International Interdisciplinary Virtual Conference on
'Recent Advancements in Computer Science, Management and Information Technology'
International Journal of Scientific Research in Computer Science,
Engineering and Information Technology | ISSN : 2456-3307 (www.ijsrcseit.com)

Review on Security-Based LEACH Protocol for Wireless Sensor Network

Dr. P. G. Sarpate[1], Dr. N. D. Jambhekar[1], Dr. A. A. Tayade[2]
[1]G. S. Gawande Mahavidyalaya, Umarkhed, Dist- Yavatmal, Maharashtra, India
[2]G.S. Science, Arts and Commerce College, Khamgaon, Maharashtra, India

ABSTRACT
Wireless sensing nodes emerged as a response to the growing demand for ubiquitous monitoring of particular environments, enabled by advances in communications and IT. It's cheap, versatile, compact, and energy efficient, but only in moderation. One of the most pressing issues in wireless sensor networks is how to extend the network's operational lifespan. Many different routing protocols have been developed, each with its own set of advantages and disadvantages. It is preferable for low-energy and long-lived networks because routing protocols can be relied upon to find the most efficient channel of communication between the transmitter and the receiver. The goal of this study is to compare and contrast various routing protocols and highlight their advantages and disadvantages.

Keywords—Energy efficiency, Hierarchical routing protocol Residual energy, Wireless sensing nodes, LEACH

I. INTRODUCTION

The idea behind wireless sensor networks (WSN) depends on eliminating the need for human intervention at each stage of the data collection and transmission process [1]. WSN is composed of a large number of relatively small autonomous sensing nodes that collaborate to gather data about their immediate surroundings and process it before transmitting it to a central station. Random sensor nodes are placed in inaccessible regions. Though most of the uses for this network include war and disaster management, such as earthquake and fire detection, it also has numerous peaceful uses, including as air traffic control, healthcare, electronic selling points for a variety of businesses, and more [1]. To "route" anything is to choose the best path between a starting point and an endpoint. On order to ensure high reliability and rapid performance, this is done in the network layer to direct and transport data.

Because of how inconvenient it is to go to the sensor nodes' publishing locations, it's crucial that they stay operational for as long as possible to ensure reliable monitoring. Batteries, which are contained in such nodes, are known to have a finite lifespan. Therefore, avoiding the premature energy depletion of sensor nodes is a key and essential aspect of prolonging the lifespan of the network as a whole. Numerous routing protocols, such as those based on geography and those based on clustering, have been created in recent years, each of

which may be further subdivided into a number of subcategories. hybrid routing protocols, data-centric routing protocols, and other such protocols [3]

Additional groups may be found in [2][4], which are as follows (according to the initiator of communications, according to the operating mode, according to the protocol operation and according to the design of network flow). Section II covers the remaining research. Topics include obstacles in route, Routing in WSNs Methods and common routing protocol descriptions, Section III; Section IV. Section V. different LEACH-type routing protocols is the last chapter of this paper. Section IV. low-energy adaptive clustering hierarchy Final Thoughts and Citations.

II. TOPICS OF ROUTING CHALLENGES

Due to limited energy, arithmetic, and basic units like memory and others, the design of this network is influenced by numerous issues, including the inability to scale, lack of awareness of energy level, and lack of complexity in the routing protocol that we consider excellent in WSN [2].:

A. Deployment of the sensor node

The efficiency of the routing protocol is heavily influenced by the deployment strategy for the sensor nodes, which in turn is determined by the kind of application being used. There are two main methods for deploying sensor nodes: randomly (self- organizing), as we discussed before, or carefully and precisely. Energy efficiency is heavily dependent on the positioning of the sensor nodes, particularly the cluster head and base (monitoring) station..

B. Network traffic status

Due to the simplicity of regulating them and defining the proper routing protocol, ordinary sensing nodes other than the group's (cluster's) head or monitoring station are preferred to be (static) non-moving. However, there are cases when a moving sensor node is necessary..

C. Tolerance of Faults

When a sensor node fails, the routing protocol must establish new connections to prevent the network from losing data about the surrounding area..

D. Scalability of the WSN

The potential for dozens or perhaps millions of sensor nodes routing protocols need to be able to deal with a large density of nodes, perhaps in the tens of thousands, in the region being monitored.s.

