MAXIMIZING THE LIFETIME OF MULTIPATH ROUTING ENERGY EFFICIENCY BY EQGOR PROTOCOL USING QUADRATIC ASSIGNMENT TECHNIQUES IN WSN

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ABSTRACT

Wireless Sensor Networks (WSNs) are a research topic of growing interest over the recent years due to its wide applications. A large number of applications including medical care, habitat monitoring, precision agriculture, military target tracking and surveillance, natural disaster relief, hazardous environment exploration and monitoring are all using this technology. Wireless Sensor Networks (WSNs) are critically resource-constrained by their limited power supply, memory, processing performance and communication bandwidth. Due to their limited power supply, energy consumption is a key issue in the design of protocols and algorithms for WSNs. Hence, most existing works (e.g., clustering, lifetime prolonging) in the WSN area are dealing with energy efficiency. In this paper, there are several mobile sensor nodes available with the limitation of mobility in the entire wireless sensor network. This network monitors all the mobility nodes using the efficient QoS aware GOR protocol which helps to overcome the limitation of mobility. First we initialize the energy for the mobile sensor nodes. Based on that we can decide whether it is chargeable or non rechargeable in WSN using EQGOR protocol. This protocol is used for packet delivery based on the neighbor mobile nodes with certain limitations. At the same time all the mobile sensor nodes collect the neighbor mobile nodes details using Forward Candidate Algorithm, which is useful in calculating the connectivity of hop count and the packet size (for storage purpose) to forward to each and every mobile sensor nodes while moving from one location to another location. Suppose if any data is lost by the relay nodes then those node will choose another capable neighbor mobile node to perform the packet transfer of mobile nodes based on the multi objective evolutionary algorithm. This algorithm enables each mobile sensor node to choose the adjacent node for the next hop based on prioritization. Here two kinds of priority exists, one is the higher priority for the highest size packet transmission and the other is the lowest priority for the lowest size packet transmission with timer setting. Hence using Quadratic Assignment technique with EQGOR protocol and the proposed algorithm we can detect data aggregation with limitation of mobile sensor nodes and also we can achieve the transfer of packet delivery more quickly than the available QoS algorithm.

Keywords:* *Algorithm, Energy Efficiency, EQGOR protocol, Quadratic Assignment Technique, WSNs.

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a network that consists of small low-cost, low-power wireless communication devices, so called sensors or sensor nodes, which are capable of interacting with their environment by sensing or controlling physical parameters and performing simple computations on them. The main idea of WSNs is that sensors detect events or phenomena at a certain place or in a certain region, collect, process, aggregate and finally transmit these data to the final destination in the network, e.g. an interested end-user's notebook. Sensor networks are networks of small embedded low-power devices that can operate unattended to monitor and measure different phenomena in the environment. Sensor networks are suited for applications such as habitat monitoring, infrastructure protection, security, and tracking. Geographic protocols are very promising for sensor networks. These protocols take advantage of the location information of nodes to provide higher efficiency and scalability. In wireless environments, the locations of nodes correspond to their network connectivity, which makes geographic protocols natural components in these environments and it is expected that they will become major elements for the development of these networks. For obtaining the location information, different kinds of localization systems exist such as GPS, infrastructure based localization systems, and ad-hoc localization systems. The basic geographic protocols at the network layer are geographic routing, geo-casting and geographic rendezvous mechanisms. Geographic routing provides a way to deliver a packet to a destination location, based only on local information and without the need for any extra infrastructure, which makes geographic routing the main basic component for 3 geographic protocols. With the existence of location information, geographic routing provides the most efficient and natural way to route packets comparable to other routing protocols. Geo-casting is the delivery of packets to nodes within a certain geographic area. It is an extension to geographic routing where in this case the destination is a geographic region instead of a specific node or point. Geo-casting is an important communication primitive in wireless sensor networks, since in many applications the target is to reach nodes in a certain region. In geographic-based rendezvous mechanisms, geographical locations are used as a rendezvous place for providers and seekers of information. Geographic-based rendezvous mechanisms can be used as an efficient means for service location and resource discovery, in addition to data dissemination and access in sensor networks. We propose a novel energy efficient routing protocol by using quadratic assignment technique. We propose an energy-efficient geographic opportunistic routing (EGOR) framework applying the node selection algorithms to achieve the energy efficiency. The paper is organized as follows. Section 2 reviews the related work. Proposed framework and problem formulation has been discussed in section 3. Section 4 deals with the proposed protocol and algorithm. In section 5 Simulation Results of the paper has been discussed. Conclusion of the work and future directions are provided in the last section.

