Mobile Networks and Applications (2020) 25:882–895
https://doi.org/10.1007/s11036-020-01523-5

Systematic Literature Review on Energy Efficient Routing Schemes in WSN – A Survey

Maryam Shafiq[1] · Humaira Ashraf[1] · Ata Ullah[2] · Shireen Tahira[3]

Published online: 16 February 2020

Abstract
In wireless sensor networks (WSN), routing is quite challenging area of research where packets are forwarded through multiple nodes to the base station. The packet being sent over the network should be shared in an energy efficient manner. It also considers the residual power of battery to enhance the network life time. Existing energy efficient routing solutions and surveys are presented but still there is a need for Systematic Literature Review (SLR) to identify the valid problems. This paper performs SLR for energy efficiency routing with 172 papers at initial stage. Next, 50 papers are shortlisted after filtration based on quality valuation and selection criteria by ensuring relevance with energy efficiency. Initially, we present literature that includes schemes for threshold sensitive, adaptive periodic threshold sensitive, power efficient, hybrid energy efficient distribution and low energy adaptive mechanisms. Result of systematic review reveals that consumption of energy is the most fundamental issue in WSN however, is not noticed by the researchers and practitioners where as it can contribute for the improvement of the energy efficiency. It also elaborates the weaknesses of the existing approaches which make them inappropriate for energy efficient routing in WSN.

Keywords WSN · Routing · Energy Efficiency · SLR

1 Introduction

In Wireless Sensor Networks (WSN), multiple sensors nodes continuously record values to share with sink node via either node-to-node communication or cluster heads. The data is sent from sensor node to cluster head node which are then forwarded to BS for further communication [1, 2]. Figure 1 illustrates the overview of WSN where sensors, cluster heads (CH) and other smart devices share the data to a sink node or data server. During this process, energy efficient routing is a major concern. It is very difficult to change battery of sensor nodes once activated in the critical environments in remote areas where nodes are deployed using small airplanes. Routing becomes more challenging in such scenarios when a number of nodes are expired due to excessive energy consumption [3].

Routing protocols are based on location based protocols, Data-centric protocols, Hierarchical protocols, Mobility based protocols, Multi-path based protocols, Heterogeneity based protocols and QoS based protocols. In Fig. 2, taxonomy of routing protocols is presented along with hierarchical clustering based protocols. Hierarchical based protocols are based on TEEN protocols, APTEEN protocols, HEED protocols, PEGASIS and LEACH. WSN routing protocols are based on location based protocols, Data-centric protocols, Hierarchical protocols, Mobility based protocols, Multi-path based protocols, Heterogeneity based protocols and QoS based protocols. We have thoroughly explored the existing routing protocols to identify the mechanisms that effectively utilize energy.

Energy efficiency is a challenging area of research where the packets are sent over an unreliable network. Numerous approaches have been proposed for the consumption of energy. However, clustering routing protocols are one of the most dependable protocols that are used for the efficiency of energy, load balancing, communication cost and used to send the packets from the sink node to the base station (BS) [4]. Existing surveys have mainly focused on consumption of energy. This research focus

✉ Ata Ullah
aullah@numl.edu.pk

[1] Department of Computer Science and Software Engineering, International Islamic University Islamabad (IIUI), Islamabad 44000, Pakistan

[2] Department of Computer Science, National University of Modern Languages (NUML), Islamabad 44000, Pakistan

[3] Faculty of Computing, Riphah International University, Islamabad 44000, Pakistan

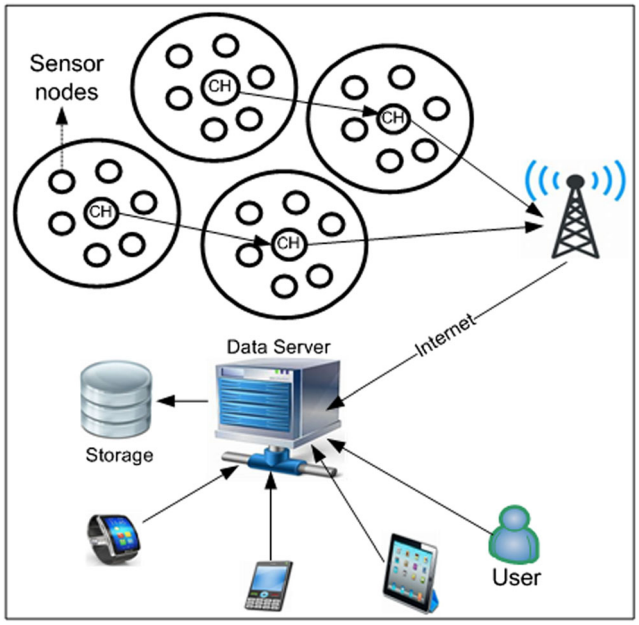

Fig. 1 MPAKE Scheme

on WSN energy efficient schemes from year 2016 to 2018. Furthermore, Section 3 explores a detailed description of these articles. There is a significant amount of research carried out to handle energy efficiency in WSN. In WSN many routing protocols are used for the consumption of energy i.e.; an efficient centroid-based routing protocol (ECBRP) [5] is used to transmit the data to the BS and to consume the energy. Majority of data is made by sensor nodes in which heavy traffic load create collision. Multi-channel communication is one of the method that is used to moderate the conflict between sensor nodes. Energy efficient composite event detection (ED) [6] is used to make the energy efficient and to overcome the amount of data. Reality is used to detect the change in the WSN. In the past most of the existing technique are used on composite event detection [6, 7] for the consumption the energy.

