An Extensive Literature Review on Route-selection of Multi-level Routing Protocols in WSNs

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Abstract:-Wireless Sensor Network (WSN) applications have been increased in recent times in fields such as environmental sensing, area monitoring, air pollution monitoring, forest detection, machine health monitoring, and landslide detection. In such applications, there is a high need of secure communication among sensor nodes. There are different techniques to secure network data transmissions, but due to power constraints of WSN, group key based mechanism is the most preferred one. Hence, to implement scalable energy efficient secure group communication, the best approach would be hierarchical based like Clustering. Various clustering algorithms similar to Energy-Efficient Multi-level Clustering Algorithm for Large-scale WSNs (EEMC), Low Energy Adaptive Clustering Hierarchy Protocol for WSNs (LEACH), Power Efficient and Adaptive Clustering Hierarchy Protocol for WSNs (PEACH), Hybrid, Energy-Efficient, Distributed Clustering Approach for WSNs (HEED) and Energy Efficient Clustering Algorithm for Maximizing Lifetime of WSNs (EECML) has been done to analyze their performance with respect to various parameters like power consumption of sensor nodes, cluster overlapping, cluster stability, fault tolerance and node-cluster information based on the literature survey and on the basis of these parameters

Keywords: signal processing; energy conservation; mathematics computing; routing protocols; wireless sensor networks; cluster based routing, WSN.

I. INTRODUCTION

Wireless sensor network consists of large number of small, low power, low cost sensor nodes with limited memory, computational, and communication resources and a Base Station [4]. These nodes continuously monitor environmental conditions and collect detailed information about the physical environment in which they are installed, and then transmit the collected data to the BS. BS is a gateway from sensor networks to the outside world. The BS has a very large storage and large data processing capabilities. It passes the data it receives from sensor nodes to the server from where end-user can access them. The sensors nodes are generally deployed around the area of the Base Station and form groups as per the need of the Base Station [2].

WSN has an advantage of being operated unattended in the environment where continuous human monitoring is risky, inefficient or infeasible. Sensor nodes run on batteries and once nodes are deployed their batteries cannot be recharged, so they have short lifespan. There are various applications of Wireless Sensor Network; they are mainly deployed in military and health applications. Also they are applied in robot control, automatic manufacturing, once or home automation. WSN is useful in detecting forest based on temperature information it receives from large number of distributed sensor nodes [5].

Clustering

WSN [1, 2] consists of a large number of sensor nodes, moreover these sensor nodes run on non rechargeable batteries. So to serve the objective of fault-tolerance, load balancing and network connectivity, grouping of nodes is required. Clustering [3] is a process of dividing sensor nodes into groups on the basis of various parameters, and selecting a group leader from each group.

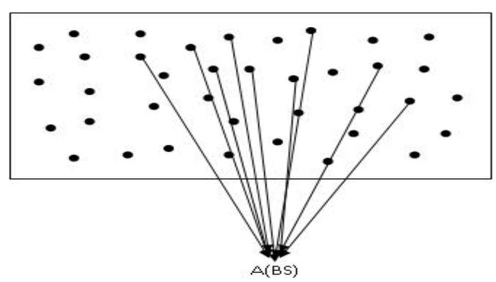

Fig.1: Sensor information forwarding without clustering and aggregation

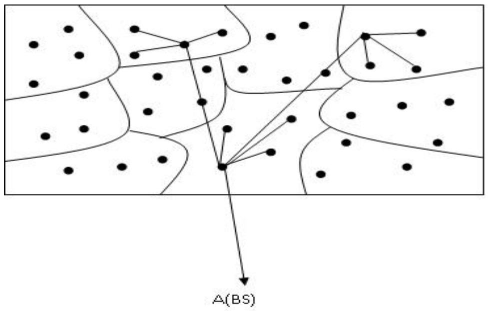

Fig. 2: Sensor information forwarding with clustering and aggregation

The groups are called clusters and group leaders are called Cluster Heads(CHs) of the clusters. Parameters for forming the clusters include distance between cluster head and its member, intra- cluster communication cost, residual energy of sensor nodes, location of node with respect to BS etc. Also helps in optimal utilization of network resources, load balancing, node failure management, energy consumption and network lifetime management.