II. RELATED WORK

Routing is the function that allows information to be transmitted over a network from a source to a destination through a sequence of intermediate switching/buffering stations or nodes. Routing is necessary because in real systems not all nodes are directly connected. Routing algorithms can be classified as static or dynamic, and centralized or distributed. Centralized algorithms usually have scalability problems, and single point of failure problems, or the inability of the network to recover in case of a failure in the central controlling station. Static routing assumes that network conditions are time-invariant, which is an unrealistic assumption in most of the cases. Routing algorithms can also be classified as minimal or non-minimal. Geographic opportunistic routing

(GOR) [9] is a branch of the opportunistic routing, where location information is available at each node. In opportunistic routing, at the network layer a set of forwarding candidates are selected while at the MAC layer only one node is chosen as the actual relay based on the reception results in an a posteriori manner. The candidate selection and relay priority assignment at each hop are the two important issues [16]. In GeRaF [11], the relay priority among forwarding candidates is simply assigned according to the single-hop packet progress provided by each potential forwarder. More recently, several opportunistic routing algorithms [17] are designed for duty-cycled WSNs. Akkaya and Younis classified routing protocols for WSNs to four groups: QoS aware, data centric, location-based, and hierarchical. QoS-based routing protocols do not prepare any assurance in terms of QoS used in the applications, are classified as best-effort . Preparing QoS assurance in WSNs carries very challenging problems, but some approaches have been offered in the literature for QoS protection. Routing in ad hoc and sensor networks is a challenging task due to the high dynamics and limited resources. There has been a large amount of non-geographic ad hoc routing protocols proposed in the literature that are either proactive (maintain routes continuously), reactive (create routes on-demand) or a hybrid. On the other hand, geographic routing protocols require only local information and thus are very efficient in wireless networks. First, nodes need to know only the location information of their direct neighbors in order to forward packets and hence the state stored is minimum. Second, such protocols conserve energy and bandwidth since discovery floods and state propagation are not required beyond a single hop. Third, in mobile networks with frequent topology changes, geographic routing has fast response and can find new routes quickly by using only local topology information.

