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Analyzing the Performances of WSNs Routing Protocols in Grid-Based Clustering

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***Abstract*— Nowadays wireless sensor networks (WSNs) became a modern research theme owing to the various applications range in assorted fields. Clustering considered from the more efficient techniques for solving the WSN drawbacks of energy consumption. The grid-based cluster has definitely done its effectiveness, especially for networks with high dynamic, all nodes in the clusters represented and the values of data are collected from sensor nodes by the cluster head (CH). For balancing the energy consumption with network traffic, the (CH) must be exchanged between all sensor nodes and the cluster size ought to be closely determined at different network parts. The most important issues for WSN is developing an energy-efficient algorithm by Grid-based clustering for improving the network lifetime, reduced cost, and increasing the network reliability. The equipment of the sensor nodes attached with limited power sources, the Grid-Based Clustering algorithm (GBC), therefore efficiently employing the energy of the sensor nodes can preserve a prolongation of the network lifetime. The network Performances of the sensor node are largely based on the application of the routing protocols, three routing protocols OLSR, AODV, and DSR in grid-based cluster WSN are evaluated by using Qualnet simulator. The results show DSR outperforms in the range of throughput, and end to end delay, while the AODV can be considered as the best in the package delivery ratio PDR with compared to others.**

***Keywords*— grid-based clustering; routing protocols; WSN; qualnet.**

I. INTRODUCTION

Currently, Wireless Sensor Networks (WSNs) is one of the leading essential technology for the beginning of this century. WSN considered a large network, which consists of a spatially scattered huge number of sensing nodes that are instantly contacting with a sense of the physical limit field like (temperature, humidity, etc.) [1]. It established in physical areas, consistently combine a large quantity of data obtained around the environment. The sensing nodes are each transmitting or receiving information to/from a physical wired location named base stations (BS). These stations typically work as an access point for another network like a gateway. WSN has a universal application ranges as beneficial technology in the fields comprising; tracking, monitoring, scientific investigations, peripheral implementations, military employments, security controls of homes, etc. [2], [3].

WSNs confront several designing challenges, starting with its rigid toward rules and policy modifications like manager access with business practicability. The business requirements modifications will be solid to dominate with algorithms so that a reprogramming will be needed or maybe manually rearrangement, which is difficult for management [4]. Other challenges come from the purpose of cost-effective further the size of sensor nodes, which must be a suitable compact for any purpose. The compacting consequence for the restricted memory storage restricted strength calculation besides the power source limitation [5]. The total information in WSN stored in a data warehouse needs a reduction with a confirmation of the summarized algorithm for providing accommodations to the restricted memory storage.

Moreover, the size of the nodes is small; thus, the power node is quite necessary. However, they are useful for storing the energy as well as increasing the network lifetime by utilizing more efficient routing algorithm [6]. The technical challenge is associated with limited, typically un-renewable supplying the sensor nodes energy. Hence, providing some of the nodes must be considered as the main restriction, whereas designing the routing protocols [7].

The routing protocols in the wireless network, consider an important function in dealing with the formation, arrangement, and maintenance of the network topology. The

grid topology has many proceed advantaged regarding scalability and availability to any node to send its data without central controlling [8]. These features make the routing mechanism critical. So, the demand for estimating the performance of routing protocols under different scenario is essential.

This paper presents the grid-based clustering WSNs in a specific area divided into a number of zones. Such networks consist of a many position's sensor nodes within a proven field which is similar to the mobile node management and enhance the resource efficiency of the network in a specified zone. Best communication among the nodes of the network should be completed at the dynamic method. Thus, grid-based clustering route technique is utilized if several nodes are grouped into a few groups called grids, and the sensing nodes can connect simply to the clustering head nodes, then cluster heads are connected to the processing office. A gird strategy is established on the base network is arranged in this paper, A network area may be divided into grids so that grids will be gathered for creating clusters.

For the remainder of the research is prepared as clustering with a grid-based cluster in the next section and then section three describes the routing protocols and their three types of routing protocol mentioned. Section 4 shows the research methodology and the proposed flow chart algorithms; then section five gives the evaluation and simulation result of the suggested scenario.