This paper presents a survey of Energy Efficient schemes in WSN where our key contributions are as follows;

1) Systematic Literature Review (SLR) is performed to analyze the existing latest schemes on Energy efficiency in WSN and identify a gap for further research.
2) A number of related energy efficient schemes during 2016 to 2018 are searched as per research question and thoroughly studied to identify strengths and weaknesses.
3) Next, quality evaluation is performed to verify the linkage of article with the research question. It considers that whether articles include only energy efficient schemes or also consider clustering routing protocols.
4) An inclusion and exclusion criteria is applied for article selection by primary and inferior examination.

The rest of the paper is divided as follow: Section 2 discuss SLR, where each research process is discussed. Section 3 present literature review about studied articles. Section 4 concludes our work.

2 Systematic literature review

Systematic literature review (SLR), is a type of literature reviews that helps to discover, categorize, and examining the existing literature for any specific research question. The main purpose of SLR is to evaluate the existing literature as per research question and find the gap. Figure 3 illustrates all the steps of SLR [8] where step 1 explores the selection process and data extraction, step 2 include the literature for various routing schemes.

2.1 Research question

A research question is mandatory to collect and articulated in order to verify if there exist an energy efficient and load balancing algorithm which has low energy consumption.Question: "Is there any energy efficient routing algorithm which has low energy consumption, reduce transmission cost and balancing the load??"

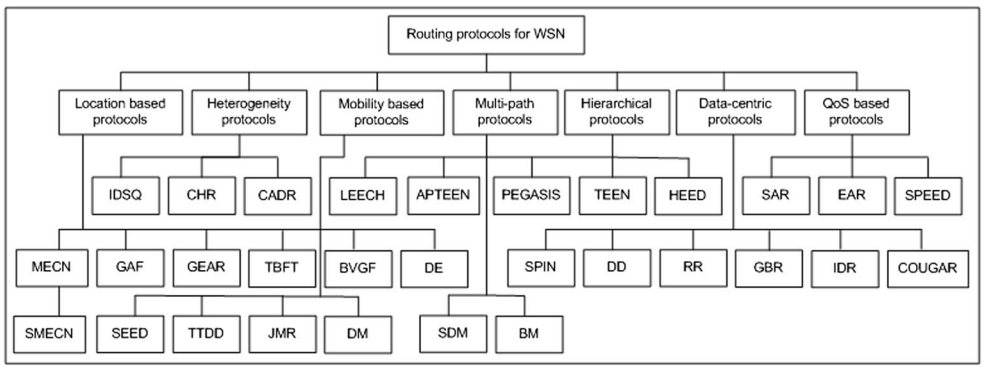

Fig. 2 Routing protocols for WSN

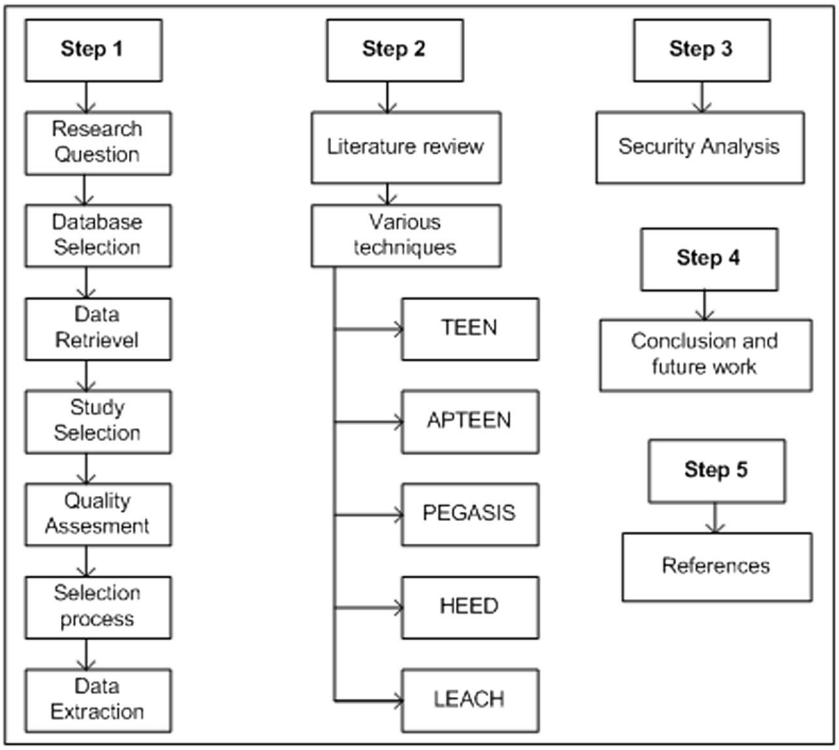

Fig. 3 Overview of SLR Steps

2.2 Databases

Digital Libraries used for searching:

(i) Science Direct (www.sciencedirect.com/)
(ii) IEEE (www.ieeexplore.ieee.org/)
(iii) Springer (www.springerlink.com/)
(iv) Others (https://scholar.google.com.pk/)

2.3 Data reclamation

After defining research questions, the second most important step is to design strings and phases that help in searching. In order to have a quality research multiple steps are followed in this paper as mentioned below:

i. Identifying the focal words and the complete understanding of the research question
ii. Use different replacements of phrases and words that can be used for literature searching
iii. Combine different words to produce meaningful phrases.
iv. Phrases used for researching are using by Boolean: ((“Energy efficiency in WSN (Wireless Sensor Network)” **OR** “Energy computation cost in WSN” **OR** Energy in WSN” **AND** (“energy efficiency” OR “improved energy efficient” **OR** “energy efficient using hierarchical protocols e.g. SEP **OR** using LEACH” **OR** HEED protocols”)))

2.4 Collection of study

This collection of study is built upon using the following standards. In this elaborate and prohibited standards as follow:

1) ELABORATE STANDARDS

(i) Research articles on energy efficiency in WSN.
(ii) Research articles with available PDF.
(iii) Research articles from recent years
(iv) Survey articles used if necessary
(v) Optional research articles which focus on energy efficiency and routing security.