III. PROPOSED FRAMEWORK

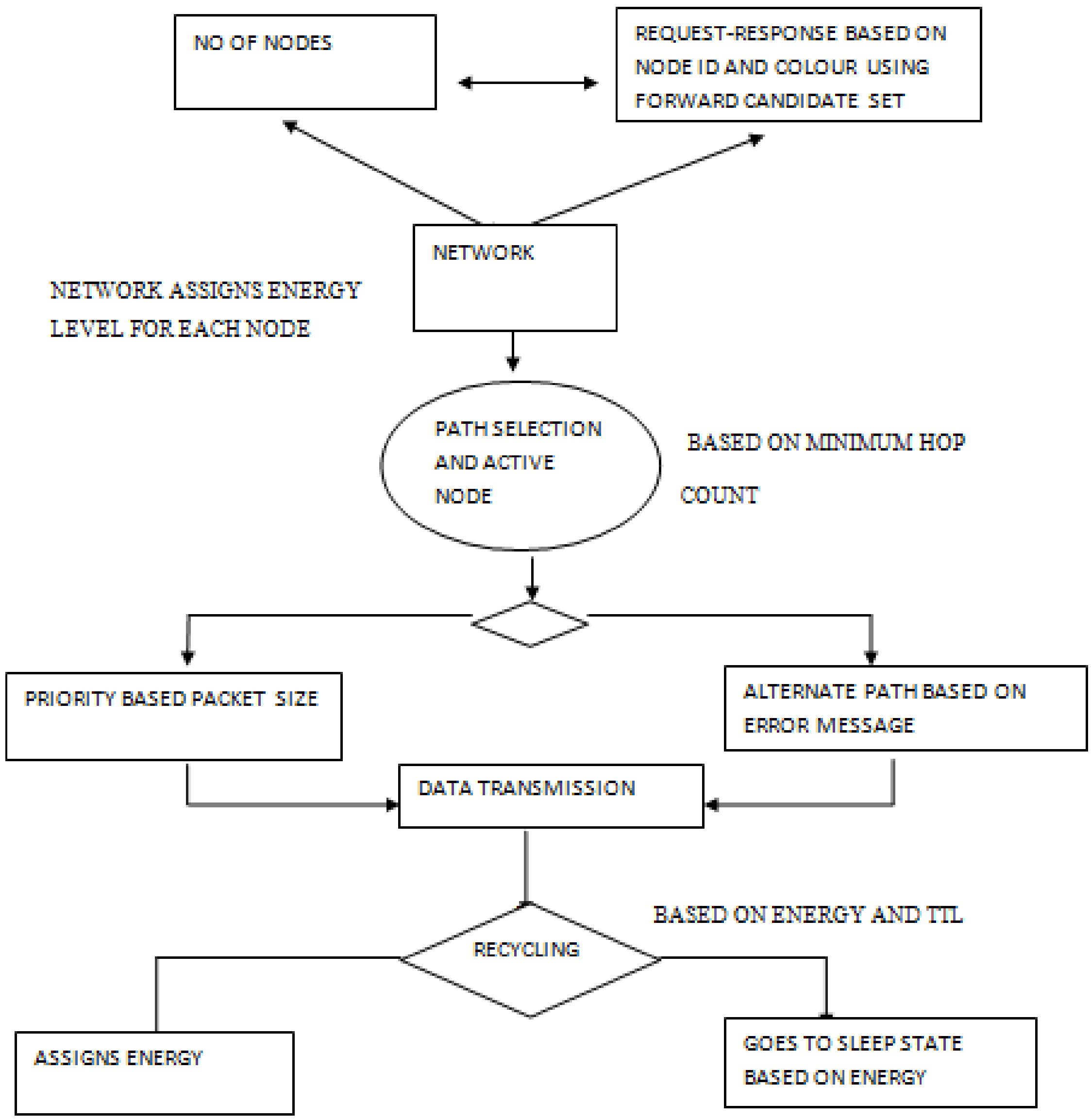
Consider a wireless sensor network with set of N nodes = {1,2,3…n} .Here there are several mobile sensor nodes available with the limitation of mobility in the entire wireless sensor network. This network monitors all the mobility nodes using the efficient QoS aware GOR protocol which helps to overcome the limitation of mobility.

The above problem can be solved by using QAP that can be stated as follows: Let the set of nodes be N = {1,2,3…n} and three nxn matrices $F = (f_{ij})$, $D = (d_{ij})$ and $C = (c_{ij})$. and the quadratic assignment problem with coefficient matrices F,D, and C shortly denoted by QAP can be stated as follows :

$$\min_{x \in X} \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n}\sum_{l=1}^{n} f_{ik} d_{jl} x_{ij} x_{kl} + \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij} x_{ij}$$

$$\text{such that } \sum_{i=1}^{n} x_{ij} = 1,\ i \in N,\ \sum_{j=1}^{n} x_{ij} = 1,\ j \in N,\ x_{ij} \in \{0,1\}, i, j \in N$$

f_{ik} denotes the amount of flow between facilities i and k, d_{jl} denotes the distance between locations j and l and c_{ij} denotes the cost of locating facility i at location j. A more general version of the QAP was introduced by Lawler. In this paper we are using flow distance products f_{ik} d_{jl} instead of considering dimensional array. Applications of QAP include the allocation of plants to candidate locations, layout of plants, backboard wiring problem, design of control panels and typewriter keyboards, balancing turbine runners, ordering of interrelated data on a magnetic tape, processor-to-processor assignment in a distributed processing environment, placement problem in VLSI design, analyzing chemical reactions for organic compounds, and ranking of archaeological data.



IV. PROPOSED PROTOCOL

Geographic opportunistic routing (GOR) which uses the location information of nodes to define the candidate set and relay priority. Owing to its scalability, statelessness, and low maintenance overhead, geographical routing is considered as an efficient paradigm for data forwarding in multi-hop wireless ad hoc and sensor networks. Early works on geographic routing exploit the concept of maximum advancements towards the destination to route packets in a greedy manner. However, recent empirical measurements have proved that the unit disk connectivity model, on which these solutions are based, often fails in real settings. More recent works on geographic routing are focused on lossy channel situations. They concluded that packet advancement timing packet reception ratio, the EPA, is an optimal metric for making localized geographic routing decisions in lossy wireless networks with ARQ (Automatic Repeat request) mechanisms, and is also a good metric for Non-ARQ scenarios. GOR incorporating the proposed algorithm achieves better throughput and delay performance than the corresponding opportunistic routing and geographic routing at any single rate under contention-based medium assess mechanisms.