E. Constraints on hardware

All units that make up the sensor node must be present as small as possible and consume the lowest possible power and examples of these units are: GPS, communication, sensor, power, memory, etc.

F. Information Transfer

In most cases, data is sent wirelessly, which is susceptible to interference and results in a weaker signal than a wired transfer would.

G. Conservation of energy

When the network is first being constructed, energy efficiency is a major factor in deciding which paths to take. assuming that the network's reliance on radio transmission power decreases at a rate proportional to the square of the distance squared or greater in the presence of interference and obstructions, Single-hop is efficient for low-density networks with close-by sensor nodes, whereas multi-hop uses less energy while adding to the network's problems..

H. Models for data delivery

Continuous, event-based, inquiry-specific, or a hybrid of these modes of data delivery to the monitoring station are all possible. Every sensor node transmits data on a periodic basis if the process is continuous. However, in the second and third types of delivery, the node is engaged when an event happens or when the data source requires specific information. This method of distribution impacts the routing protocol, particularly with regards to the problem of low power usage..

I. Aggregation / fusion of information

It is the process of aggregating information from several sensor nodes with the aim of thwarting any possibility of repetition. Packets are collected from various sensor nodes by the network in an effort to lessen the amount of data sent and, by extension, the amount of power required for the transmission.

III. WSN ROUTING METHODS AND EXPLANATIONS OF COMMON ROUTING PROTOCOLS

Reactive routes calculate the pathways when the true need is only, whereas proactive paths calculate the paths in advance of when they are really needed, and mixed paths do both. As the network often consists of hundreds of sensing nodes, mixed protocols integrate them, whereas proactive calculates all pathways in advance of the true requirement for them and keeps these paths in a routing table for each node, rendering proactive worthless.

Generally speaking, routing protocols may be categorised into three broad groups: flat-routing, hierarchical, and location-based. routing. the first one (in flat-based routing) all of the nodes perform the identical function so data is transmitted from each sensor node with a high redundancy of data [2].

Hierarchical Protocols, this type of protocol is intended to raise the efficiency of the network, extend its lifetime, increase the scalability, and cover a larger field of sensor nodes based on two steps: the first is to select the head of the cluster and the second for routing. Clusters are created in this type of protocol [2].

Location-based protocols, there is a correlation between the distance between two sensing nodes and the energy needed to transfer data between them, so sometimes we need to know the location of the node and we can do this either through GPS or other methods [2]. See Figure 1.

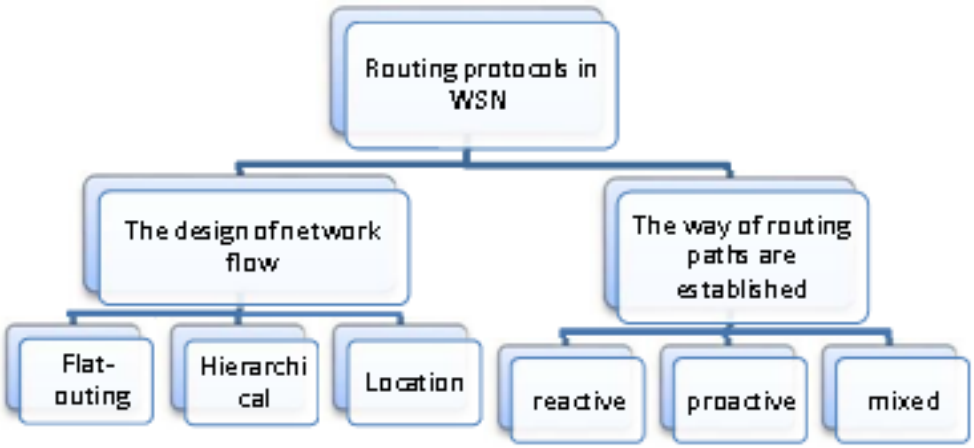

Fig. 1: Types of routing protocols.

The conventional wisdom holds that each sensor node should send its data directly to the base (monitoring) station; this method is known as Direct Transmission (DT), but it does not guarantee a fair distribution of power consumption among the nodes, which eventually results in the death of the sensors (MTE). Therefore, emphasis was placed on hierarchical protocols that save more power than flat routing.