II. Materials and Method

A. Clustering

The nodes in WSN are often arbitrarily distributed within a specified geographical zone. Some regions in these situations within the network acquired heavily populated while other regions receive the least number of nodes. Clustering approach can be considered the main proper for extending the lifetime of the network, the energy consumption in addition to the network throughput in WSN. Necessarily, the process of the clustering are rationally sensor nodes grouped with a cluster origin classification of utilizing algorithms localizes hierarchical, density, separating, and grid algorithms [9]. Cluster-based technique and grid-based can be used to manage these problems. The schemes for cluster-based may be minimized the consumption of the energy as well as simplified the network management by considering a related node within groups.

The scalability and robustness can be increased in cluster-based approaches in addition to the data aggregation and load balancing is provided [10]. The Grid-based clustering as a technique is approved for efficient clustering at which the whole area can be separated within a virtual grid. It is very simple and feasible and has many advantages with regard to other clustering technique. In grid-based WSN, the cluster head works as a base station (BS). All information is collected in a cluster zone, which passes through sensor nodes. Every zone is divided into own their square shape area for particular one small zone. Every zone is a combination of several sensor nodes. Every cluster head and node are doing work in each zone. A zone does not interact next to near zone. Therefore, it consumes more energy in this process. It is connected with each other.

A smart grid saves the energy, reduce cost and increase the reliability of the network [11]. The cluster head (CH) selection per grid is typically decided with sensor nodes themselves, and that leads to large-scale network compatibility. The techniques of grid-based are widespread owing to their scalability, very simple, in addition to the uniformity in the consumption of energy through the network.

B. Routing Protocols

Routing can be considered as a manner for finding out the route between a source and a destination node. WSN Routing is interesting because of the fundamental characteristics that distinguish these networks from others and also considered the act of sending the information source to destination [13]. This section describes the most three Routing protocols in WSN; these are Ad-hoc on-demand vector routing (AODV), Optimized Link State Routing (OLSR), and Dynamic source routing (DSR).

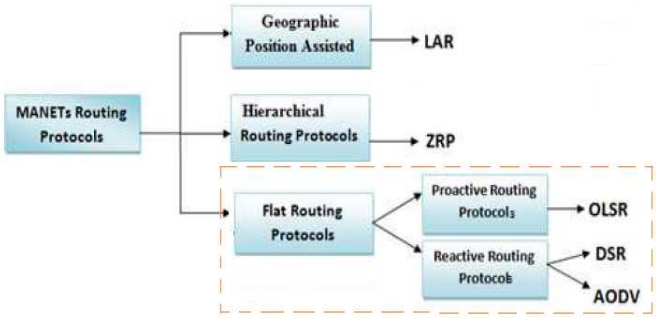

Fig. 1 Classification of Routing Protocols

A protocol with reactive routing considered as a demand routing such as AODV and DSR. In reactive routing protocols, two operations are used, they are Routes discover, and Route maintains. Routes discovery is found all possible routes and examined Route supports is continued route procedure. Increasing the bandwidth of mobile stations and reducing the control overhead may be achieved by on request routing protocol [14]. The other type is Proactive routing, which is also known as table-driven routing such as OLSR. Such type of routing within a routing table can be preserved by each node to contain the information of the latest route of any node in the network.

1) Ad-Hoc on-Demand Distance Vector Routing (AODV): The AODV protocol accomplishes a route discovery task with the help of control message that collects information about route request and route reply from the sender to receive the package. However, if a source node finds any route error message, then it could restart the routing process. It's working like flat routing protocol; therefore, any central administrative infrastructure does not require for handling routing system. If some nodes who want to wish to communicate with the nearest nodes before they have to be start route discovery process. However, if they do not available in the route to the destination, then it is called the route request package [15].

2) Dynamic Source Routing (DSR): The DSR stands as an on-demand routing form that matches the AODV. Though it does not depend on routing table which related to AODV, however, as a substitute, it utilizes a source routing

concerning the intermediate device. Design of the DSR has originally limited the bandwidth employment that has a consumption with control packages existing at Ad-hoc networks. Essentially, the DSR is important in reactive approach which reduces the requirement of the periodic broadcasting within a network [16].