We first generalize the definition of expected packet advancement (EPA) for arbitrary number of forwarding candidates which follow a specific priority rule to relay the packet in OR. Through theoretical analysis, we prove that the maximum EPA can only be achieved by giving the forwarding candidates closer to the destination higher relay priorities. This relay priority rule convinces us that given a forwarding candidate set, the relay priority among the candidates is only relevant to the advancement achieved by the candidate to the destination, but irrelevant to the packet delivery ratio between the transmitter and the forwarding candidate. The analysis result is the upper bound of the EPA that any GOR can achieve. We further prove that, given a set of M nodes that are available as next-hop neighbors, a subset of the available next-hop neighbors with r ($r < M$) nodes achieving the maximum EPA is contained in a subset with more nodes achieving the maximum EPA. Leveraging the containing property, we unveil that the maximum EPA of selecting r (r · M) nodes is a strictly increasing and concave function of r. This property indicates that although getting more forwarding candidates involved in GOR will increase the maximum EPA, the extra EPA gained by doing so becomes less significant. It also implies the consistency between EPA and reliability. These principles of GOR will help us analyze the capacity of OR and design efficient local candidate selection and prioritization algorithms for achieving energy and throughput efficiency respectively. Here we make the following assumptions. Each node knows its geographic location using some localization mechanism. Location awareness is essential for many wireless network applications, so it is expected that wireless nodes will be equipped with localization techniques. Several techniques exist for location sensing based on proximity or triangulation using radio signals, acoustic signals, or infrared. These techniques differ in their localization granularity, range, deployment complexity, and cost. In general, many localization systems have been proposed in the literature: GPS (Global Positioning System), infrastructure-based localization systems and ad-hoc localization systems.

4.1 Proposed Algorithm

Evolutionary algorithms are relatively new, but very powerful techniques used to find solutions too many real-world search and optimization problems. Many of these problems have multiple objectives, which leads to the need to obtain a set of optimal solutions, known as effective solutions. It has been found that using evolutionary algorithms is a highly effective way of finding multiple effective solutions in a single simulation run.

- Comprehensive coverage of this growing area of research
- Carefully introduces each algorithm with examples and in-depth discussion
- Includes many applications to real-world problems, including engineering design and scheduling
- Includes discussion of advanced topics and future research
- Can be used as a course text or for self-study
- Accessible to those with limited knowledge of classical multi-objective optimization and evolutionary algorithms

4.2 Simple Evolutionary Multi Objective Optimizer (SEMO)

Choose an initial individual x uniformly from X = {0, 1} n

P ← {x}

loop

Select one element x out of P uniformly.

Create offspring x by flipping a randomly chosen bit.

P ← P \ {x ∈ P |x x}

if ∃x ∈ P such that (x x ∨ f(x) = f(x

)) then

P ← P ∪ {x

}

end if

end loop

4.3 Fair Evolutionary Multi Objective Optimizer (FEMO) :

Choose an initial individual x uniformly from X = {0, 1}n

w(x) ← 0 {Initialize offspring count}

P ← {x}

loop

Select one element x out of {y ∈ P |w(y) ≤ w(x) ∀x ∈ P } uniformly.

w(x) ← w(x)+1 {Increment offspring count}

Create offspring x by flipping a randomly chosen bit.

