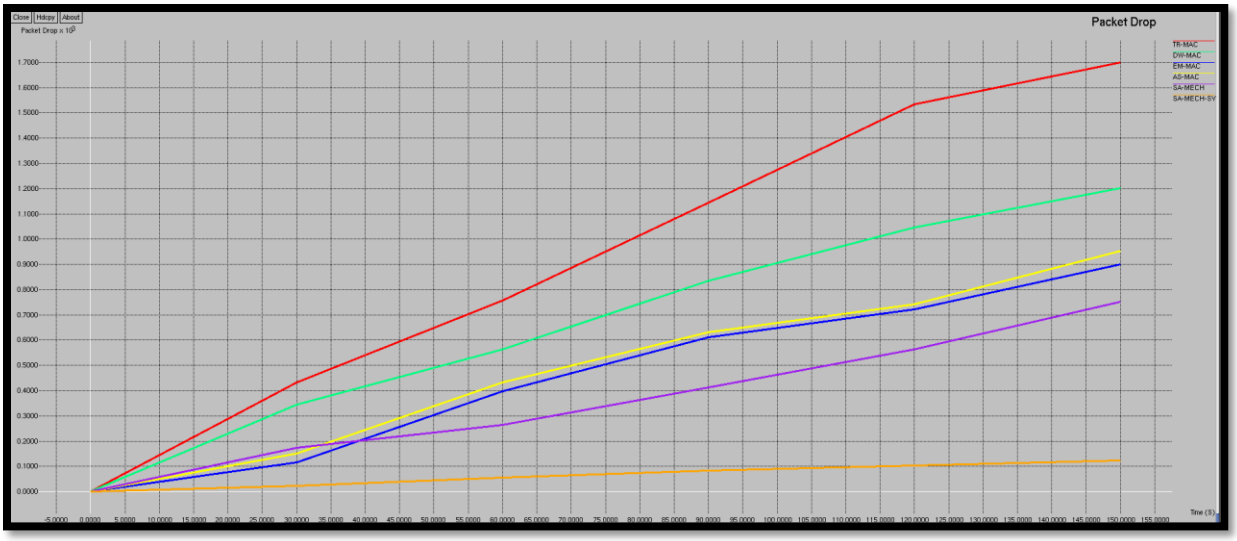

Figure 5Packet Drop Calculation of the Network

- **Packet delivery ratio calculation of the network**

The estimation of the Packet Delivery Ratio (PDR) relies upon the acquired and built bundles or bundles as enrolled in the following archive. In like way, PDR is addressed as the extent between the obtained packets by the area and the conveyed packets at the source. PSR is settled using awk content that prepares the follow report and presents the result. [17]