In dynamic source routing, source nodes are forwarding route request towards all nodes which are under wireless transmission range. The source nodes generate unique request identification numbers for the route request package. When the source node is not able to utilize the current route for destination because of the change network topology, then it uses the route maintenance Mechanism. The target node before sending the route reply request close to the source it scans own route for the route request [17].

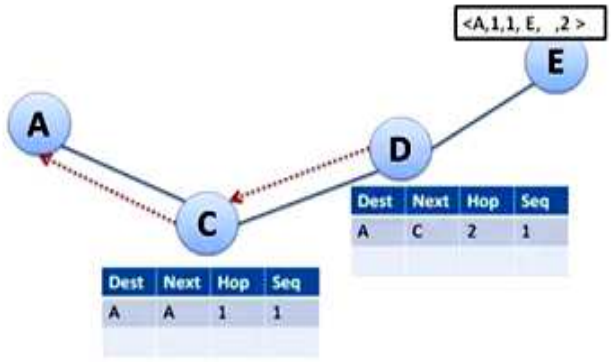

Fig. 2 AODV Route Discovery

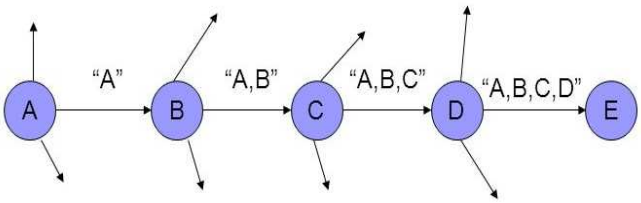

Fig. 3. Route Path of DSR

3) Optimized Link State Routing Protocol (OLSR): The OLSR Protocol relates to a group of proactive routing protocol that enhances mobile ad-hoc networks utilized in WSN [18]. OLSR simplify considered as efficient flooding for controlling the messages during the network with a selection of several nodes named Multipoint Relays (MPRs). This network flooding problem can be dominated by MPR nodes. Each node can choose the MPRs and can use in forwarding the control messages which result in the protocol distributed operation. Plus, the nodes constantly keep their routes for each destination within a network, and hence make the protocol very suitable for traffic pattern which considers random and infrequent. OLSR protocol is more promising with a traffic pattern which can a great nodes subset be communicated with other large subsets, besides the pairs of source and destination can change over any time. This protocol is primarily appropriate for both networks, large and dense. The advantage of making the routes immediately accessible if needed can be achieved owing to the proactive nature of it. For a protocol state of the pure link, all the links to a neighboring node are acknowledged and then flooded within the complete network.

C. Method

The concept of the grid-based cluster network can be described in Figure 4. Grid-based cluster WSN main aim has reduced the power consumption for all sensor nodes to reduce the traffic load. In network model grid has squared shaped, each squared shape prepared by coverage area zone. The Grid is set of n × n nodes. The n× n is the number Row and column. The Grid represents the left to right and top to bottom. Left to right present the rows (n) and top to bottom present the columns (n). A 2×2 grid-based network model in fig. 4 with a row is shown R and columns shown C [19].