When using a WSN's clustering techniques, the sensor network is partitioned into a number of clusters, with one node in each cluster being designated as the "cluster head" by the other nodes in the network. This node's responsibilities as cluster head will be shared among the other nodes in the network in accordance with the routing protocol's chosen algorithm. At present, the cluster header delivers a single signal packet to the base (monitoring) station by combining and collecting data from many packets [5].

Elections are broken up into numerous rounds in clustered routing; modifications may be made after each round to provide a more optimal distribution of energy use in a wireless sensor network. By dividing the clusters into smaller networks, the overall network's size is reduced via the process of clustering.

Advantages of the Cluster Process are discussed below [6]:

- Clustering divides the network's nodes into smaller groups; the cluster's leader handles communications with the base station so that everyone in the group may focus on their own tasks..

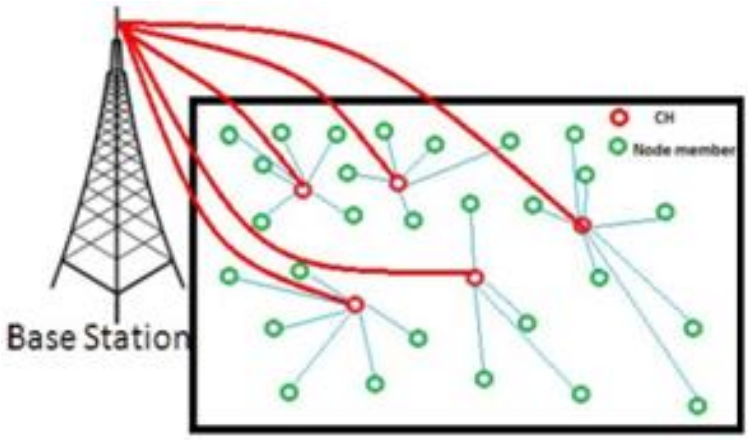

Fig. 2: Creation of clusters. [5]

- To sum up: • Unlike with conventional routing protocols, the base station only communicates with a small subset of the network's nodes; the remainder of the cluster's members need not even interact with the base station at all..
- The allocation of loads should be regulated: the result of dividing the wireless sensor network into groups is the final functions are spat, which ultimately helps to ensure the same power dissipation between all sensor nodes. Consequently, every sensor node has a specific work to do at a specific time, while the nodes that fall away from the monitoring station die faster in flat routing protocols, losing their energy faster than the nearby nodes and thus increasing the energy consumption of the entire network.
- Information aggregation / fusion: Nodes transmit data signals to cluster headers, which aggregate the data to either eliminate duplication or combine the data signals into a single signal.
- By switching the cluster leader around and minimising the chances of failure for the far-flung nodes, the network's lifespan is increased and made more reliable.
- Since only the cluster leader communicates with the base (monitoring) station, collisions are avoided, unlike in the flat model where all sensor nodes relay their data to the central hub..

IV. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

It has been suggested by W.B.Heinzelman in [3], LEACH is the original hierarchical routing system for sensor networks, LEACH is an adaptive clustering method which uses randomized cluster head rotation to evenly distribute the energy load between the sensor nodes in the network. It is a very flexible and random (self-organizing) protocol. LEACH utilizes a one-hop routing.

Every WSN is split into clusters and each cluster consisting of a cluster header and normal cluster nodes. In this protocol, the head of the cluster is randomly chosen and this role revolves around the rest of the sensor nodes to check the power balance of the network. The head of the cluster is directly connected to the monitoring station and stops the rest of the nodes as much as possible to reduce energy use, as stated in this protocol, Operation LEACH is split into various rounds, and each of these rounds consists fundamentally of two phases: one is the Setup phase and the next is the Steady phase.