2) PROHIBITED STANDARDS

i. Inappropriate research question
ii. Research articles from years not from 2016 to 2019
iii. Articles that focus mainly on routing of WSN.
iv. Research articles focus mainly on body area network.

2.5 Quality valuation

This section specifies requirements taken in consideration to select a research article. Few quality test are performed before selection of any articles. The quality measurements are described in Table 1 and Table 2 shows the evaluation

Table 1 Quality evaluation measurements

Rules	Rank	Points	Quality Evaluation
Routing Protocol	1	1	Average
Secure and Energy efficient Algorithm	2	1.5	Decent
Energy efficiency routing Protocol	3	2	Outstanding

of each research article. We have considered total 24 articles; 9, 9 and 6 articles are taken from year 2016–19. Quality valuation of each article should be based upon the following question stated as "Does the article give an efficient solution for energy efficiency in WSN?

2.6 Selection method

After defining the search phrase and fulfilling the selection standards, various other process are started as mentioned in Fig. 4.

1) KEY EXAMINATION STAGE.

In this phase research article are searched using the string or phrases defined earlier in the mentioned sources (e.g. IEEE, Google scholar etc.).

Table 2 Research article evaluation

Research articles	Rank	Points	Quality evaluation
EAHBRP [9]	3	2	Outstanding
SCERP [3]	2	1.5	Decent
EECBRP [5]	3	2	Outstanding
EECBRA [4]	2	2	Average
EEKCP [10]	2	2	Average
SEP-E [11]	2	2	Average
MHR [12]	1	1	Medium
DHCRP [13]	1	1	Medium
CH-Leach [14]	2	1.5	Decent
REEHCBRP [15]	3	2	Outstanding
ILA [16]	2	1.5	Decent
E2HRCRA [17]	2	2	Average
EDT [18]	3	2	Outstanding
NTARP [19]	1	1	Medium
RAEED- EA [20]	1	1	Medium
OR metric [21]	2	1.5	Decent
HCDM [22]	2	2	Average
RAEED-LB [23]	2	1.5	Decent
TPLBSOR [24]	2	2	Average
EXOR [25]	1	1	Medium

2) SUBSTANDARD EXAMINATION STAGE.

In this phase research article are selected on behalf of the research question defined earlier. Research articles which fulfil the criteria defined in Table 1of Quality Evaluation Measurements are selected has the literature review.

3 Literature review

In WSN, energy efficiency is very important, many energy efficient algorithm have been proposed. However, all of these are not efficient enough. There have been many routing algorithms provided in order to overcome multiple problems, such as load balancing [24], consumption of energy [21] and transmission cost [3]. The literature review is based on Hierarchical based routing in which the multiple techniques of Cluster based routing protocol are explored as follows;

3.1 Threshold sensitive energy efficient sensor network (teen) protocol

TEEN protocol is one of the energy efficient routing protocol in the WSN that is used to reduce the consumption of energy and to improve the constancy and the lifetime of the network. The drawback of TEEN protocol is that all the dies nodes not reached to the end point and the user not take any data from the network. Due to the cause of this nodes not communicate with cluster head. For this introduce another routing protocol TSEP is used. In the TSEP protocol use three levels of Heterogeneity nodes; advance nodes, intermediate nodes and normal nodes. TEEN protocol is used for the efficiency of energy. For time sensing serious request TEEN is suitable. This is the main issue of the TEEN.

3.2 Adaptive periodic threshold sensitive efficient energy sensor protocol

Many hybrid routing protocols are existing for the consumption of energy and the lifetime of the network. In this one of the routing protocol is Adaptive Periodic Threshold Sensitive Efficient Energy Sensor (APTEEN) is proposed. In this research [26] author compares the TEEN protocol and LEACH protocol with APTEEN protocol for the lifetime of the network and the consumption of energy. For the sending of

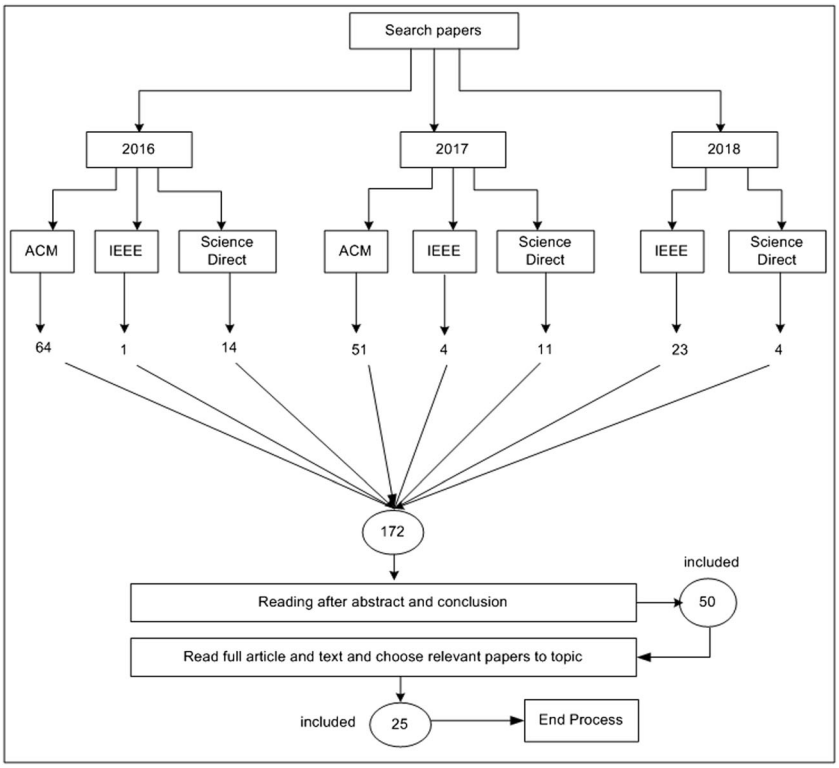

Fig. 4 Article Selection Process

data periodically APTEEN protocol use the network of responsive and practical. In this paper "Security models for hierarchical clustered wireless sensor network" [27] proposed the framework of security, secure routing schemes and key management modules are used. Secure hierarchical security routing protocols are used for security and discuss three modules. Secure routing module, key management module and cluster formation module.

