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Data Collection Methods in Wireless Sensor Network: A Study

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Abstract*—Data collection is a fundamental task in Wireless Sensor Network. Some of the issues in data collection are energy consumption, time delay, packet collision, more bandwidth constraint, latency, scalability and so on. To overcome these issues is a challenging task in Wireless Sensor Network. This paper presents the detailed survey of various techniques to minimize the data collection issues in Wireless Sensor Network.

Keywords*—Wireless Sensor Network,network lifetime, Clustering, Data Collection, Energy Efficiency.

I. INTRODUCTION

In Wireless Sensor Networks, sending large amount of data directly to the sink node may cause several problems. So, the data collection is a basic task in wireless sensor network. Certain application needs approximate data collection. The wireless sensor networks are used in applications like military surveillance, battle fields etc. A wireless sensor networks consist of minute resource bounded sensor, which is equipped with limited battery power. The transmission may consume a lot of energy. To avoid this problem, data aggregation technique is taken into account.

The data aggregation technique efficiently reduces data redundancy and saves energy. The problems occur due to i) the quality of data getting lost because of packet loss. ii) Huge data collection leading to excessive communication overhead. So, it is necessary to design the data collection strategy carefully to minimize energy consumption and to increase the lifetime of the network as much as possible [51]. The approximate data collection is the suitable method for long term data collection in wireless sensor networks with bounded bandwidth.

The number of application in WSNs needs to collect data approximately and efficiently due to constraints in energy budget and communication bandwidth. This technique is called ADC (Approximate Data Collection).In wireless sensor networks; the main power supply of the sensor node is battery. However, in most application scenarios; users are usually difficult to reach the location of sensor nodes. Due to a large number of sensor nodes, the replacement of batteries is impossible. However, the battery energy is finite in a sensor node and a sensor node draining of its battery may make sensing area uncovered. Hence, the energy conservation becomes a critical concern in wireless sensor networks [18]. In order to increase energy efficiency and extend the network lifetime, New and efficient power saving algorithms are developed. The Approximate Data Collection scheme should be scalable. This technique is more efficient to physical environmental changes and reduces message retransmission. The rest of the paper is organized as follows: In Section I explained about the survey introduction. Section II provides a brief survey about the data collection methods in Wireless Sensor Network. Issues in the data collection are discussed in section III, and present the conclusion in section IV. And finally presented study references.

II. DATA COLLECTION IN WIRELESS SENSOR NETWORK: A STUDY

In 2000, W.Heinzelman et al. [1] (**"Energy-Efficient Communication Protocol for Wireless Micro-sensor**

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Networks") proposed clustering-based protocol Low-Energy Adaptive Clustering Hierarchy (LEACH), it utilize randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. The method localized coordination to enable scalability and robustness of dynamic networks and incorporated data fusion into the routing protocol to reduce the amount of information transmitted to the base station. The results showed that the LEACH could be achieved as much as a factor of 8 reductions in energy dissipation consumption when compared to conventional routing protocols. In addition, LEACH was able to distribute energy dissipation evenly throughout the sensors, and double the lifetime of the networks.

In 2001, Arati Manjeshwar and Dharma P. Agrawa [2] proposed a formal classification of sensor networks, based on their mode of functioning, as proactive and reactive networks. Reactive networks, as opposed to passive data collecting proactive networks, respond immediately to changes in the relevant parameters of interest. And also introduced a new energy efficient protocol, TEEN (Threshold sensitive Energy Efficient sensor Network protocol) for reactive networks. And the performance of the protocol is evaluated for a simple temperature sensing application. In terms of energy efficiency, the protocol outperformed well. **("TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks")**

In 2002, Konstantinos Kalpakiset al. [3] proposed the maximum lifetime data gathering problem, with and without aggregation and polynomial time algorithms for maximizing the network lifetime, which is defined as the time until the first sensor runs out of energy. The aggregation problem is formulated as a problem of a network flow problem using an ILP (Inductive logistic programming), Maximum Lifetime Data Aggregation (MLDA), to find a maximum lifetime schedule. The case without aggregation, called the Maximum Lifetime Data Routing (MLDR) problem is formulated as a maximum flow problem with energy budgets on the nodes and again solved using an ILP. The results showed that the model significantly outperformed than previous methods, in terms of system lifetime. **("Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks")**.