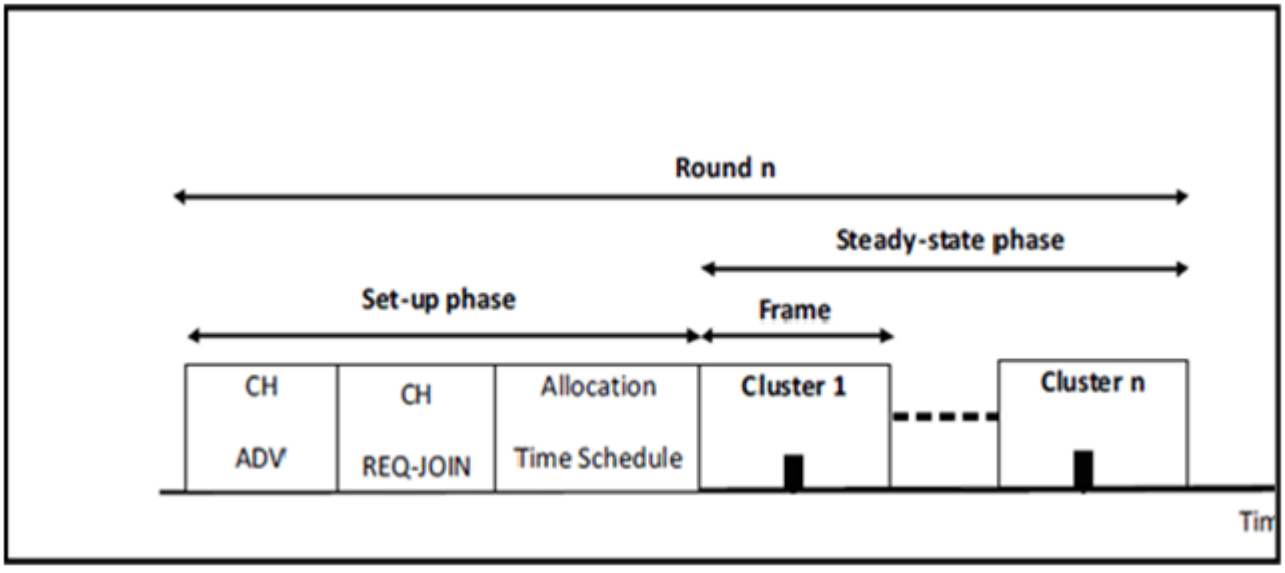

Fig.3: Operation of LEACH [12].

Initially, the node will choose a random number (n). Whether this number (n) is less than the threshold defined in the first equation T(n), then the node is chosen as the header of the cluster.

$$(n) = \begin{cases} \dfrac{p}{1 - p * (r \bmod \frac{1}{p})} & \text{if } nc\ G \\ 0 & otherwise \end{cases} \quad (1)$$

While p is the likelihood of the cluster head, G is the collection of nodes that will never be selected as cluster-head nodes before 1/p round.

After the heads of the cluster have been chosen, each cluster header node will send its data to the other nodes via CDMA (Code Division Multiple Access), and the normal nodes will connect the closest head to it. Then the cluster head nodes use TDMA (Time Division Multiple Access) to provide time for the transmission of data for each node attached to them.

In the second stage, data is transferred from the normal nodes to the head attached to it and processed (combined and assembled) at the head of the cluster, and then the head of the cluster sends it to the monitoring station.

According to [7][3], the most prominent disadvantages of LEACH are:

Because the LEACH protocol does not account for the initial energy of each node, each node has an equal chance of becoming the cluster leader, which is unacceptable. If a node with low energy is randomly selected, that node will die rapidly, bringing the whole network down with it.

- Unacceptable distribution for cluster heads: due to the random, non- studied selection of the cluster head, it generates an imbalance in the network load, the distance, and other metrics.

Not considering the distance between the cluster's leader and the central hub prevents the network's energy from being optimised, which is a major issue.

There is added responsibility for the cluster's leader node, which must gather data from the regular nodes and relay it to the control centre in a single hop (hop). We can predict that it will run out of juice sooner than typical nodes. Once the cluster's leader passes away, the rest of the nodes will soon follow.

- Because of the delay it causes, it is incompatible with the time-sensitive application.

It can't be connected to a wide-scale sensor network.

- As we've established, data transfer to the monitoring station may take many forms, including a constant stream, a burst of information in response to an event, a specific query, or a combination of these. However, the LEACH protocol is best suited for the continuous form of delivery.

Since randomly created clusters might vary in size, some could have a lot of sensing nodes while others have very few. As a result of these disadvantages of the LEACH protocol, we will show in section five some of the protocols that have been found in order to solve these issues.