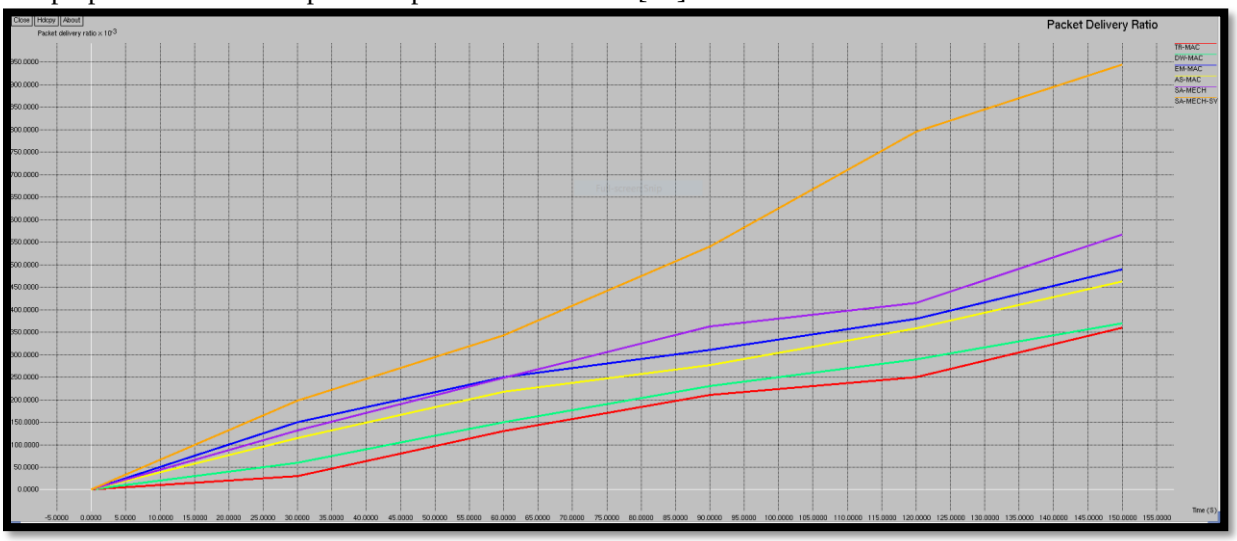

Figure 6Packet Delivery Ratio Calculation of the Network

- **Throughput calculation of the network**

Network throughput applies to the normal information pace of successful information or message transmission over a specific interchanges interface. Network throughput is evaluated in bits every second (bps). A commonplace misconstruing on scaling network throughput is that estimating the time it requires to upload or download a major record is the most elevated throughput of a network. The previously mentioned technique doesn't take into depiction interchanges overhead, for example, Network beneficiary window size, machine limitations, or network inactivity. The best network

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throughput coordinates the TCP window region isolated by the full circle time of data information packets.

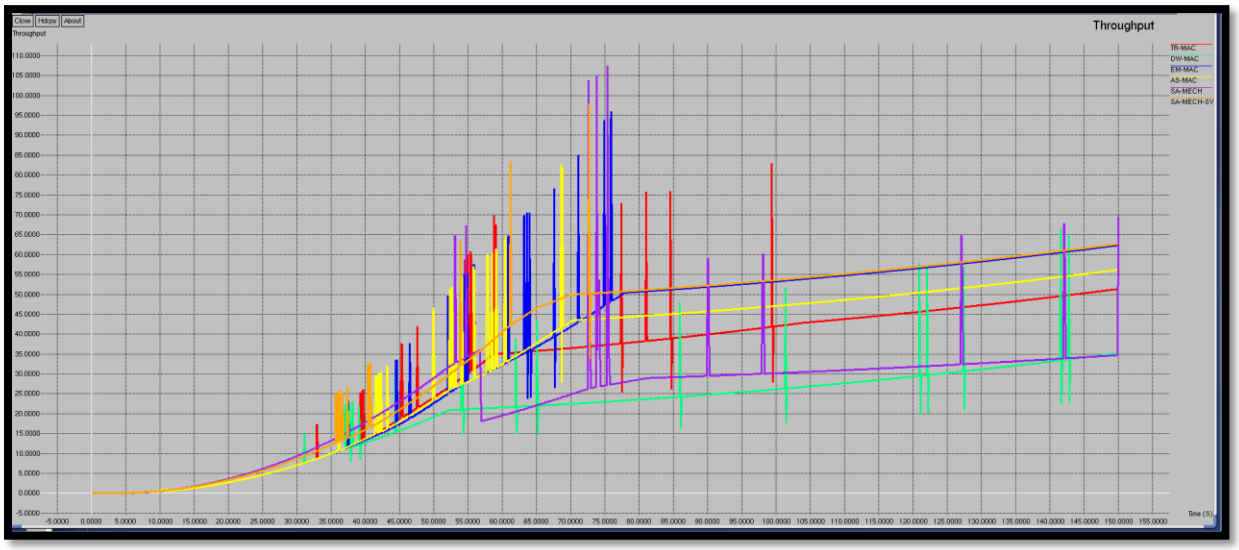

Figure 7Throughput Calculation of the Network

- **Routing overhead calculation of the network**

  Routing Overhead is the quantity of steering packets requested moving toward network correspondence. Routing Overhead is masterminded to apply awk content which gives the follow record besides gives the outcome.