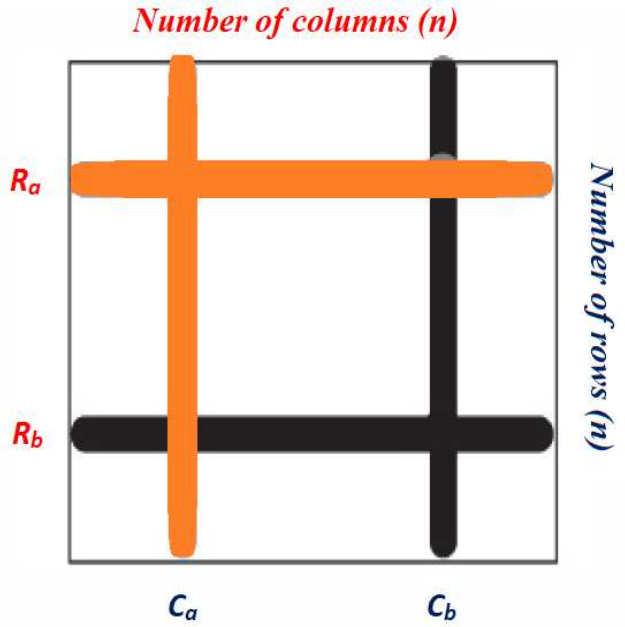

Fig. 4. Grid Topology

In grid-based cluster WSN, the cluster head considers as a base station in single grid-based cluster and all sensor nodes transmitted and received the information from the cluster head nodes, thus the power consumption will be distributed among the nodes as shown in fig 5 and this will provide a smart grid that can be improved with energy economize, decreasing cost and network reliability increasing [20]. The main purposes of this manuscript are to explore the advantages of grid topology and the classification of routing protocols as well as their features and then simulate wireless sensor routing protocols in term of network performance using Qualnet simulator.

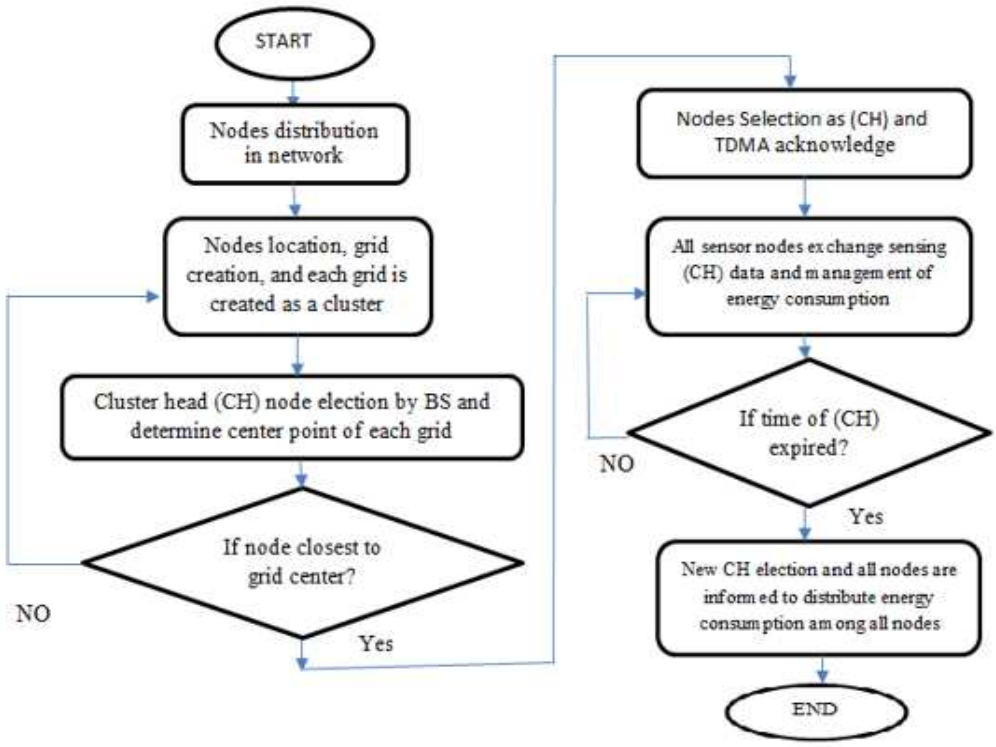

Fig.5. Grid Based Cluster Flowchart

D. Simulation Setup and Scenario

The simulation is performed using the Qualnet simulator. The Grid scenario is established as a first step by deploying a number of nodes in 1500*1500 network area, then defined the simulation parameters.

E. Building the Scenario

In this scenario shown in fig. 6, after grid-based clusters are formed, the communication of the sensing nodes is only done with cluster heads, consequently the cluster heads will communicate with the processing center represented by base Station. This would save node energy with distributing energy consumption as well as save network energy.