V. VARIOUS ROUTING PROTOCOLS OF TYPE LEACH

Various routing protocols of type leach listed below:

A. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY CENTRALIZED (LEACH-C)

LEACH-C is based on the LEACH basic protocol and also made up of rounds and is split into two-phase, it is a centralized protocol, this protocol assumes the following:

- Each sensor node can compute its energy level and send it to the monitoring station.
- Each sensor node can send its location exactly monitoring station.

Information about the location and energy of each sensor node is sent to the monitoring station by the nodes. Then the station chooses the nodes to have more energy than the average total power of the network as a cluster head, and create the best clusters depending on the minimum distance [6].

B. LEACH-Balanced (LEACH-B)

LEACH-B this revised version of the LEACH protocol gives a second choice for cluster heads at the Setup stage in each round in order to keep the cluster heads number constant and closer to optimal (Based on what was mentioned in [10] the optimal value for the number of cluster heads ranges between 3 percent and 5 percent) and thus reduce energy consumption, it is decentralized protocol, LEACH-B has improved energy efficiency compared to the original LEACH protocol [3].

C. Advanced Low Energy Adaptive Clustering Hierarchy (A- LEACH)

We also know that the head of the cluster is the one what collects data from the normal nodes and transfers them to the monitoring station so that its energy is quickly drained relative to the normal nodes, in the Advanced-LEACH protocol increases the period of stability (The time previous to the demise of the first node) and reduces the probability of death of the head of the node, each sensor node the beginning of each round is known by a synchronized clock.

We assume that (n) is the full number of nodes while (m) is the number of nodes that carry more energy than normal nodes name CGA nodes (nodes chosen as cluster heads or gateways) and the rest is (n)*(1-m) represents normal nodes, and these nodes remain sent to the monitoring station even after the normal nodes fails [4].

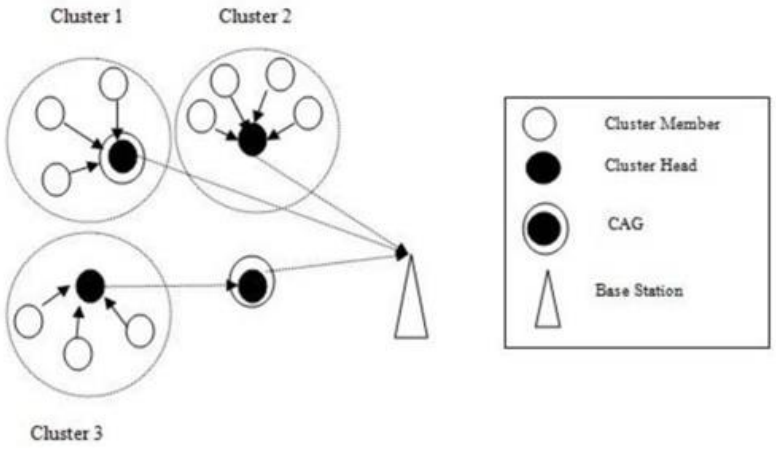

Fig.4: LEACH -A system [4].

D. Energy Low Energy Adaptive Clustering Hierarchy (LEACH-E)

Based on the LEACH protocol, E-LEACH ensures that all nodes consume an equal amount of energy. This is especially important in hierarchical routing protocols, where the number of cluster heads has a significant impact on the protocol's ability to function correctly: if there are many cluster heads, the protocol will run inefficiently and reduce the lifespan of the network as a whole, while if there are few cluster heads, each will have to handle a larger area, which increases the likelihood of failure.

E. Fixed Number of Clusters LEACH (LEACH- F)

Like the LEACH-C protocol, this protocol is a centralized approach, the clusters are fixed, and the rotation is only for the header of the cluster within the same cluster. The steady-state is identical as the original LEACH since the number of clusters has been determined in advance, the energy required for re-clustering is provided, but it is not flexible in the event of adding, removing or dying a sensor node [4].