In [28] a technique for the organization of the keys is proposed. In the WSN, assign key set to every group head and assign group keys to every group in the BS. In this case, BS is a fixed point where customer cellular phones are communicated. These keys are used for the communication of different nodes in the network. To ensure the security data is passed through encryption to increase security of network.

3.3 Power efficient gathering

Power efficient gathering in sensor information system (PEGASIS) is the routing protocol to transfer packets of all nodes to the BS in a sequential form [29] . To enhance the lifetime of the network, LEACH protocol uses resident data calculation to send the data from the cluster to the sink. One of the issue is that, it is suitable for homogeneous network and not suitable in heterogeneous network. SEP is used to provide two stages of heterogeneity nodes. One of them is advance node and the other one is normal node. The energy of advance node is more than the normal nodes.

3.4 Energy efficient distributing clustering

In WSN, one of the main goal is to improve the energy efficiency. In this paper [30] author propose two techniques that describes to minimize the end to end delay and to minimize the consumption of energy. Firstly, the distribution clustering approach, for the consumption of energy and end to end delay in this technique the clusters choose the best cluster head. Next, In the Inter clustering routing algorithm for end to end delay use a new energy cost function. For the consumption of energy and end to end delay many heuristic solutions are proposed however, these solutions are not optimized for the coverage of long time. Clustering techniques are used for the consumption of energy and end to end delay because they are efficient in the WSN. For the combination of clusters tree is based on energy efficient distributed scheduling algorithm [31] . In this author combines all the data from all sensors in this delay is minimum when the combination of packets is reached to the sink node. Many of the routing algorithms are used for the cluster in which one of the routing algorithm that is used for the energy efficient sequence from the clusters to the sink is useful in three hop clusters [32] . In hybrid energy efficient distributing clustering (HEED) [30] on the basis of intersection, residual energy consumption and the limits of cluster head that are chosen occasionally. Another routing protocol is Delay bounded adaptive energy constrained routing (DEAR) [33] . In this protocol consider delay, energy consumption, reliability because DEAR is a multi-path

routing protocol. In Energy Delay Optimization in an asynchronous Sensor Network with Multiple Gateway [2]the researcher describe the two problems that are related to the energy efficient routing. In this first one is to construct the tress that tells the efficient routing. The second is with multiple transmitting trees how to give wakeup frequencies. The author gives the optimized solution to resolve the first problem. And the solution of the second problem is that these problems are NP problems and to solve these problem use polynomial time algorithms. In the WSN the trade-off in geographical forwarding occurs for the delay of energy. In WSN, multi objective optimization problem [34] is one of the main problem for the selection of CH in the clusters. It combines the data from responding sensor nodes and relays the aggregated data to the sink. For the dissipation of energy hardware radio the data is received by l-bit. In a fixed length packet the cluster heads is used to get the data from its members. To expand the member of cluster head use cluster fuses.

3.5 Low energy adaptive cluster head protocol

In WSN, energy efficiency is one of the main issue. Preserve valuable sensor nodes in the result of energy efficient**.** This plays an important role in the lifetime of the network. In the WSN sensors are based on battery, in this energy is not changeable in many situations when energy is imperfect available. One of the routing protocol is used in this paper is LEACH protocol. LEACH protocol is used for the consumption of energy and to improve the lifetime of the network. In the WSN many different ways are used to design the cluster based WSNs. Exclusively same data and same event are used to transmit the data to the BS. To reduce the consumption of energy cluster head are used. In this paper we propose cluster head LEACH protocol that is used for the consumption of energy and to improve the lifetime of the network. When received the request messages from the cluster head it fixed in the table of routing and to fix the all nodes in the cluster will be up-to-date according to the list of TDMA. In the network layer, transport layer and the data link layer clustering routing protocols are used to overcome the problem of "hot spot" and to improve the performance of the network. In the WSN leach is the initial classified routing protocol. In leach active cluster head nodes and native cluster group are the key features. In leach stochastic algorithm is used [35]. In leach minimum lifetime of the nodes and the maximum volume of data mains to occupied with deceased nodes. In the leach the issue of extendibility of huge number of network is not appropriate. A better version of leach is Leach-C, in this nodes forwarded the message to the remaining energy to the BS on the start of each round. The drawback of leach-c is that near the sensor nodes when the BS is placed then the performance of leach-c does not achieve better as compared to leach. The key assignment of the clustering algorithm is to reduce the consumption of energy by nodes. The requirements of the nodes are to divide the load in a specific period of time [36]. A sensor node will select the cluster head with the appropriate signal strength, this schemes require high energy within the clusters and to transmit the collective data to the BS. Drawback of leach protocol is that it is not circulated in the cluster head. For this Leach-C protocol is used [37] . Low energy adaptive clustering hierarchy (leach) is used for the consumption of energy and to increase the network lifetime and to divide the average energy node in the sensor network. Leach algorithm is distributed into posterior and forward numbers and these posterior and forward numbers are distributed for the stable process and the formation of clusters. Random numbers are generated for the formation of clusters between the range of 0 and 1. If the formed number is less than the random numbers of threshold then calculating the threshold value as given below in eq. (1), here $rmod\left(\frac{1}{P}\right)$ is the number of the nodes that are particular in the round robin cycle, for the fraction of cluster head P is used.

$$T(n) = \begin{cases} \dfrac{P}{1-P_*\left(rmod\left(\dfrac{1}{P}\right)\right)} & if\ n \in G \\ 0 & otherwise \end{cases} \tag{1}$$

The main concern of this paper is based on Hierarchical based clustering. In this the routing protocols are used for the efficiency of energy cluster scalability, scalability, delivery delay and load balancing as shown in Table 3.