In 2003, Shah et al. [4] proposed an idea of mobile sinks called "data MULEs (Mobile Ubiquitous LAN Extension)" for random walk to pick up and drop off after a few access points to the data. Because of the short transmission range of the sensors, energy consumption is largely reduced. However, a random moving sink is not aware of the residual energy of sensor nodes, and thus might threaten the energy balance among sensor nodes. The results showed that the proposed MULE achieved minimum energy consumption in sensors and avoided the energy threaten problem. **("Data MULEs: Modeling a Three-tier Architecture for Sparse Sensor Networks")**

In 2003, Liang Qin Thomas Kunz [5] presented a link breakage prediction algorithm to the Dynamic Source Routing (DSR) protocol. In the approach, the mobile node uses signal power strength from the received packets to predict the link breakage time, and sends a warning to the source node of the packet if the link is soon-to-be-broken. The source node can perform a proactive route to the best way to avoid disconnection. Experiments demonstrated that adding link breakage prediction to DSR can significantly reduce the total number of dropped data packets (by at least 20%). The tradeoff increased the number of control messages by at most 33.5%. It was found that the proactive route maintenance does not cause any significant improvement in average packet latency and average route length. Enhanced route cache maintenance based on the link status can further reduce the number of dropped packets.**("Increasing Packet Delivery Ratio in DSR by Link Prediction")**

In 2003, Seema Bandyopadhyay et al. [6] proposed a distributed, randomized clustering algorithm to organize the sensors in a wireless sensor network into clusters. The method is used to arrange sensors in WSN in to clusters. They create a hierarchy of cluster heads and the energy savings that will increase the size of the array to track the number of steps into the stretch. The results showed that the distributed, randomized clustering algorithm helps to reduce the total energy consumption. **("Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks")**

In 2004, Gang Lu et al. [7] proposed DMAC (Dynamic Medium Access Control) protocol, an energy efficient and

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low latency MAC (Medium Access Control) that is designed and optimized for such data gathering trees in wireless sensor networks. The DMAC is designed to solve the interruption problem and allow continuous packet forwarding by giving the sleep schedule of a node as an offset that depends upon its depth on the tree. DMAC also adjusts the duty cycles adaptively according to the traffic load in the network. Further a data prediction mechanism is proposed to More-To-Send (MTS) packets in order to alleviate problems pertaining to channel contention and collisions. The results showed that the DMAC saves significant amount of energy and reduce the latency while ensuring high data reliability. **("An Adaptive Energy-Efficient and Low-Latency MAC for Data Gathering in Wireless Sensor Networks")**

In 2004, OssamaYounis and Sonia Fahmy [8] proposed a Hybrid Energy-Efficient Distributed clustering (HEED) for periodically selects cluster heads according to the hybrid of a node residual energy and a secondary parameter, such as node proximity to its neighbors or node degree. HEED terminates after more iteration, incurs low message overhead and achieves fairly uniform cluster head distribution across the network. With appropriate bounds on node density and intra-cluster and inter-cluster transmission ranges; HEED can asymptotically almost guarantee to the connectivity of clustered networks. The results showed that the proposed approach is effective in prolonging the network lifetime and supporting scalable data aggregation. **("HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad-Hoc Sensor Networks")**

In 2004, Ignacio Solis and Katia Obraczka [9] evaluated the effect of timing in data aggregation algorithms. In-network, the method uses energy-efficient data propagation by processing data as it flows from information sources to sinks. When it is enabled, the data accuracy and freshness of the target node in the database showed that there is a significant performance impact. Three aggregation timing policies are analyzed and compared based on information produced by the entire node in sensor network. The results showed that setting up the clock out timer based on a node's position in the aggregation tree achieved "cascading effect", considerable energy efficiency, and maintained data accuracy and freshness.**("The Impact of Timing in Data Aggregation for Sensor Networks")**

In 2005, Mao Ye et al. [10] proposed a clustering schema Energy Efficient Clustering Scheme (EECS) for wireless sensor networks, which are better suited for the periodical data gathering applications. In this approach cluster heads are elected with more residual energy through local radio communication while well cluster head distribution is achieved. Furthermore, it is introduced to balance the load among the cluster heads. The results showed that EECS significantly improved in prolonging the network lifetime over 35 % than LEACH. **("EECS: Energy Efficient Clustering Scheme in Wireless Sensor Networks")**

In 2006, Selvadurai and Sukunesan [11] proposed the Time-Controlled Clustering Algorithm (TCCA) to minimize the total energy dissipated by using non-monitored rotating cluster head election without location information in priori. TCCA control a cluster's diameter based on the message TTL (Time-To-Live) and approximate distance between nodes and cluster heads using the message timestamp, which could be used to create a collision-free transmission schedule. An analytical model for algorithm is derived based on stochastic geometry to determine a realistic energy dissipation and network lifetime patterns. It was demonstrated that there is an optimal probability, which could easily be determined from the given expression and pre-configured into the nodes, to achieve an overall energy efficient operation. It was also found that there is degradation in the improvement on network lifetime, when more nodes are deployed within the same region.**("An Energy-Efficient Clustering Algorithm for Multi-hop Data Gathering in Wireless Sensor Networks")**