F. Vice Cluster Head LEACH (V- LEACH)

V-LEACH this revised version of the LEACH protocol,

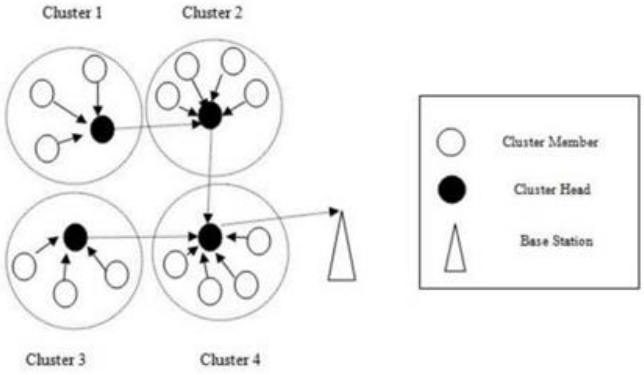

Fig.5: LEACH -E system [4].

We also know that the cluster leader's energy is rapidly depleted in comparison to the regular nodes since it is the leader that gathers data from the normal nodes and passes it to the monitoring station. As a result, you'll perish before the rest of the nodes, and once it dies, the whole cluster loses relevance since it can't send data back to the base station. This protocol was designed to prevent this from happening. When the CH's life is taken, another character takes up their duties. As a result, all information will reach the monitoring station, extending the network's overall lifespan; yet, should the vice- CH die, the protocol will still be helpless to resolve the resulting issue. [7].

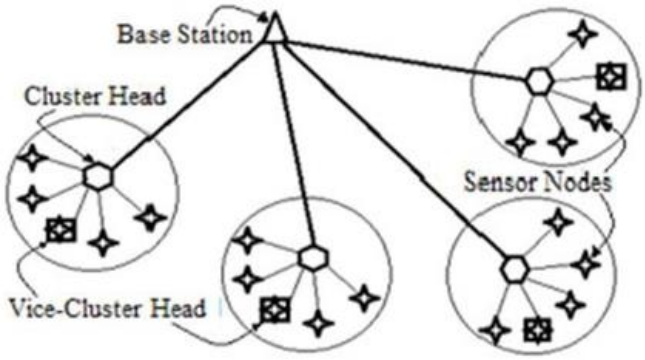

Fig.6: LEACH -V system [13].

G. Cell Low Energy Adaptive Clustering Hierarchy (Cell- LEACH)

This is a revised protocol from the original LEACH protocol, the entire network is split to several clusters and each cluster is split to seven sub-clusters called cells and each cell has a head whose task is to collect data from the normal nodes (it is chosen at the beginning and in the later stages each old cell head makes calculations dependent on the remaining energy, a new cell head is selected) and the heads of the cells and the heads of the clusters are contacted directly [8].

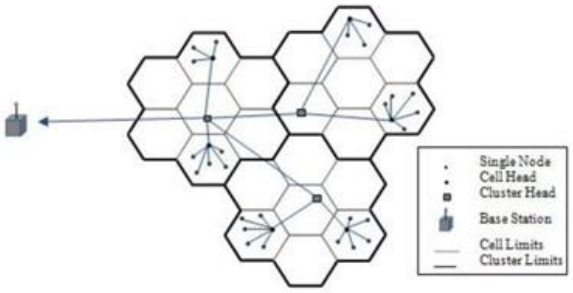

Fig.7: LEACH -Cell system [2].

H. Multi-Hop LEACH

The cluster head of an intermediate cluster is used in the LEACH protocol to shorten the distance between the sensor nodes and the monitoring station, saving a lot of energy. This is referred to as multi-hop communication. The cluster leader that is physically closest to the monitoring station collects data from the other cluster leaders and transmits it to the station; this uses less power and takes use of the most direct route between the cluster leader and the monitoring station [9]. Knowing that in the original LEACH protocol, any sensor node can become a cluster head, and that becoming a low-energy node of a cluster head signals the death of the entire network, an adjustment was made to the choice of the head of the cluster based on its energy; to increase the likelihood of the sensor with the most energy becoming a cluster head and thus increase the network's lifespan. [9].

To get the best exploit of the free TDMA, TDMA schedule is improved in the steady state. In some protocols for a specific event to happen, some sensing nodes may not have data that you want to send so the TDMA slot is lost. Each sensor node looks at its role in the current round if the node has data to sendthen send it and if it does not have data, the TDMA slot is given to another sensor node as Fig 8 [9].