Features of hierarchy

TinyOS provides mainly three things which make developing sensor network ap- plications and systems easier:

- Component Model: It de_nes how to write small piece of code and convert them into larger abstractions. It is grounded in nesC [9]. It allows us to write pieces of reusable code which explicitly declare their dependencies.

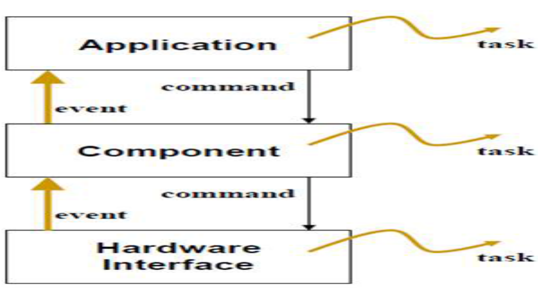

Fig. 3: Clustering hierarchy

File Types in Hierarchy

There are three types of in hierarchy namely-

- Interfaces : It specifies functionality to outside world, what type of com- mands can be called and what events need handling. Standard name syntax .
- Module : This is able in which real code is implemented, it contains the code for the interface functions defined in interface . Its standard name syntax.
- Configuration : This is which is used for wiring of components in an Application

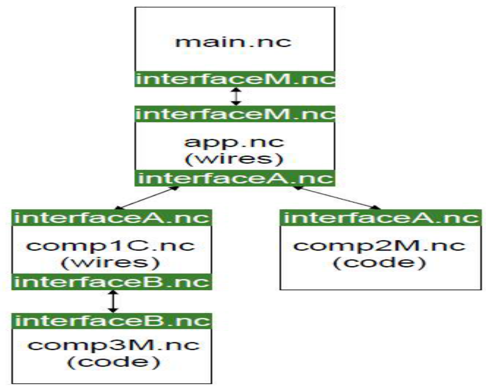

Fig. 4: Hierarchy of the various file

II. SYSTEM MODULE

Usually, routing in WSNs can be divided into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure. In flat-based routing, all nodes are typically assigned equal roles or functionality. In hierarchical-based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network [8]. A routing protocol is considered adaptive if certain system parameters can be controlled in order to adapt to the current network conditions and available energy levels. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, or routing techniques depending on the protocol operation. In calculation to the above, routing protocols can be classified into three categories, namely, proactive, reactive, and hybrid protocols depending on how the source sends a route to the destination. In proactive protocols, all routes are computed before they are really needed, while in reactive protocols, routes are computed on demand. Hybrid protocols use a combination of these two ideas. When sensor nodes are static, it is preferable to have table driven routing protocols rather than using reactive protocols. A significant amount of energy is used in route discovery and setup of reactive protocols. Another class of routing protocols is called the cooperative routing protocols. In cooperative routing, nodes send data to a central node where data can be aggregated and may be subject to further processing, hence reducing route cost in terms of energy usage[8].

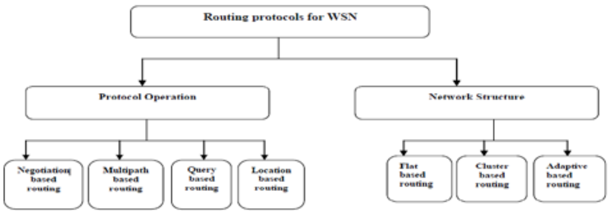

Fig. 5: Taxonomy of routing protocols for WSN

Principle of Evolutionary Algorithms

Evolutionary algorithms model natural processes, such as selection, recombination, mutation, migration, locality and neighbourhood. Figure 2.2 shows the structure of a simple evolutionary algorithm. Evolutionary algorithms work on populations of individuals instead of single solutions. In this way the search is performed in a parallel manner[5].