3.6 More cluster based routing protocols

In the WSN some of the routing protocols are of special types. These routing protocols are used for energy efficiency and to maximize the lifetime of the network. Many existing routing protocols are designed for WSN e.g. cluster based protocols, energy efficient protocols etc. In the efficient cluster based routing protocol the effective use of energy is require in the WSN.

Sensor nodes designing in WSN with the different aspects like adaptability, small size, cost, security etc. [38] . In the past many techniques are proposed on clustering based routing protocols. In the cluster head sensor nodes sends their sensed data that relates to the same clusters. Cluster head remove the two sets of data to overcome the final packet and combine the data from several measurements to the data sink. For this energy efficiency and lifetime of the network is improved. Clustering based protocols are used to transmit the data to the data sink. Secured- Scalable Energy Efficient Clustering Hierarchy Protocol for WSN **(S-**SEECH) [1] is the most

Table 3 Cluster based routing protocols

Scheme Name	Energy Efficiency	Cluster Scalability	Scalability	Delivery Delay	Load Balancing
LEECH	Very low	Medium	Very low	Very small	Medium
HEED	Medium	High	Medium	Medium	Medium
TEEN	Very High	High	Low	Small	Good
PEGASIS	Low	Low	Very low	Very long	Medium

recently introduced method that describe the distance is large between the cluster head and the sink node. According to the aspects of security authentication, availability, confidentiality and integrity of services are available [39] . For the security purpose many cryptographic and stenography methods are used. In the WSN many attacks occur with the respect of security and routing mechanisms. Some of the major attacks are DOS attacks, Sybil attacks, black hole attacks etc. In the WSN to improve the performance of security and to minimize the consumption of energy keys are used [40] . To fulfill the requirement of security authentication, integrity, secrecy is used and to fulfill the requirement of energy efficiency network connectivity, maximum supporting network size, minimum energy storage, and low computation overhead is used. More and less specific issue in the security mechanism and the solution exist in one of the problem. MAC protocol used in WSN to improve the efficiency of energy. MAC protocol is already implemented in the WSN, however, no one protocol has accepted as a single standard. [41] . Holistic approach is used to improve the performance of the network and lifetime of the network. This concerns all layers in the network to ensuring the security [42] . This provides security to all of the layer of WSN. The solution of security on a single layer is not the efficient solution whereas holistic approach is the best solution [43] . The drawback of holistic approach is that it takes a lot of time to execute the complex calculations [44] .

In the terms of energy efficiency DEC and SEP are most important cluster based protocols. In the WSN limited energy is the major issue. To effect the lifetime of the network the power of the battery and the nodes of the inefficient energy expires rapidly. If we reduce the traffic of packets, then we improve the usage of energy. In the WSN two types of the network homogeneous and heterogeneous. With the perspective of hardware and energy efficiency the sensor nodes are arranged in the WSN. Whereas in the heterogeneous network extra processing and additional vitality improves the lifetime of the network. When it compares to the sensor node additional battery cost is low. Due to the cause of the heavy traffic the nodes dies quickly when they surrounding the sink [45] .

For two level clustering approach SEP protocol is energetic. The sensor nodes transmit the data when the network is energetic. For two level clustering approach Stable Election Protocol (SEP) is energetic. In the SEP protocols two level of heterogeneity is introduced in the WSN [46] . In the advanced nodes additional energy is allocated than the normal nodes. Stable Election Protocol (SEP) is founded on the development sensors and the normal energy. Sep protocol has two optimal weight one for normal node and other one is for advance node. SEP protocol with the help of advance nodes the energy and lifetime of the network improve. Heterogeneity protocols are of three levels in SEP protocol [47] in this protocol to control the loss of energy with three level of heterogeneity. TEEN protocol is another routing protocol that is used to reduce the consumption of energy and to improve the constancy and the lifetime of the network. The drawback of TEEN protocol is that when threshold number of nodes expire and data is not extracted from sensors, then communication with cluster head is also not possible through these nodes. To resolve this issue, a reactive routing based TSEP was proposed that uses three levels of heterogeneity nodes; advance nodes, intermediate nodes and normal nodes. The drawback of SEP protocol is that it does not supports variations in energy consumption [48]. Moreover, among the normal nodes and advance nodes, the selection of cluster head is not active that's why mostly utilized nodes expire first [49]. In TSEP, for the extra amount of energy μ is used for advanced nodes, and for the normal and middle nodes $\mu/2$ is used to manage extra space. In the SEP protocol, the energy and lifetime of the network improves with the help of advanced nodes.

Deterministic Energy Efficient Clustering Protocol (DEC) is one of the most suitable clustering approach. Single hop or multi hop is a communication within a cluster. In the single hop avoid the terminated of data and only single data is forwarded to the single neighbor. In the single hop energy is better and the consistency is decreased. Whereas in the communication of multi hop reliability the cost of energy is high and it to transmit the data to its neighbor nodes [50] . In two level hierarchical network 3-T node is classified, and the influence of that work is SEP delay called SEP-E. The purpose of this paper is to maximize the lifetime of the network and to attain the strong self-configured. Stable Election Protocol (SEP) is founded on the development of sensors and the normal energy. Sep protocol has two optimal weight one for normal node and other one is for advance node. DEC determines each node on the basis of energy and the selection of cluster head. The ideal solution is to approve the DEC algorithm. The apprehensive in the cluster head election is the main advantage in the DEC model [51] .For the use of residual energy the selection of cluster head process is modernized. For the system non cluster head elects the BS at round m in the DEC, if

m = 1, the steady phase initiates after the setup phase at the top. The existing cluster head form the greedy assisted to decide cluster member residual energy and the cluster head will continue and to reject the choosing of some nodes in the clusters in which RE as a new cluster. After that all the result is based on the new clusters and the current data is related to the BS.