In 2006, Dajin Wang [12] proposed a data collection energy saving scheme for the WSN, based on the concept of the center of the graph in graph theory. The purpose of the scheme is to use less power in the process of data collection. The sensors of WSN are powered by batteries where power saving is an especially important issue in WSN. The experimental results showed that the proposed scheme saves about 20% of the power while collecting data from sensors. **("A Graph-Center-Based Scheme for Energy-Efficient Data Collection in Wireless Sensor Networks")**

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In 2007, Wenyu Qu et al. [13] proposed a data aggregation algorithm. It exploited the tradeoff between data quality and network lifetime to improve data collection accuracy while the network lifetime is modified. This problem is formulated as an optimization problem by combining the changing pattern of sensor readings, the residual energy of sensor nodes and the communication cost from the sensor node to the base station. This data aggregation algorithm is theoretically analyzed and further evaluated by conducting simulation experiments. To the best of author's knowledge, this is the first study on minimizing the total error bound while achieving the adaptive network lifetime.**("An Efficient Method for Improving Data Collection Precision in Lifetime-adaptive Wireless Sensor Networks")**

In 2007, Guihai Chen et al. [14] proposed an Unequal Cluster-based Routing (UCR) protocol for grouping the nodes into clusters of unequal sizes. The distance from base station to cluster head and its size is smaller because thus they can some energy for inter-cluster data sharing. A greedy Energy-Aware a Routing Protocol is designed for the inter-cluster communication, which is the tradeoff between the energy cost of relay paths and the residual energy of relay nodes. The results showed that UCR achieves an obvious improvement in the network lifetime. **("An unequal cluster-based routing protocol in wireless sensor networks")**

In 2008, Huang Lee and Abtin Keshavarzian [15] proposed a collision-free scheduling algorithm for data collection in wireless sensor network. In this collision-free scheduling, network flow optimization techniques and optimized tree topologies are used to achieve energy efficiency. The reliability is guaranteed by including many retransmission opportunities in the schedules. The proposed protocol gets the connectivity graph as the input and assigns layers to the nodes to create a hierarchy in the network. First a layer assignment is assigned to the nodes, connected to the sink. By using a BFS order, all nodes in the graph are assigned to correspondent layers. After the layer assignment, a parent graph is created by removing the links among the nodes at the same layer. The parent graph is used to create, all the potential parent sets for the nodes. Based on the parent graph, optimal flow rates are calculated to minimize the energy consumption and its usage percentages of links are also calculated accordingly. The algorithm uses the same to construct a set of trees for each data collection cycle. Finally, for each tree a collision free schedule list is created by the sink node and the schedule is broadcast back to the nodes in the network. **("Towards Energy-optimal and Reliable Data Collection via Collision-free Scheduling in Wireless Sensor Networks")**

In 2008, M.Vahabi et al. [16] proposed a Traffic Adaptive Periodic Data collection Medium Access Control (TA-PDC-MAC) protocol which is designed in a TDMA (Time Division Multiple Access) fashion. It assigns the time slots for each node due to their sampling rates in a collision avoidance manner. The method ensures minimal consumption of network energy and increases network lifetime, as well as it provides small end-to-end delay and less packet loss ratio. The results showed that the protocol achieve up to 35% better performance than others in terms of energy consumption. **("Adaptive Data Collection Algorithm for Wireless Sensor Networks")**

In 2008, Tran Minh Tam et al. [17] formulated the min-sum optimization problem of building a minimum cost hierarchical architecture for correlated data gathering with in a network. To solve this problem, a minimum cost distributed algorithm is developed using only simple message passing rules. The method acts as energy aware because High-powered sensor nodes. The priority encoding and an appropriate sense of the raw data from the relaying nodes are acting as cluster heads. After the cluster formation phase, joint-entropy coding technique with explicit communication is applied at every CH to remove possible data redundancy in-network aggregation. The results showed that the network lifetime can be significantly improved.**("Lifetime Optimized Hierarchical Architecture for Correlated Data Gathering in Wireless Sensor Networks")**

In 2009, Zhang ShuKui et al. [18] proposed a data aggregation algorithm to detect the event attribute value in the positions where the sensor nodes are lacked through the construction of the splay tree. In the construction phase of the tree, the root choice is distributional. It limits the number of communications and fixed-size information. Also without taking the depth of the aggregation tree into account, its

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percentage of error can be controlled within an acceptable range when data compression ratio remains constant. The results showed that the algorithm effectively improved the perception capacity of the overall network and reduced the energy consumption. **("An Efficient Approximation Algorithm for Data Aggregation in Wireless Sensor Networks")**