At the beginning of the computation a number of individuals (the population) are randomly initialized. The objective function is then evaluated for these individuals. The first/initial generation is produced.

Energy Minimization Techniques

A. Energy-aware Coverage-preserving Hierarchical Routing Algorithm

$$\alpha_i = (q_i)^{T_1} \times \left(\frac{\|O(s_i)\|}{\|C(s_i)\|}\right)^{T_2} \times \left(\frac{1}{d(s_i, BS)}\right)$$

$$H = \operatorname{argmax}\alpha = \arg_{ics} \max\alpha_i$$

B. Energy-efficient Cluster ID based Routing

$$P_{hop} = P_{tx\_clec} + P_{rx\_clec} + P_{DA}$$

$$P_{out} = \overline{E_b} R_b \frac{(4\pi d)^2}{G_t G_r \gamma^2} M_t M_f$$

$$P_{DA} = (1+\alpha) P_{out}$$

$$E_{hop} = (1+\alpha)\overline{E_b} \frac{(4\pi d)^2}{G_t G_r \gamma^2} M_t M_f + \frac{P_{tx\_clec}}{R_b} + \frac{P_{rx\_clec}}{R_b}$$

Placement & Localization of sensor nodes:

at this time, permit us original converse some placements and localization techniques measured in our testing:

Constant placement:

In this placement, sensor nodes are placed so that their compactness is invariable. They call this constant placement.

$$F(X) = \frac{1}{|A|}$$

R-random placement:

In this method called the R-random residency, antenna nodes are uniformly scattered in terms of the radius and angular direction from the hub, whose coincides with the base station.

$$F(r,\theta) = \frac{1}{2\pi R}, \qquad 0 \le r \le R, 0 \le \theta \le 2\pi$$

Alfa Placement Algorithm:

Sensor nodes are uniformly scattered in terms of the radius and angular direction from the core, whose coincides with the base station. Density function of the sensor is given by

$$\rho(r,\alpha) = \frac{K^*(2-\alpha)^*(r^{-\alpha})}{2\pi R^{2-\alpha}}, \qquad 0 \le r \le R, 0 \le \alpha \le 2$$

III. LITERATURE REVIEW

In the year of 2012 Fareed, M.S.; Javaid, N.; Ahmed, S.; Rehman, S.; Qasim, U.; Khan, Z.A.,[1] The study of the field of Wireless Sensor Networks (WSNs) in recent years has seen the growth of extremely small and low-cost sensors that possess sensing, signal processing and wireless communication capabilities. These sensors can be expended at a much lower cost and are capable of detecting conditions such as temperature, sound, security or any other system. A good protocol design should be able to scale well both in energy heterogeneous and homogeneous environment, meet the demands of different application scenarios and guarantee reliability. On this basis, they have compared six different protocols of different scenarios which are presenting their own schemes of energy minimizing, clustering and route selection in order to have more effective communication. This research is motivated to have an insight that which of the under consideration protocols suit well in which application and can be a guide-line for the design of a more robust and efficient protocol. MATLAB simulations are performed to analyze and compare the performance of LEACH, multi-level hierarchal LEACH and multihop LEACH.

In the year of 2012 Kaushik, S.K.; Aggarwal, R.; Sharma, R.,[2] Investigated on Wireless sensor networks (WSN) have generated tremendous interest among researchers these years because of their potential usage in a wide variety of applications. The most predicament issue that happens in

WSN is Congestion. Congestion causes packet loss, which in turn reduces throughput and energy efficiency. Therefore congestion in WSNâs needs to be controlled for high energy - efficiency, to prolong system lifetime, improve fairness, and improve quality of service (QoS) in terms of throughput (or link utilization) and packet loss ratio along with the packet delay. This paper proposes a new protocol for data delivery into high congested areas. Proposed algorithm provides an efficient way to overcome congestion in wireless cluster sensor network. Proposed algorithm provides priority both on data and location.