In WSN, the lifetime of the network, stability and energy are one of the important factors. In this paper we propose a new clustering technique DCHRP (Dual cluster head routing protocol) [13]. This technique is used to improve the lifetime of the network with three stages of heterogeneity in dual cluster. To minimize the wastage of energy it is necessary to reduce the collection of clusters. DCHRP protocol compared with other protocols ETSSEP and TSEP and evaluation with SEP. Three stages in the process of clustering; cluster head selection, creation of cluster, and the communication of facts to the sink. The selection of cluster head is depending on the probability. When the selection of cluster head is done nodes intellect data to the cluster head and then refer data to the sink.

In E2HRC clustering algorithm, the position of the node is secured where cluster head performs the extensive operations. For measuring the probability of threshold for different nodes as per attributes is defined by cluster head as follows;

$$T_{K,J}(s) = \begin{cases} \frac{C_{ch}(k)}{\frac{N}{c}} * \frac{E_{left}(j)}{E_{init}(j)} * (t) & s \in G(k) \\ 0 \qquad\qquad Otherwise \end{cases} \tag{2}$$

In eq. (2), the number of ring communication area C is used, for the total number of nodes k is used, for remaining energy $E_{left}(j)$ is used, $E_{init}(j)$ is the initial node energy [17]. A clustering algorithm description following data structure to define the clustering algorithm. Definition 1 (Global Configuration System): {S, N, C}, to calculate the total number of coverage area S is used, N is the number of nodes in the network, for the total number of ring C is used. Definition 2 (DIO_CLUSTER Data packet): In the network the total configuration of sphere layer k, to ring domain clustering probability T(k), optimal cluster head number $C_h(k)$. Definition 3 (DIO_CCH Data packet): Data packet of cluster head is used to calculate the residual energy E, domain k, and distance from the cluster head node. Definition 4 (DIO_CH data packets): For cluster head and address information data packets contains layer of sphere k. In the cluster head rotation mechanism, the following packet definition, the author introduces the cluster head rotation mechanism. (DIO_CH_POISONING): Including cluster head the packets of data are belonging to the course abundant of the ring domain. (DIO_CH_POISONING_ACK): This use for the reaction of packet. Definition 7 (DIO_ CH_ APP): In this appointment of address including cluster head. Definition 8 (DIO_CH_LOSE): To multicast the data packets to other nodes when nodes fail to reconnect. In the first announcement sink sends DIO message by cluster head, then selects the sink as a parent and sends DAO message. In the first announcement, send DIS message if the DIO message does not receive by the sink. To identify the optimal parent node with maximum value of ϑ and then send DAO message as per descending value. If abundant value is greater than the receiving nodes abundant values, then nodes send DIS message to assessor. Back-bone network time out if no optimal parent node is identified.

In the WSN one of the main issue is to detect the composite event. In the past many existing techniques, exchange the information and collectively detect the event, in which one of them is the routing tree. In terms of energy, such a tree is not ideal. Authors proposed the event detection tree (EDT) which is used to make it energy efficient and to overcome the amount of data exchanged [52] . There are two types of events; openly detected by the sensors are called Primitive events and the events that are based on the multiple correlated sub-events are called composite events. In the first phase EDT is made and in the second phase composite event is detected for the similar data [53, 54] . In the EEDT the one benefit is that when the source node is small and unobvious then the transmission cost of the source node increases.

In WSN, efficient protocols are used for the trust reputation system. The coordination among the nodes and the selection of candidate are focuses on OR protocol [55]. In the WSN many ideas of routing however, EXOR is the new idea of routing that can works successfully and resourcefully [56] . Security is one of the main issue in the WSN, because in this the data is forwarded to the undeveloped paths. For this many security algorithms are used, these security algorithms provide security in the external network for this attacker does not damage to the network [57]. Between security and utilization of resources sensor nodes try to balance the limited resources. In the WSN dynamic routing structure are proposed for the trust based social network. One of the trust based routing protocol is ETARP [58]. These protocols use the low cost of communication and define the path of route on the basis of maximum consumption. However, ETRAP was not energy efficient [59] . Researcher proposed new trust aware energy efficient routing metric. The proposed metric improves the lifespan of network and data security. In Opportunistic Routing (OR) the most important phase is forwarded candidate selection. Forwarded candidate has been selected from neighboring list and is given priority value. One having highest priority send data first. In WSN specially introduced a new opportunistic metric. This metric needs information about forwarded nodes, ID, and energy reception packets ratio. These values acknowledge the impact and energy consumption. For the distance packet forwarding progress (PFP) will be used. In the WSN opportunistic routing is proposed for the trust based energy efficiency simulations are used to check the performance of parameters. The drawback of opportunistic

routing is that it contains forward set selection and prioritization [60] . The issue in forward set selection is that it is difficult to choose the moral co-predictors of the period in the characteristics of the sets [61]. The drawback of prioritization is the formal code analysis with the test units [62].

In WSN, many routing protocols are used for the consumption of energy i.e.; Energy efficient Cluster-based routing algorithm (EECBRA) [4] is used to transmit the data to the BS and to consume the energy. Majority of data is made by sensor nodes in which heavy traffic load create collision. Multichannel communication is one of the method that is used to moderate the conflict between sensor nodes. Energy efficient composite event detection tree (EDT) [6] is used to make the energy efficient and to overcome the amount of data. Reality is used to detect the change in the WSN. In the past most of the existing technique are used on composite event detection for the consumption the energy. The trust aware routing protocol (TAR) is another routing protocol that is used to provide the protection against malicious attacks with the perspective of energy, data, communication and commendation. Schemes [63–65] [58, 66] discuss the cost of energy, distance from sink node to the neighbor node and efficient routing. In some positive and negative points, the most important point is to introduce any approach that provide the energy efficient path. In the sensor nodes some features are used to provide trust aware mechanism for the protection of malicious attacks [66]. The aim is how to select an optimal path in trust value.