In 2009, Yi-hua Zhu et al. [19] proposed a routing algorithm termed Energy-Efficient Routing Algorithm (EERA) to Prolong Lifetime, while the efficiently improve energy. In the EERA, a Data Gathering Sequence (DGS) is used to avoid mutual transmission and create loop for transmission among nodes, and each node proportionally transmits traffic to the links confined in the DGS. In addition, a mathematical programming model, in which minimal remaining energy of nodes and total energy consumption are included, is also presented to optimize network lifetime. Moreover, genetic algorithms are used to find the optimal solution for the proposed programming problem. Further, simulation experiments are conducted to compare the ERAPL with some well-known routing algorithms and also the results showed that the ERAPL outperformed well. **("An energy-efficient data gathering algorithm to prolong lifetime of wireless sensor networks")**

In 2009, Ayon Chakraborty et al. [20] proposed a data gathering protocol for enhancing the network lifetime by optimizing energy dissipation in the nodes. To achieve the design objective, Particle Swarm Optimization (PSO) with Simulated Annealing (SA) is applied to form a sub-optimal data gathering chain and a method was for selecting devised an efficient leader for communicating to the base station. In this scheme, each node communicates only with a close neighbor depending on its residual energy and location. It rules out the unequal energy dissipation by the individual nodes of the network that gives superior performance as compared to LEACH (Low-Energy Adaptive Clustering Hierarchy) and PEGASIS (Power Efficient Gathering in Sensor Information Systems). **("Energy Efficient Scheme for Data Gathering in Wireless Sensor Networks Using Particle Swarm Optimization")**

In 2009, A. Allirani, and M. Suganthi [21] proposed an energy efficient cluster formation protocol for the objective of achieving low energy dissipation and latency without sacrificing application specific quality. The objective is achieved by applying randomized, adaptive, self-configuring cluster formation and localized control for data transfers. It involves application specific data processing, such as data aggregation or compression. The cluster formation algorithm allows each node to make independent decisions, so as to generate good clusters. The results showed that the proposed protocol utilizes minimum energy and latency for cluster formation. **("Energy Efficient Cluster Formation Protocol with Low Latency in Wireless Sensor Networks")**

In 2010, Young Sang Yun et al. [22] proposed a framework to maximize the lifetime of the wireless sensor networks (WSNs) by using a mobile sink when the underlying applications tolerate delayed information delivery to the sink. Within a prescribed delay tolerance level, each node does not need to send the data immediately as it becomes available. Instead, the node can store the data temporarily and transmit it when the mobile sink is at the most favorable location for achieving the maximum WSN lifetime. To find the best solution, it is formulated as optimization problems to maximize the lifetime of the WSN subject to the constraints delay bound such as, node energy, and flow conservation. The extensive computational experiments is conducted and found that the lifetime can be increased significantly when compared with the stationary sink model and also with more traditional mobile sink models. **("Maximizing the lifetime of WSN with mobile sink in delay-tolerant applications")**

In 2010, Cheng et al. [23] presented two approaches for data collection; Top-down and bottom up approaches. In bottom up approach, the network structure is not much energy efficient while transmitting the data to base station since large network structure consumes large amount of energy. More numbers of nodes are involved to transmit their data to a longer distance. The problem of reducing the transmission distance among nodes by forming a different network structure for the nodes is addressed to transmit data as fast as possible. **("A Delay-aware data collection in WSN")**

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In 2010, Jeremy Bouldin and Natarajan Meghanathan [24] proposed a Rank-Based Data Gathering (RBDG) algorithm for wireless sensor networks with randomly distributed sensor nodes. For every round of data communication, the algorithm functions as follows: A set of sensor nodes are assigned in a random rank between 0 and 1. A link is formed between any two nodes if they are within each other‘s transmission range. If a sensor node has the highest rank among its neighbors, then it is considered as an associate node, else it is categorized as a leaf node. Next, a complete graph is formed among the associate nodes with edge weights representing Euclidean distance between the nodes. A minimum spanning tree algorithm runs on this complete graph and transforms it to a rooted directed data gathering tree with the root being the sensor node with the highest residual energy. Energy-Efficient version of the Rank-Based Data Gathering algorithm (EE-RBDG) is developed wherein the rank of a node is the sum of the random number (between 0 to 1) assigned for the node and the fraction (also from 0 to 1) of the initial energy currently available at the node. The results showed that the E-RBDG algorithm performs better than the RBDG and other well-known data gathering algorithms in terms of network lifetime, delay and energy and delay per round**. ("Rank-Based Data Gathering In Wireless Sensor Networks")**