P ← P \ {x ∈ P |x x}

if ∃x ∈ P such that (x x ∨ f(x) = f(x

)) then

P ← P ∪ {x

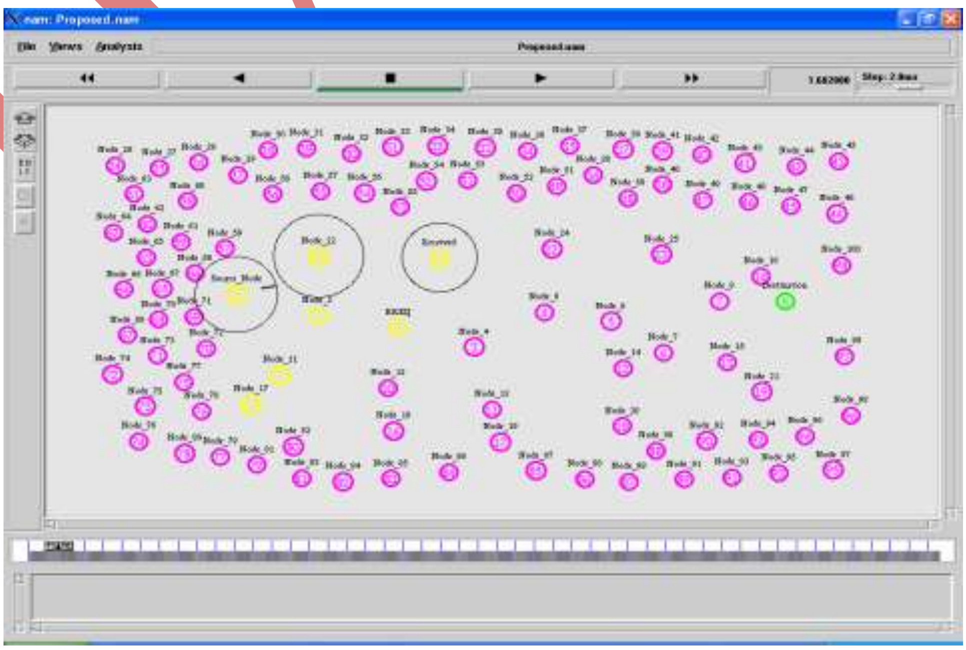
}

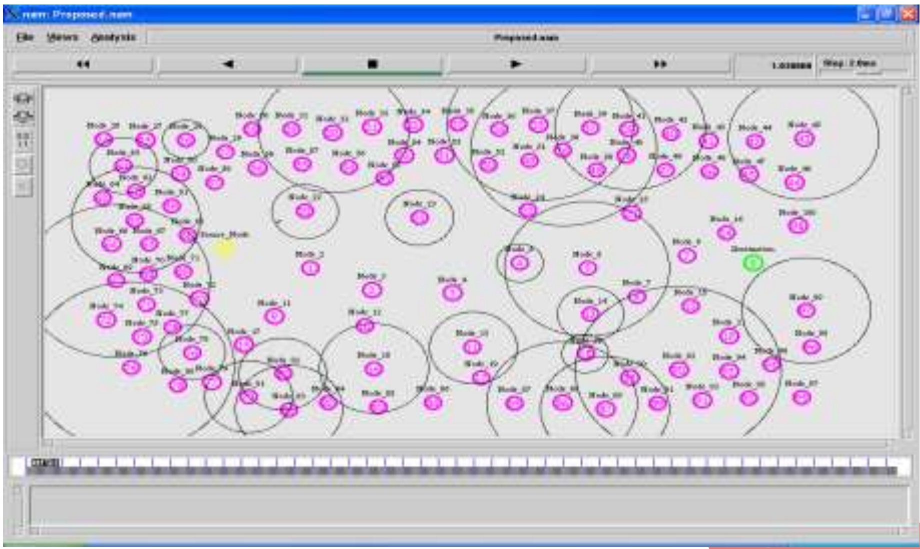
w(x) ← 0 {Initialize offspring count}

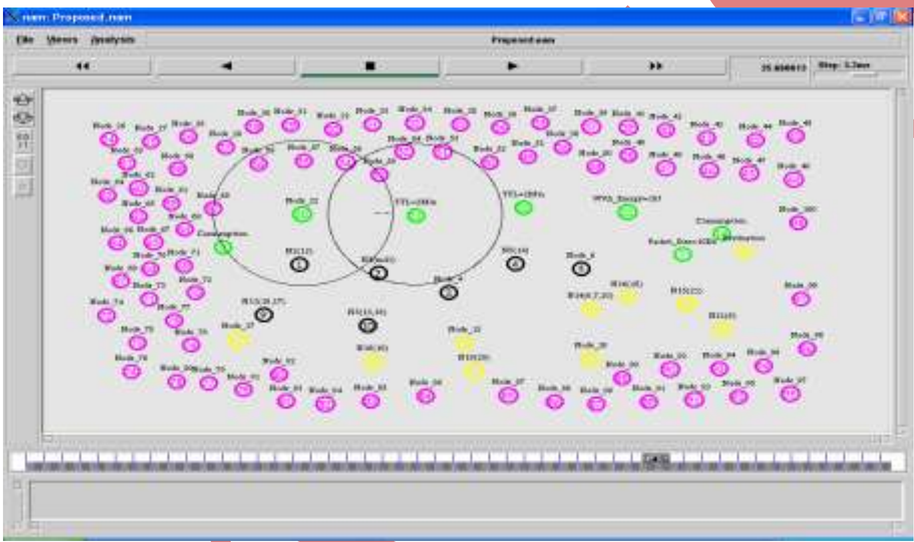
end if

end loop

V. SIMULATION MODEL







5.1 Performance Metrics

Fault tolerance, scalability, production cost, operating environment, network topology, hardware constraints, transmission media, power consumption are the important factors that is to be considered in the design process of sensor networks. The performance of the network is then measured based on experimental parameters called performance metrics. End-to-end Delay: the time taken for a packet to be transmitted from the source node to the sink node. Given the end-to-end delay QoS requirement, this metric measures the on-time packet delivery ratio. Packet Delivery Ratio: the ratio of the amount of packets received by the destination to the total amount of packets sent by the source. Energy Efficiency: Each sensor should have spent the same amount of energy in each data gathering round. A data aggregation method is said to be energy efficient if it maximizes the functionality