Table 4 briefly presents different schemes that provide energy efficient protocols. We identify that still there is a gap to present energy efficient schemes that can provide dependable solutions. In [15], heterogeneity reactive energy efficient heterogeneous cluster based routing protocol are compared with current heterogeneity based routing protocols. Heterogeneity depends on computation based, link or energy based models [67]. The higher recollection and CPU utilization results in the in availability of nodes. The nodes have high bandwidth i.e., link based heterogeneity when some of the nodes offer high energy. In these models, the energy based heterogeneity is more suitable. It uses the random selection of cluster head where expiry of head node results in no transmission between the BS due to black-hole attack [68]. As the author of paper [16], modified the leach algorithm, It is better in energy efficiency to reduce the dead nodes by 88%. In [11], SEP protocol is used for the efficiency of energy. The protocol does not support the change in energy consumption for certain tasks [48].

Table 5 briefly discuss many different schemes that give results and criticism of cluster based routing protocols from multiple different approaches. In the paper [15] author introduce the heterogeneity reactive energy efficient Heterogeneous cluster based routing protocol and compared it with the current heterogeneity based routing protocol. The heterogeneity depends on computation based, link based or energy based [67]. The higher recollection and CPU ability have small numbers of nodes are available in the computational link.The nodes of the sensor have high bandwidth called link based heterogeneity. It suffers from black-hole attack due to random selection of head node [68].

3.7 Secure energy efficient routing algorithm

Routing is used to choose shortest path among nodes in WSN. It has become center of attraction from last few years, energy is emerged as one of the biggest issue. Routing protocols are used to prevent attacks among data communications from one node to another node. In the “RAEED-EA: A formally Analyzed Energy Efficient WSN routing Protocol”, nodes are equipped with routing protocol of Robust Formally Analyzed Protocol for WSN (RAEED). In new version Energy Aware (RAEED-EA), decision of routing depends on throughput and residual energy. To evaluate the performance, routing protocols are formally evaluated by measuring

Table 4 Analysis table of cluster based routing protocols

Scheme	Impact on Energy Efficiency	Drawback
EAHBRP [9]	Holistic approach is used to achieve energy efficiency.	The paper used holistic approach. The drawback of holistic approach is that it takes a lot of time to execute the complex calculations [44]
SCERP [3]	Consumes more energy when it is far away from the BS.	Black hole attack [68]
EECBRP [5]	It make energy more efficient than other existing protocol	In this paper randomly selected the cluster head node however random selection of a node is insecure because a node may be a Sybil node [69]
EECBRA [4]	The proposed algorithm performance is 4 energy joule better than LEACH protocol	In this paper the main drawback is multipath fading that degrades the performance of system [70]
EEKCP [10]	Results shows that proposed scheme has high energy.	The drawback of k-mean is that it only changes the symmetrical data and k means accepts to deal with a circular clusters and that each cluster has randomly equal numbers of opinions [71]

Table 5 Results of cluster based protocols

Scheme	Results with quantitative measures	Criticism
SEP-E [11]	Energy in SEP-E protocol is increased almost 30%	SEP protocol which does not support the change in energy consumption [48]
MHR [12]	Approximately 85% consume energy	Symmetric links are used that does not offer numerical signs which are not rejected. The other drawback is that the key is to be transmitted before the actual message is to be transmitted [74]
DHCRP [13]	9.99% increase in comparison	Black hole attack [68], Fabrication attack [75]
CH-Leach [14]	Approximately 85% of energy is improved.	k-means assumes the variance of the spreading of each variable is circular and all variables have the same variance, supposing if any of these are missing, then the k mean fails [71] Sybil attack [69]
REEHCBRP [15]	99.9% better than existing ones	Black hole attack [68]
ILA [16]	Improved algorithm reduces dead nodes by 88%	Black hole attack [68]
E2HRCRA [17]	The algorithm is 1.7% better than the original RPL	It randomly selects cluster head which is insecure because a node may be a Sybil node [69]

lifetime of the network. One of the technique is formal verification that is used to check the paths and to measure minimum and maximum consumption of energy. It provides security against DoS attack [72].

Clusters are utilized for transferring the data after collection of sensing data. After data collection from the nodes, transmit it to BS through cluster head (CH). CH can be divided into two parts to overcome the load of cluster head i.e. Routing Cluster Head (RCH) and Data Cluster Head (DCH). In the RCH overcome the path among the BS and nodes. Whereas in the DCH the dense of data and the collection of data is referring to the RCH. The ability of communication is high when the level of energy in the BS is high. BS selects the cluster head to forward the aggregated data to the BS in the formation of cluster. DCH technique that is used for data collection. The main drawback is that it becomes difficult when the end to end confidentiality among devices and the sink is anticipated [73] . RAEED is a routing protocol that is used for the security against DOS attacks. In this paper an improved version of RAEED is RAEED-LB. It works in three phases.

Key Setup Phase (KSP), Route Setup Phase (RSP), and Data Forwarding phase (DFP). The first phase is used for the encryption of data. In this two keys are exchanged with each other. Pair key and Cluster Key. When a node has to exchange the message pair keys are used. For the encryption of messages Cluster keys are used. In the second phase know their neighbors and next level of node. In this assign a level to each node and it depends it's hop distance from the sink. The third phase is used to select the next node with the highest throughput. Suitable changes in the third phase to select the node. The distribution of load in RAEED-LB protocol ensures that message does not exceed certain limit. Load balancing is the important issue. In the network when a large amounts of nodes are improved due to the cause of procedure it will affect the performance and too small the quality of services as well.