In the year of 2010 Lo, C.K.; Vishwanath, S.; Heath, R.W.,[3] The study of problem of selecting either routes that consist of long hops or routes that consist of short hops in a network of multiple-antenna nodes, where each transmitting node employs spatial multiplexing. This distance-dependent route-selection problem is approached from the viewpoint of energy efficiency, where a route is selected with the objective of minimizing the transmission energy consumed while satisfying a target outage criterion at the final destination. Deterministic line networks and 2-D random networks are considered. It is shown that short-hop routing requires less energy than long-hop routing when (1) the number of hops traversed between the source and destination grows large, (2) the target success probability approaches one, or (3) the number of transmit and/or receive antennas grows large. It is also shown that if both routing strategies are subject to the same delay constraint, long-hop routing requires less energy than short-hop routing as the target success probability approaches one. In addition, a numerical analysis indicates that, given loose outage constraints, only a small number of transmit antennas are needed for short-hop routing to have its maximum advantage over long-hop routing, while given stringent outage constraints, the advantage of short-hop over long-hop routing always increases with additional transmit antennas.

In the year of 2010 Manisekaran, S.V.; Venkatesan, R.,[4] In] Investigated on various large-scale sensor systems, a particularly challenging problem is how to dynamically organize the sensor nodes into a wireless communication network and route sensed information from the field sensors to a remote base station. This work presents a new energy-efficient dynamic clustering technique for large-scale sensor networks. By monitoring the received signal about power from its neighboring nodes, each node estimates the number of active nodes in real time and computes its optimal probability of becoming a cluster head, so that the amount of energy spent in both intra- and inter-cluster communications can be minimized. Cluster head selection is an important problem in sensor networks. Cluster-based routing has been shown to be more energy efficient and increase the network lifetime through data aggregation. The goal is to select cluster heads that minimize transmission costs and energy usage. Based on the clustered architecture, this work proposes a Multi level Hierarchical Approach in Dynamic Clustering using Election Algorithm for the efficient Cluster Head selection and Dynamic Energy Efficient Hierarchical routing algorithm for energy efficient routing. When compare to existing work the Multi level Hierarchical Approach will work efficiently. The new clustering and routing algorithms will work efficiently and reduces the energy consumption of sensor nodes.

In the year of 2009 Fapojuwo, A.; Cano-Tinoco, A.,[5] The study of analyzes a Quality of service enhanced Base station Controlled Dynamic Clustering Protocol (QBCDCP), suitable for the support of video and imaging traffic over resource constrained wireless sensor nodes. The protocol achieves energy efficiency through a rotating head clustering approach and delegation of energy-intensive tasks to a high-power base station, while providing quality of service (QoS) support by including delay and bandwidth parameters in the route selection process. A Time Division Multiple Access (TDMA) scheme is used for intra- and intercluster communication, providing bandwidth reservation. Performance of QBCDCP is evaluated in terms of energy consumption and end-to-end image delay via analytical and discrete-event simulation techniques. Numerical studies provide insights on the selection of network parameters such as number of clusters that improve the sensing node lifetime while maintaining high quality of service. The studys also demonstrate the trade-off between end-to-end image delay and sensor node lifetime.

In the year of 2009 Tomar, G.S.; Verma, S.,[6]] Investigated on Wireless sensor networks have the problem of lifetime and scalability. To increase lifetime and scalability itpsilas necessary to have control over topology of the network. Dynamic clustering with adaptive feature is the best way to achieve the above. In this paper they propose a dynamic multilevel hierarchal clustering (DMH) approach for sensor networks. The proposed approach will create a dynamic system which can vary topology architecture according to traffic patterns. This approach can decide size of cluster, nodes in a cluster and level of hierarchy of a cluster and will vary according to state of the system. In this approach for clustering they use nodes having multiple energy level for energy efficient clustering and cluster heads are selected periodically based on different attributes (i.e. residual energy, node degree etc) but unlike previous approaches here they use mutual negotiation between nodes as a criteria for cluster formation. Also here they used dynamic adaptive level of hierarchy according to the traffic pattern and use the highest level of hierarchy for routing of aggregated data to the base station.