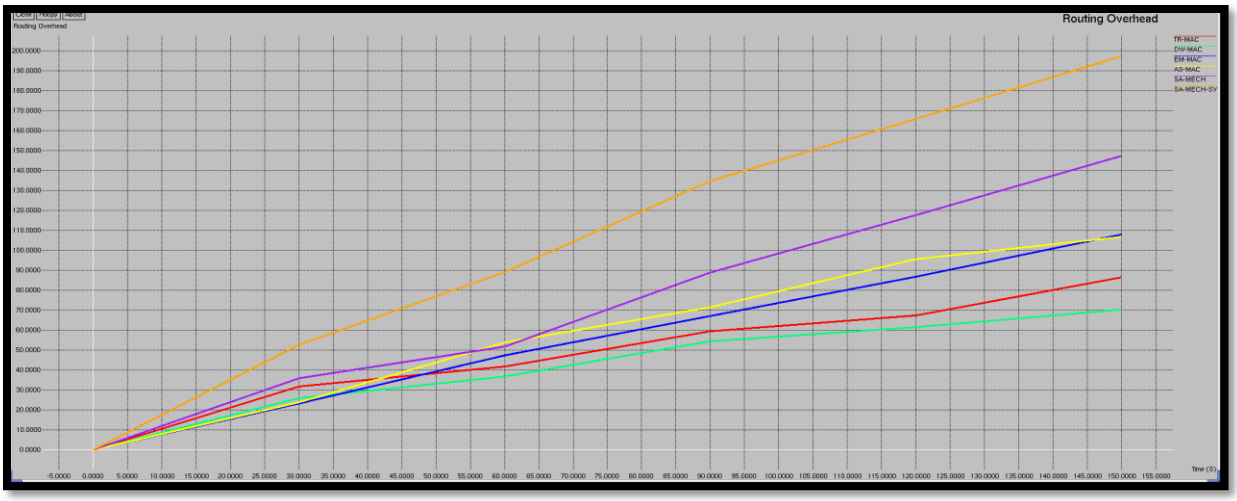

Figure 8Routing Overhead Calculation of the Network

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While working the above investigation devices we have accomplished a specific number of correlation diagrams. A portion of the huge inadequacies of the model were additionally acknowledged like high packet loss, energy loss quick, the obtained packet conveyance proportion is low which is 0.8, lastly a bigger number of dead nodes.

So, resolve the issues of the current model another work is done in which a hybrid calculation is utilized with theself-adaptive sleep/wale-up algorithm. The hybrid calculation utilizes the blend of the conventional calculation and ant colony optimization algorithm.

3.2 Ant Colony Optimization

The two classes of routing conventions that remain responsive and proactive. Under receptive routing conventions, the courses are planned especially only when the source desires to transmit the message to goal though in proactive directing conventions are table-driven. [15]

The conservation of time-sensitive states is a fundamental component of AODV which means that a directing section that isn't of late utilized is ended. The neighbors are educated in the event of course destruction. The assurance of the course from source to the goal relies upon the question in addition to answering cycles including the middle of the intermediate nodes that store the course report as course table records simultaneously the course. Command messages rehearsed for some recognizable proof including the wreckage of the course are as per the following – RREQ, RREP, RERR and HELLO Messages.

Ant Colony Optimization (ACO), is the restricted collaboration regarding numerous straightforward specialists accomplish a worldwide objective. Each insect in a social bug state appears to have a plan. The focal expectation of the subterranean insect state enhancement (ACO) meta-heuristic is acquired from the food looking through the conduct of genuine ants. Ant specialists are grouped in the following two fragments: FANT (Forward Ants) and BANT (Backward Ants).

The supreme goal of the subclass of those specialists is to help BANTs to employ the important data assembled by FANTs from source to goal. In view of this hypothesize; no node directing data refreshes are executed by FANT, whose single goal in life is to report network check conditions to BANT.

Natural behavior of an ant foraging modesSearch mode andReturn mode

The process is defined as-

- Ants start from the home to discover the course to the food
- Ant arrives at the food utilizing the most limited way and store pheromone.
- Ant on the most brief way arrives at the home first and expands the pheromone focus on the most limited way
- The most limited way has the most elevated grouping of pheromone, all the ants utilize the briefest way and it will be the main way remaining.

The intensity level of the pheromone would be more powerful in the smallest path as more ants would have covered this route as compared to another path. Originally, an ant has no choice on which path to engage and uses all of the paths with uniform probability. Though, after a specified period, the ants would choose the path that has the greatest level of pheromone concentration. This would be the shortest route considering more ants would have traveled in this path as compared to any other path in a provided time interval. The proposed ant-based routing algorithm has numerous characteristics that make it fitting for the above-specified requirements.