In 2010, Samer Awwad et al. [25] proposed mobility and traffic adapted Cluster Based Routing for mobile nodes (CBR-Mobile) in WSN to support the mobility of sensor nodes in an energy-efficient manner while maintaining maximum delivery ratio and minimum average delay. The mobility and traffic adapted scheduling based MAC enables the cluster heads in WSN to reuse the free or unused timeslots to support the mobility of sensor nodes. Each cluster head maintains its own databases. The proposed CBR-Mobile protocol enables the mobile sensor nodes that disconnected from their cluster heads and rejoin to the network through other cluster heads within a short time. The results showed that the method achieved around 43% improvement on packet delivery ratio and also lower delay and energy consumption compared to LEACH-Mobile protocol.**("Cluster Based Routing Protocol with Adaptive Scheduling for Mobility and Energy Awareness in Wireless Sensor Network")**

In 2010, Mohamed Yacoab M.Y and Dr.V.Sundaram [26] proposed multiple sink based data aggregation technique for WSN. In this technique, initially a sink oriented tree is constructed for each sink. If the amount of data in the network becomes large, the data is transmitted in the slots allocated for the specific part of the data in order to avoid interference in the data transmission. As data is aggregated at the nodes which are nearer to the sink, data will be compressed and then forwarded to the next level. By this way, data is efficiently transmitted to the sink without any loss and interference. The results showed that the proposed technique achieved good packet delivery ratio with reduced energy consumption and delay. **("Multiple Sink Based Compressive Data Aggregation Technique for Wireless Sensor Network")**

In 2011, Volkan Dedeoglu et al. [27] proposed energy consumption model that allows to allocate variable transmit power and data compression rate for each sensor node. The total energy cost of lossless data gathering is minimized by using joint power and transmission rate allocation under Slepian-Wolf rate and capacity constraints. It is analyzed for the special case that when the cost of being active dominates, the power allocation separates from the rate allocation problem. The results showed that the total energy cost of lossless data gathering is minimized by using joint power and rate allocation. **("Minimizing Energy Consumption for Lossless Data Gathering Wireless Sensor Networks")**

In 2011, Gurpreet Singh Chhabra and Dipesh Sharma [28] proposed an improved version which uses both cluster and tree based protocols. The proposed protocol improves the power consumption by improving First Node Death (FND). The method has several advantages in WSNs for data gathering. It reduces power consumption to avoid the communication directly between sink and sensor nodes. Threshold mechanism is also used to increase the number of alive nodes which increases the network lifetime when compared to others. It protected the parent node death slowly, because each node has chances to be a parent. The clustered-tree based data gathering protocol works in two phases. With the help of first phase, the network life time is maximized by balancing the energy consumption of nodes. And in the second phase the communication overhead is reduced by

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forming tree structure. **("Cluster-Tree based Data Gathering in Wireless Sensor Network")**

In 2011, Luca Mottola et al. [29] presented MUlti-Source MUlti-Sink Trees for Energy-efficient Routing (MUSTER), as a routing is protocol designed for many-to-many communication. First, an analytical model is devised to compute, in a centralized manner, the optimal solution to the problem of simultaneously routing from multiple sources to multiple sinks. Next, MUSTER is implemented for heuristics approximating the optimal solution in a distributed setting. To increase network lifetime, MUSTER minimizes the number of nodes involved in many-to -many routing and balances their forwarding load. **("MUSTER: Adaptive Energy-Aware Multi-sink Routing in Wireless Sensor Networks")**

In 2011, Bin Cheng et al. [30] focused on collecting spatial correlated data in multi-sink scenario. The main challenge in this scenario is that data collection process is considered as how to exploit the spatial correlation and decide which sink transmit the data at the same time. To address this challenge, heuristic algorithm is proposed to select a subset of sensor nodes as representative to represent the whole multi-sink sensor network based on the spatial correlated sensing readings. The problem is firstly formulated as a Binary Integer Linear Programming (BILP). Since the problem is proved to be NP-Complete, two heuristic algorithms (Correlation First Algorithm, Distance First Algorithm) are designed for approximation. The results showed that the proposed algorithms largely reduce the number of the sources and then significantly improved energy efficiency. **("Spatial Correlated Data Collection in Wireless Sensor Networks With Multiple Sinks")**

In 2012, Arun K et al. [31] proposed a mobile data collection model to reduce the data latency. The MDC collects the data from the nodes and transfers it to the sink in multi-hop. Using a combination of a touring strategy based on clustering and a data collection mechanism based on wireless communication, the delay can be reduced significantly without compromising on the advantages of MDC. Using extensive simulation studies, the performance of the proposed approach is analyzed and proved that the packet delay is reduced by more than half as compared to other approaches. **("On reducing delay in mobile data collection based wireless sensor networks")**