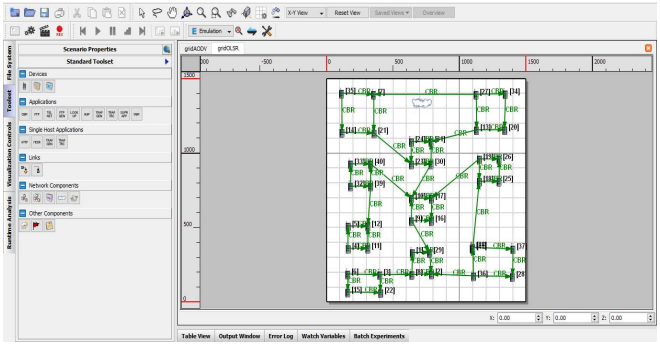

Fig. 6 Building the scenario

And then identify number of nodes (40 node) and the location of each node by choosing the grid model. Then, set the simulation values as seen in table 1.

TABLE I
SIMULATION PARAMETERS

Parameter	**Value**	**Parameter**	**Value**
Network type:	WSN	Network Protocol:	IPv4
Number of nodes	40	MAC Protocol:	IEEE 802.11
Terrain:	1500 -1500	Pause time:	20 sec
Simulation time:	30 sec	Phy Layer model	Phy 802.11b
Traffic application	CBR	Data Rate:	11 Mbps
Number of CBR:	10	Transmission Power:	25 dBm
Item to send:	2	Noise Factor:	10.0
Package size:	512B	Receive Sensitivity:	83.0
Interval:	0.1 sec	Number of channels:	1
CBR start-end:	5 – 0 sec	Wireless channel freq	2.4 GHz
Routing Protocols:	AODV, DSR, OLSR		

F. Simulation Run

For evaluating the three protocols **(**AODV, DSR, and OLSR) performances and running each scenario three times, each time for one protocol and get the result of (Throughput, End-End Delay, and Package Delivery Ratio). The analyzer result is shown in fig. 8, we observed several metric values depending on the nodes number.

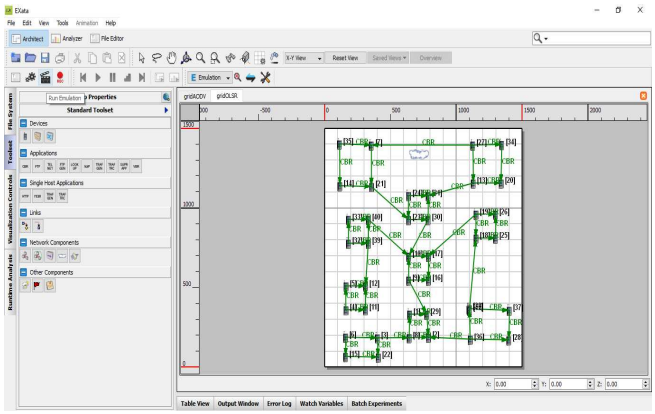

Fig. 7. Run The Simulation

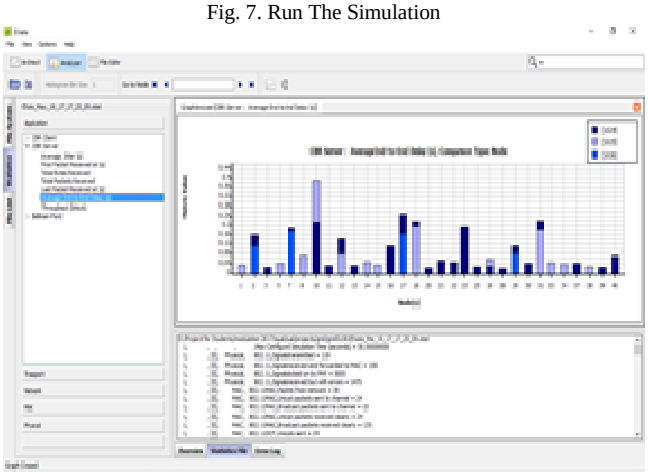

Fig. 8. Results Obtained From Simulation

III. Results and Discussion

A. Average Throughput

Throughput can be considered as the value of the network performance at a certain time. From the Figure 9, it's clear the DSR outperform both the AODV and OLSR. The reason behind that is the DSR is not forwarding route request towards all nodes when it can't find the suitable route. It maintains its optimum route from other nodes under its wireless transmission range. AODV has slightly different compared to DSR. OLSR has the worst.