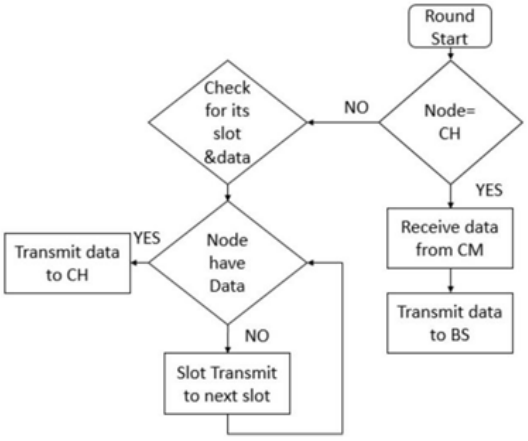

Fig 8: The new revised TDMA outline [9].

VI. CONCLUSION

The rapid development of subjects like multiple computing, novel nanotechnology, and a wide range of contemporary applications means that this kind of study is far from being exhausted. We share some findings from our investigation into the various routing protocols and attempt to show how doing so reduces the network's overall power usage. We found that the Multi-Hop LEACH protocol improves upon LEACH by making three changes: allocating the dormant TDMA node to the next node if the previous node has no data to offer; carefully selecting the head of the node; and increasing the number of terms in the original equation. The introduction of procedures other than LEACH is something I want to do in my future research.

VII. REFERENCES

[1]. Sohraby, Kazem, Daniel Minoli, and Taieb Znati. Wireless sensor networks: technology, protocols, and applications. John Wiley & Sons, 2007.

[2]. Kumar, Prabhat, M. P. Singh, and U. S. Triar. "A review of routing protocols in wireless sensor network." International Journal of Engineering Research & Technology (IJERT) 1.4 (2012): 1-14.

[3]. Mohammad, Inam. "A Survey on Leach Protocol and its Enhanced Version." International Journal of Computer Applications 975: 8887(2018).

[4]. Dhawan, Heena, and Sandeep Waraich. "A comparative study on LEACH routing protocol and its variants in wireless sensor networks: a survey." International Journal of Computer Applications 95.8 (2014).

[5]. Hnini, Abedelhalim, Ezzati, Abdellah, Fihri, Mohammed and Hajami, Abdelmajid. "Time Slots Investment of a dead node in LEACH protocol on Wireless Sensor Network." Editorial Preface (2014).

[6]. Kumar, Amit, R. K. Saini, and Er Brijbhusahn. "Comparison and Review of LEACH, LEACH-C and PEGASIS Routing Protocols."(2016).

[7]. Varshney, Shweta, and Rakesh Kuma. "Variants of LEACH routing protocol in WSN: A comparative analysis." 2018 8th International conference on cloud computing, data science & engineering (confluence). IEEE, 2018.

[8]. Yektaparast, Arezoo, Fatemeh-Hoda Nabavi, and Adel Sarmast. "An improvement on LEACH protocol (Cell-LEACH)." 2012 14th international conference on advanced communication technology (ICACT). IEEE, 2012.

[9]. Sony, Chinchu T., C. P. Sangeetha, and C. D. Suriyakala. "Multi-hop LEACH protocol with modified cluster head selection and TDMA schedule for wireless sensor networks." 2015 Global Conference on Communication Technologies (GCCT). IEEE, 2015.

[10]. Tong, Mu, and Minghao Tang. "LEACH-B: an improved LEACH protocol for wireless sensor network." 2010 6th international conference on wireless communications networking and mobile computing (WiCOM). IEEE, 2010.

[11]. Leu, Jenq-Shiou, Tung-Hung Chiang, ; Min-Chieh Yu , Kuan-Wu Su. "Energy efficient clustering scheme for prolonging the lifetime of wireless sensor network with isolated nodes." IEEE communications letters 19.2 (2014): 259-262.

[12]. https://www.researchgate.net/figure/Time-line-operation-of-leach- 5_fig1_323809323.[online].[Accessed Jan.9,2020].
[13]. https://www.researchgate.net/figure/Architecture-of-V-LEACH-Protocol_fig6_297661909.[online].[Accessed Jan.9,2020].