In 2012, Maryam Ahmadi et al. [32] proposed a simple and efficient Partition based Nearest-Job-Next algorithm (P-NJN) for data collection using a mobile sink in wireless sensor networks. The P-NJN scheme clusters the sensor nodes by partitioning the sensing field into grids, and schedules the data collection which is carried out by the mobile sink based on this clustered structure. The travel of the mobile sink are classified into two parts, they are intra-cluster and inter-cluster travel, also theoretically evaluated the performance of the P-NJN scheme in terms of the data collection latency. The results showed that it is energy efficient and the accuracy of data collection is achieved without any loss. **("A Partition-based Data Collection Scheme for Wireless Sensor Networks with a Mobile Sink")**

In 2012, Xu Li and Jiulin Yang [33] proposed a localized Integrated Location Service and Routing (ILSR) scheme, based on the geographic routing protocol (GFG), for data communications from sensors to a mobile sink in WSNs. In ILSR, sink updates location of neighboring sensors after or before a link breaks and whenever a link creation is observed. Considering both unpredictable and predictable sink mobility, ILSR is compared with other competing algorithm. The result proved that ILSR can generate routes close to shortest paths dramatically with lower message cost. **("Localized Geographic Routing to a Mobile Sink with Guaranteed Delivery in Sensor Networks")**

In 2012, Nandha kumar.R and Dr.P.Varalakshmim [34] presented two algorithms for efficient data aggregation and transmitting to base station. The methods are demonstrated with different clustering algorithms based on grouping and data delivery ratio between sensor nodes. In this method, grouping of sensor nodes with similar pattern and transmitting aggregated data to base station with minimum delay is taken into consideration. Relay nodes with more transmission range is used to transmitting collected data efficiently to base station without any delay and packet loss. **("An Efficient Data Collection Protocol in Wireless Networks")**

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In 2012, Zhenzhong Huang and Jun Zheng [35] proposed Slepian-Wolf coding based Energy Efficient Clustering (SWEEC) algorithm, which is based on a heuristic algorithm for solving the minimum set weight cover problem in graph theory. SWEEC considers both the correlation structure of data from different sensor nodes and the distance from a cluster head to the sink nodes for cluster head election. A sensor node with a larger data compression rate and closer to the sink with a higher probability becomes a cluster head. The results showed that the proposed SWEEC algorithm significantly reduce the overall energy cost for data transmission and improved the energy efficiency of the network as compared to Slepian-Wolf coding based clustering algorithm.**("A Slepian-Wolf Coding based Energy-Efficient Clustering Algorithm for Data Aggregation in Wireless Sensor Networks")**

In 2012, Shuyun Luo et al. [36] presented the raw data collection in WSNs; where nodes are communicated using a TDMA (Time Division Multiple Access) protocol to minimize the collection delay. In this method, when the interfering links are eliminated, on that place the lower and upper bounds on the collection delay for the MDCD (Minimum Data Collection Delay), problem will occur. By introducing the concept, Virtual Grid Network (VGN), further MDCD problem is converted into a max-flow problem with special constraints. In particularly proposed a Ford-Fulkerson as max-flow method is used to solve the MDCD problem. It is proved that the proposed algorithm finds an optimal solution and achieved the lower bound in polynomial time. The results also showed that the method can significantly improve the network performance in terms of time-efficiency (up to 32%) and energy-efficiency (up to 67%).**("Delay Minimum Data Collection in the Low-duty-cycle Wireless Sensor Networks")**

In 2013, Jin Wang et al. [37] proposed the uneven clustering algorithm with mobile sink strategy. CHs will be selected mainly based on their competition range and residual energy for guarantee data collection and transmission. The mobile sink node will move at a certain speed along a predetermined path back and forth at some special locations to communicate with sensors. Here, the path movement is identified in the middle of the rectangular network. The results showed that proposed algorithm can largely improve energy efficiency and extend network lifetime compared with LEACH. Besides, uneven clustering algorithm with a sink node moving along pre-determined path performs more efficiently than the node with fixed sink node.**("A Mobile Sink Based Uneven Clustering Algorithm for Wireless Sensor Networks")**

In 2013, Sandeep.Cet al. [38] proposed a method on cluster based routing and adaptive two-level scheduling for the data collection in wireless sensor network. In this adaptive two-level timeslot scheduling is based on the node density within cluster and multichannel assignment between the sink nodes and cluster heads. The method exploits the hierarchical structure of cluster heads and the optimized multiple paths along with the adaptive scheduling to support reliable, high-throughput, and energy-efficient data transmission in wireless sensor networks. The results showed that proposed fast energy efficient data collection method improved the lifetime and the data collection rate of the network. **("Clustering Approach for Fast Energy Efficient Data Collection in Wireless Sensor Network")**