Table 6 briefly discuss many different papers that provide security. Load balancing and energy efficient path from multiple different approaches. Even after providing energy efficient, secure and load balancing approaches however, they still can be not more efficient. As the author of paper [23] modified RAEED-LB. Load balancing is the important issue in the WSN routing. In the network when a large amounts of nodes are improved due to the cause of procedure it will affect the performance and too small the quality of services as well [73].. Another author of paper [55] use the EDT. EDT is used to make the energy efficient and to overcome the amount of data. Reality is used to detect the change in the WSN [52]. Hello packets are used to interchange routing information.

Table 6 Analysis table of secure energy efficient routing algorithm

Technique	Energy efficient Results	Attacks
OR metric [21]	Energy efficient ratios are 5% - 20%	This paper used opportunistic routing. The drawback of opportunistic routing is that it contains forward set selection and prioritization [60]
HCDM [22]	Energy efficient increased by 65%	DCH is used for data collection the drawback of the collection of data is that it become difficult when the end to end confidentiality among devices and the sink is anticipated [73]
TPLBSOR [24]	65% of energy consume	Drawback of opportunistic routing is that it contains forward set selection and prioritization [60]
EXOR [25]	Not mentioned	Cryptanalysis attacks, input based attacks and so on [76]

Table 7 Security analysis of schemes

Technique	Energy Efficiency	Attacks
OR metric [21]	Energy efficient ratios are 5% - 20%	–
RAEED-LB [23]	In 500 units it increases 35% than RAEED	–
EAHBRP [9]	Holistic approach is used to make the energy efficient.	–
SEP-E [11]	The energy in SEP-E protocol is more almost 30%	–
MHR [12]	Approximately 85% consume energy	–
CH-Leach [14]	Improves 85% of energy	Sybil attack [69]
EECFPCHSP [79]	Energy is efficient for no of rounds	Not mentioned
REEHCBRP [15]	99.9% better than existing protocols	Black hole attack [68]
TPLBSOR [24]	65% of energy consume	–
SCERP [3]	SCREP protocol consumes more energy when it far away from the BS.	Black hole attack [68]
EECBRP [5]	It makes energy more efficient than other existing protocol	Sybil attack [69]
ILC [16]	It is better in energy efficiency to overcome the dead nodes of approximately 88%	Black hole attack [68]
E2HRC [17]	The proposed algorithm is 1.7% better than the original RPL	–
EECBRA [4]	The proposed algorithm performance is 4 joule better than LEACH protocol	–
EEKCP [10]	Results shows that proposed scheme has high energy	–
NTARP [19]	TRPM 11% secure than the existing ones	–
DHCRP [13]	9.99% increase than other protocols	Black hole attack [68], Fabrication attack [75]
EXOR [25]	The proposed algorithm is performed 25% better than existing protocols.	Cryptanalysis attacks, input based attacks and so on [76]

Each node transmit the information to the sink node through the shortest path. This creates flooding in whole network.

In [16], leach is modified that achieves better energy efficiency by reducing the number of dead nodes by approximately 88%. It suffers from black-hole attack if head node is expired [68].

3.8 Security analysis

The research done on the basis of past papers, it considered that few of the papers can be analyzed with the perspective of security. Still multiple attacks can occur. Table 7 briefly discuss multiple attacks that occurs on multiple different approaches. Even no prevention is required to avoid these attacks. As the author of paper [22] uses HCDM approach. For data collection of data DCH technique is used. The drawback of the collection of data is that it become difficult when the end to end confidentiality among devices and the sink is anticipated [73]. The use of DES makes this approach suffer from key search attacks. Another author of paper [14] uses CH-Leach protocol. In this k-means assumes the variance of the spreading of each variable is circular and all variables have the same variance, supposing if any of these are missing, then the k mean fails. The usage of k-mean still however makes this approach attackable from chosen Sybil attack [69]. Table 8 shows the comparison of

Table 8 Comparison of surveys in the literature

Reference	Secure Routing	Energy Efficiency
EAHBRP [9]	□	✓
SCERP [3]	✓	✓
EECBRP [5]	□	✓
EECBRA [4]	□	✓
EEKCP [10]	□	✓
SEP-E [11]	□	✓
MHR [12]	□	✓
DHCRP [13]	□	✓
CH-Leach [14]	✓	✓
REEHCBRP [15]	□	✓
ILA [16]	✓	✓
E2HRCRA [17]	□	✓
EDT [18]	□	✓
NTARP [19]	□	✓
RAEED- EA [20]	✓	✓
OR metric [21]	□	✓
HCDM [22]	✓	✓
RAEED-LB [23]	□	✓
TPLBSOR [24]	□	✓
EDT [18]	✓	✓
EXOR [25]	✓	□

different papers in the literature. This table describe that which papers are fully based on energy efficiency, which one are based on secure routing and which are based on both.

4 Conclusion

WSN is getting more and more common, since the technology is increasing very quickly, and therefore sensors are being used in multiple environment. Even though sensor are commonly being used, they are considered to be very complex due to the limited amount of energy and memory they are able to use. Energy efficient is a major issue, multiple approaches has been used to make the energy efficient, and however, due to the algorithm being complex or very simple makes the approach not suitable for WSN. This research is done on the exiting data. This survey discuss systematic literature review performed in order to build research question and literature review. Many steps are performed in order to select articles related to research question as described in section 2. This paper has assembled for the efficiency of energy in WSN after the study of multiple articles during 2016–18. Since WSN is an intricate environment, few research approaches are considered to be suitable. Various research methodologies provide high energy efficient algorithm, while increasing the lifetime of the network and to distribute the load among nodes. We have considered multiple load balancing and energy efficient protocols approaches where a few are considered to be work superlative for consumption of energy in WSN.

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