B. End-End Delay

The time consumes from propagation, queuing, processing, and sending is called End-End delay. It's clear, from figure 10 that OLSR has the highest delay comparing to AODV and DSR. DSR has the lowest delay.

C. Package Delivery Ratio

The package delivery ratio (PDR) is defined as how much of the package is delivered during the transmission, and it the compliment of the package dropped ratio (PLR). The PDR is calculated as:

$$PDR: \frac{\textit{Package delivery during transmission}}{\textit{Package send out by the sender}}$$

From the figure 11, it's clear that AODV has the best package delivery ratio comparing to others. The worst case is involved in OLSR routing protocol, but DSR performs slightly close to it.

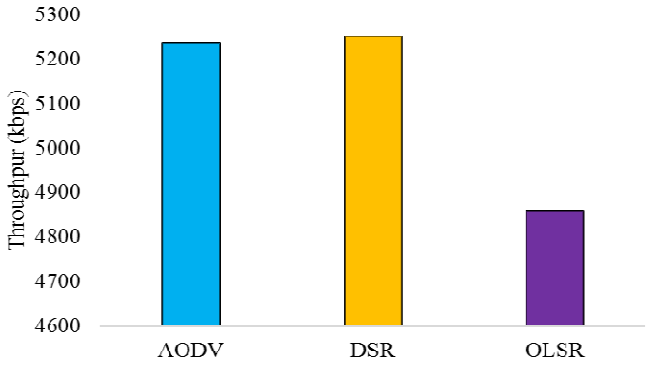

Fig. 9 Average Throughput for RP

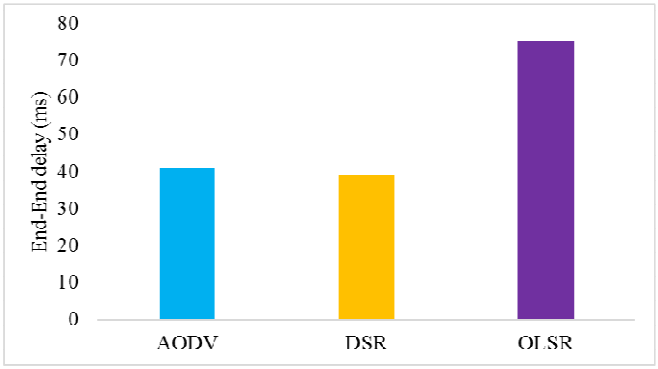

Fig. 10 The End-End Delay for Routing Protocols

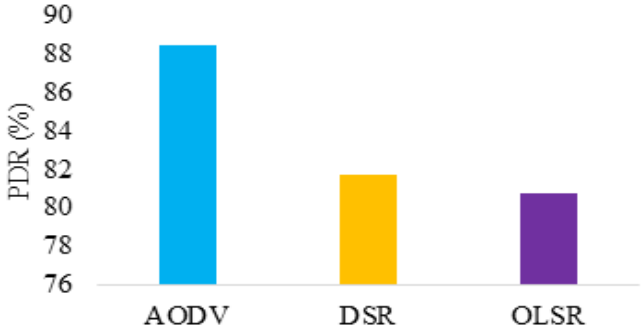

Fig. 11 Package Delivery Ratio for Routing Protocols

IV. Conclusion

Grid-based clustering considers as the central considerable topology in this century in WSN, since its communication represents an important role in data exchange for any objects. Grid-based clustering is large scale coverage area network that improves the network efficiency and reduces cost. From concerned papers, up-to-date energy-efficient grid-based clustering techniques in WSN have been critically evaluated taking into account different parameters like metrics for cluster formation, energy consumption, and network lifetime. On the basis of the evaluation metrics, a comparative analysis is presented that can help in the selection of appropriate routing protocols for specific requirements. The significance of the OLSR, DSR, and AODV protocols have been identified giving the concept about the applicability of a particular scheme in a certain operating environment. The results show DSR in

grid-based clustering provides improved throughput and delay performance if a comparison with others, while for package delivery ratio, AODV can be considered as the best and OLSR is the worst. From throughput and delay results, DSR has stability and energy consume reduction if related to other routing protocols.

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