In 2013, Jun Wang et al. [39] proposed an Energy-aware Iterative Sampling Framework (EISF) for data gathering to reduce the total number of transmissions by exploiting the correlation. In this method, all nodes in WSNs compete for reporting nodes with energy-related probability and each non-reporting node autonomously determines whether its own readings are redundant. The redundant nodes will be put into sleep mode. After a limited number of iterations, a set of sampling nodes are selected to transport data with high accuracy. The results showed proposed approach is effective in prolonging the network life. **("An Energy-aware Iterative Sampling Framework for Data Gathering in Wireless Sensor Networks")**

In 2013, Rashid M. Awadi.et al [40] presented a complete solution for energy consumption in WSNs. Associated Cluster Head Array (ACHR) is introduced to reduce the energy by selecting optimal choice for the CH. The Dynamic Sleep time for Aggregation Data (DSDA) algorithm uses dynamic sleep time rather than fixed sleep time to reduce the wasted time and energy. The results showed that the proposed dynamic

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sleep time with data aggregation model consumes less power, than a fixed sleep time in WSNs, either with single message, or aggregation message. **("An Efficient Cluster Head Selection Scheme for Dynamic Sleep Time in Wireless Sensor Network")**

In 2013, S.Nirmala and S.Jancy Sickory Daisy [41] proposed a delay-aware data collection network structure and its formation algorithms. For different applications, network formation can be implemented in either centralized or decentralized manner. The performance of the proposed network structure is compared with a multiple-cluster two-hop network structure, a single-chain network structure, a minimum spanning tree network structure, and a collection tree network structure. The proposed network structure is more efficient in terms of data collection time among all the network structures mentioned above. The results showed that the structure greatly reduce the data collection time while keeping the total communication distance and the network lifetime at acceptable level. **("Multipart Nets Structure-Collecting Data and reducing interruption")**

In 2013, Devasahayam and Kaliyamurthie K.P [42] discussed fast converge cast methods in wireless sensor network, where nodes are communicated using TDMA (Time Division Multiple Access) protocol so as to minimize the scheduling length. It is focused on fundamental short coming of interference and half duplex transceivers available on the nodes. It was observed that multiple channel method is useful in reducing schedule length and link-based (JFTSS) channel assignment schemes which are more energy efficient in removing interference, compared to TMCP scheduling schemes. **("Optimized Rapid Data Collection in Tree Based WSN")**

In 2013, Dongfeng Xie et al. [43] proposed a Weighted Probabilistic Clustering Algorithm (WPCA) clustering scheme after a comprehensive analysis on various protocols. In clustering each and every node independently decides whether to be a cluster head according to a weighted probability, which is related to the ratio between node's residual energy. The nodes with more residual energy are assigned with larger weight value and further increase the chances to be elected as cluster heads. The results showed that WPCA achieves longer lifetime compared to probabilistic-based clustering algorithms.**("A Distributed Energy-efficient Clustering Algorithm based on Weighted Probability for Wireless Sensor Network")**

In 2013, Razieh Sheikhpour and Sam Jabbehdari [44] proposed an Energy Efficient Chain-based Routing Protocol (EECRP) for wireless sensor networks to minimize energy consumption and transmission delay. EECRP organizes sensor nodes into a set of horizontal and vertical chains. Chain heads are elected based on the residual energy of nodes and distance from the header of upper level. In each horizontal chain, sensor nodes transmit their data to their own chain head based on chain routing mechanism. EECRP also adopts a chain-based data transmission mechanism for sending data packets from the chain heads to the base station. The simulation results showed that EECRP performed efficiently than LEACH, PEGASIS in terms of network lifetime, energy consumption, and number of data messages received at the base station, transmission delay and especially energy × delay metric. **("An Energy Efficient Chain-based Routing Protocol for Wireless Sensor Networks")**

In 2014, Neethu Joy et al. [45] proposed a model zone division hierarchical multiple clustering approaches with multiple moving collectors to overcome the problem of exhaustion of energy of the node nearer to sink and increasing the lifetime of the WSN. Multiple mobile collectors collect data from master node, while traversing through their transmission range to reduce the data collection latency. The results showed that the model improved the fairness of data gathering and the life time is also extended compared to Spanning tree approach. **("Efficient Data Collection in Wireless Sensor Networks Using Mobile Elements")**

In 2014, P.Madhumathy and D. Sivakumar [46] proposed a Mobile Sink Based Reliable and Energy Efficient Data Gathering technique for WSN. The method determine the next position of the sink using biased random walk model and also finds the optimal data transmission path by using rendezvous point selection with splitting tree approach. Once the data is sensed and ready for transmission, the sensor node encodes the data and transmits it to the sink. On receiving the encoded data from the sensors, the mobile sink decodes the messages