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The application of the combination of the generic algorithm with the ant colony optimization improves the packet delivery ratio (PDR) and network lifetime of the nodes,which can be presented with the help of the animation-

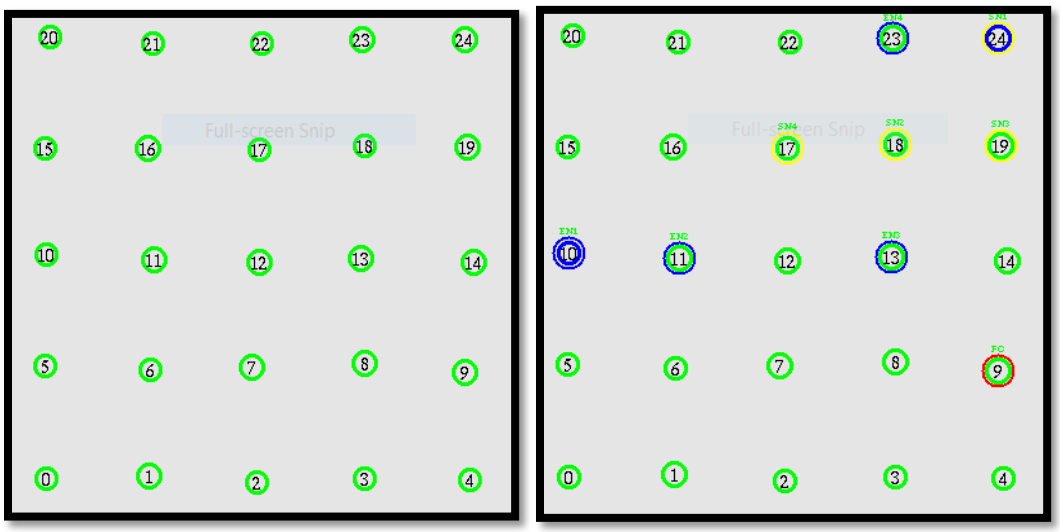

Figure 9 Animation depicting the states of the nodes A-before and after application of algorithm

There are no dead nodes detected, which consequently preserves the energy and eventually, the lifespan of the nodes is improved. Packet loss is also reduced which is attested by the graphs, various additional parameters were also improved like Packet Drop Calculation of the network, Packet Delivery Ratio Calculation of the network, Throughput Calculation of the network and Routing Overhead Calculation of the network.