In the year of 2008 De Rango, F.; Lonetti, P.; Marano, S.,[7] The study of an innovative energy aware routing protocol for wireless ad hoc network is proposed. Different routing metrics have been considered and a full analysis of their performance have been led out; the minimum drain rate metric has been selected as energy metric to integrate in the multipath dynamic source routing (DSR) protocol. Comparison of multipath DSR with MDR, cache update and round robin scheduling (MEA-DSR) has been also compared with multipath DSR with MDR metric without cache update mechanism (MDSR-MDR). The benefits of the multiple route selection have been illustrated by a performance comparison with an energy efficient DSR (DSR-MDR). An update mechanism and a simple data packet scheduling among the energy efficient paths have also been implemented to update the source route cache and for improving the traffic and energy load balancing. Many simulation campaigns have been carried out, confirming the improvements obtained in the unipath routing by the introduction of the energy aware metric.

In the year of 2008 Chaurasiya, V.K.; Kumar, S.R.; Verma, S.; Nandi, G.C.,[8]] Investigated on To increase the lifetime and scalability of a wireless sensor network (WSN) it is necessary to have control over topology of the network. Dynamic clustering is one way for achieve the above defined objective. In this paper they are proposing a multi-level hierarchal clustering approach for WSN. Our proposed approach in this paper is to create a system which will adopt a topology (i.e. size of cluster and number of hierarchal level) in accordance with the traffic patterns and density of sensor nodes deployed in a given area of interest. Load on the cluster head near the base station will be more as compared to farther cluster heads as the proximity cluster head have to do the dual work of collecting data from its own cluster and also to forward (or relay) data from distant cluster heads. Therefore this situation may study in dying out of proximity cluster heads sooner than distant cluster heads. It will study in failure of network as a whole. In this situation a bottleneck will be created near the base station. In our approach, they are proposing an algorithm of hierarchical clustering with variable cluster size based on its distance from the base station. Variable cluster size is important for balancing inter-cluster and intra-cluster traffic.

IV. PROBLEM DESCRIPTION

The primary challenge is scarcity of energy that in effect drives protocol design. In order to deal with this challenge proper management of topology is required so that most of the sensor nodes remain in operating state as long as possible. Sensor nodes are deployed randomly in the field and can be distributed arbitrarily on the ground, so some nodes may on paths which are accessed most of the times to communicate to the Base Station, this results in radically depletion of their energy while other node's energy can be left unmonitored. While in EECML this effect is taken care by keeping size of clusters closer to BS smaller as compared to clusters away from BS. Different sizes gives us an assurance that the closer CHs have enough energy to transmit the data it receives from the CHs farther from BS. Also as current CH is kept in a cluster, frequency of updating cluster-head is reduced and thus minimizes energy consumption. Clustering enables nodes to communicate with smaller power ranges at intra-cluster level for more energy savings.

V. CONCLUSIONS

A survey on different clustering algorithms has been done for selecting the best one in order for the Wireless Sensor Network to become adaptable. The main purpose is, whenever a Base Station fails, and a new Base Station takes the charge, re-clustering has to be done, but new clusters formed should not be completely different so that later when security algorithm acts on the updated cluster, the overhead reduces to minimum. Therefore, after the detailed study, it can be inferred that mentioned six metrics decide the extent of adaptability in the clustering algorithm. Specially, it has been observed that the more the cluster stability and less the cluster overlapping, the more will be the network reliability.

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