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and stores the resulting block in its local buffer. Once all blocks have been correctly decoded, the mobile sink reconstructs the original bundle. The packet losses in a specific region of the network can be prevented by increasing the pause time of the sink. The results proved that the proposed technique increased the reliability and energy efficiency. **("Mobile Sink Based Reliable and Energy Efficient Data Gathering Technique for WSN")**

In 2014, M. Sasipriya and Dr. B. Kaalavathi [47] proposed a protocol called Mobi-cluster to minimize the overall network overhead and energy expenditure associated with the Multi-hop data retrieval process while also ensuring balanced energy consumption among Cluster Nodes and maximize network lifetime. The route is formed as cluster of nodes from member node to Cluster Head. The cluster heads passes collected data to the sink node in the network. The Cluster Head performs filtering operation upon the raw data by exploiting potential spatial-temporal data redundancy and forward the filtered information to the Mobile sink. It uses Neighbor Discovery Distance Algorithm to provide ID based data transmission on the network without any damage. The results showed that Neighbor Discovery Distance method improves the performance of resources and energy level of the network latency and bandwidth estimation of the network. **("Clustering Based Data Transmission Using NDD Algorithm in WSN's")**

In 2014, Ramya.D and Ramar.C.K [48] proposed a technique called Approximate Data Collection (ADC) algorithm which divides a sensor network into number of clusters and determines data association for each cluster head. It performs global approximation of data collection from the sink node according to model parameters uploaded by cluster heads. It is formulated as the problem of selecting the minimum subset of sensor nodes. In particular, a proposed an Optimize Link State Routing (OLSR) Protocol is used to reduce the flooding of control traffic in selected nodes and also to retransmit the control messages called MPR (Minimize Packet Radio). This technique is adaptive since it significantly reduces the number of retransmissions required to flood a message for all nodes in the network. **("A Robust Scheme for Energy Aware Data Collection for Wireless Sensor Networks")**

In 2014, Sudharsan et al. [49] proposed a Secured Energy Efficient Clustering and Data Aggregation – [SEECDA] protocol for the heterogeneous WSN, which is the integration of efficient clustering, and data aggregation to achieve the best performance in terms of QoS (Quality of Service). The approach consists of a security mechanism, and cluster head election mechanism for route selection with less energy. The output showed that the SEECDA protocol performs well compared to LEACH protocol. **("A secured energy efficient clustering and data aggregation protocol for wireless sensor network")**

In 2014, Aniket et al. [50] proposed an agent based communication traffic reduction method to broadcast predicted sensor data to each sensor. The sensors predict the sensed data from other sensor to transmit the data more than acceptable margin of error. Therefore, the traffic in communication can be reduced. The results clearly showed that the effectiveness of the method. **("A Review on: Sensor Data Collection Method for Communication Traffic Reduction in WSN")**

In 2014, Jingjing Zhang et al. [51] proposed an Energy efficient Collection Tree Protocol (E-CTP) taking into account of the power available to the whole network and single node, the Expected Transmission Value (ETX) was updated. The experiments were carried on TelosB (Operating System), the results are analyzed in terms of lifetime and efficiency. And it is concluded that the method has a longer lifetime and higher efficiency **("E-CTP: An Energy-Balanced Collection Tree Protocol for Constrained Wireless Sensor Network")**

In 2014, D.Suresh and K.Selvakumar [52] proposed a clustering algorithm to achieve efficient energy consumption in wireless sensor networks. To reduce data transmission distance of sensor nodes in wireless sensor networks, the uniform cluster concept is introduced. In order to make an ideal distribution for sensor node clusters, the average distance between the sensor nodes is calculated and the residual energy is taken into account for selecting the appropriate cluster head nodes. The lifetime of wireless sensor networks is extended by using the uniform cluster location and balancing the network load among the clusters. The results showed that the proposed algorithm improve the

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network lifetime and energy consumption for the wireless sensor networks. **("Improving Network Lifetime and Reducing Energy Consumption in Wireless Sensor Networks")**

III. ISSUSES IN DATA COLLECTION

From this literature survey, the following issues are identified in Wireless Sensor Network with regarding to data collections.

- It consumes more energy and time.
- It constraint more bandwidth.
- There is high packet collision and coverage problem.
- Limited resources.
- Latency, Scalability and Integrity problem.
- There is no re-transmission process.

IV. CONCLUSIONS

The time delay in data collection is the major issue in wireless sensor network. This paper presents the overview of data collection methods in WSN and the performance is based on the statistical parameters such as energy consumption, packet collision, retransmission, and time delay are discussed clearly. Most of the fundamental issues regarding data collection in WSN are explained and the overcoming techniques are also presented. Further, this paper will help the researcher to invent novel methods in order to collect the data with minimum time delay in wireless sensor network.

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