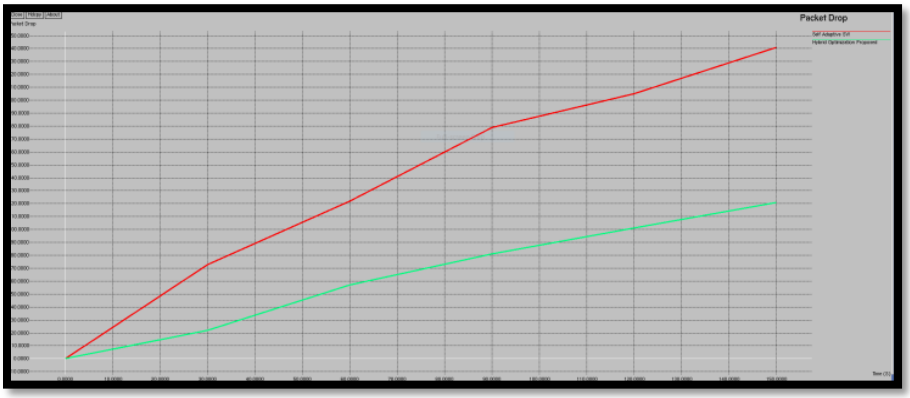

Figure 10Packet Drop Calculation of the Network

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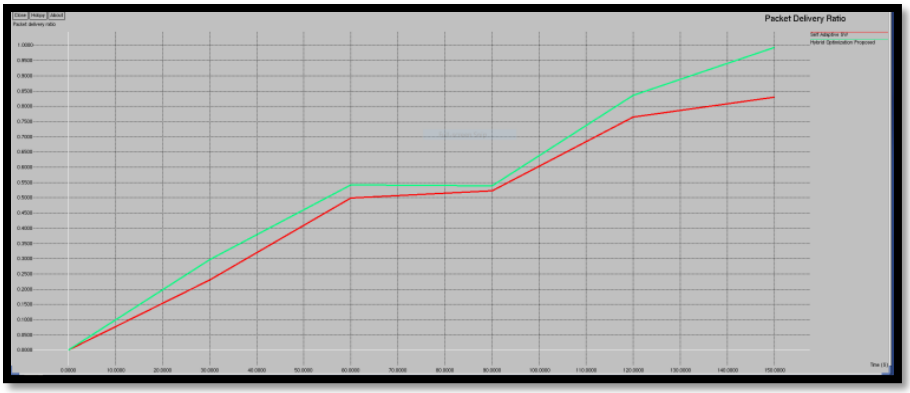

Figure 11Packet Delivery Ratio Calculation of the Network

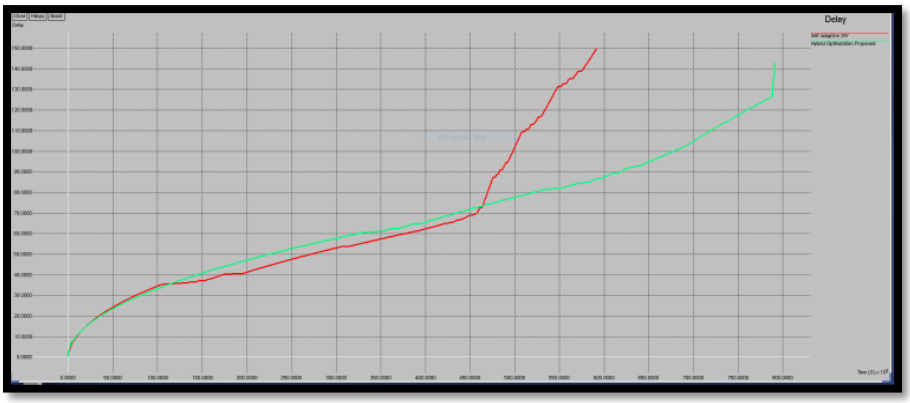

Figure 12Packet Delay Calculation of the Network

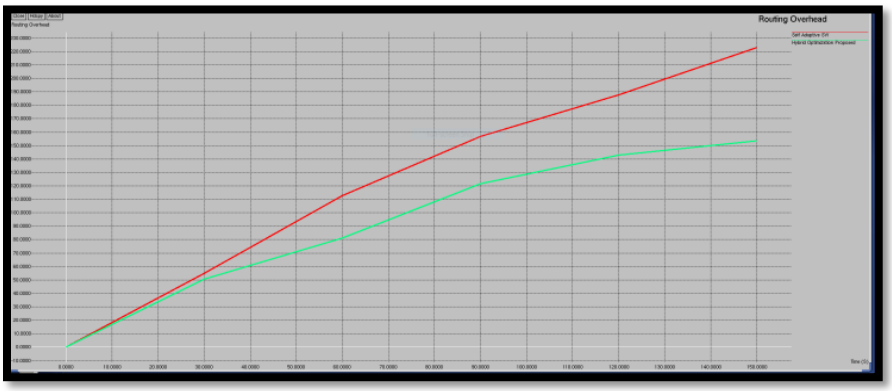

Figure 13Routing Overhead Calculation of the Network

4 Results and Conclusion

The composing sorted out a self-adaptive sleep/wake-up scheduling method. The method appears not to practice the procedure of duty cycling. Then again, isolate the time pivot inside a few time allotments likewise permit each node self-governing decides to rest, tune in, or transmit under a scheduled opening. Each node gets to an end dependent on its predominant position and an estimation of its neighbors' conditions, where such guess doesn't require association with neighbors. The protocol is performed by

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applying the ACO algorithm to enhance directing tracks, executing a sufficient multi-way close to a solitary sink including the clustering idea for data transportation to accomplish secure cooperation in the circumstance of nodes defects. We expected to support network lifetime to most elevated, while data communication is accomplished proficiently. Our examination ended to appraise the execution of an ant-based algorithm incorporating AODV directing convention throughout the Packet Delivery Ratio and Normalized Routing Load. Of the perception, it is settled that the general portrayal of an ant-based algorithm is more reliable than AODV.

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