of the network. Node Energy Consumption: The node energy consumption measures the average energy dissipated by the node in order to transmit a data packet from the source to the sink.

$$\textit{Node energy consumption} = \frac{\sum_{i=1}^{N}(E_{i-initial} - E_{i-residual})}{N\sum_{i=1}^{N_{sink}} N_{j-data}}$$

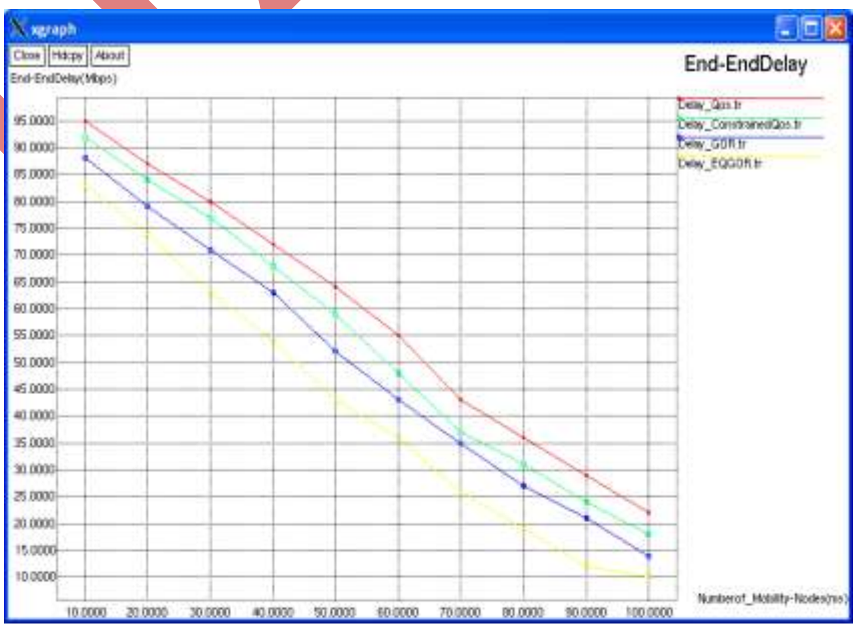
where N is the number of nodes, $E_{i-initial}$ and $E_{i-residual}$ are respectively the initial and residual energy levels of node *i*, $N_{\sin k}$ is the number of sink nodes and N_{j-data} is the number of data packets received by sink *j*.

5.2 Simulation Setup

Parameters	**Value**
Number of Nodes	100
Network Size	1800x900
Range	300m (200m – 500m)
Throughput	2 Mbps (5.5 Mbps, 11 Mbps)
Bandwidth	1.5 Mbps
Frequency	3 Hz
Average Speed of nodes	1.2 m/s
Data Transmission	1000 Bytes
Packet Rate	50 Packets per second (pps)
Request message interval	1 – 5 Seconds
Mobility Factor	5 seconds
Request message jitter	250 ms
Neighbor table refresh interval	5 seconds – 10 seconds
Mobility Detection Interval	10 seconds
Initial Energy Assigned	100 Joules
Energy Consumption	30 Joules
Protocol	EQGOR Protocol
Simulation Time	1500 seconds

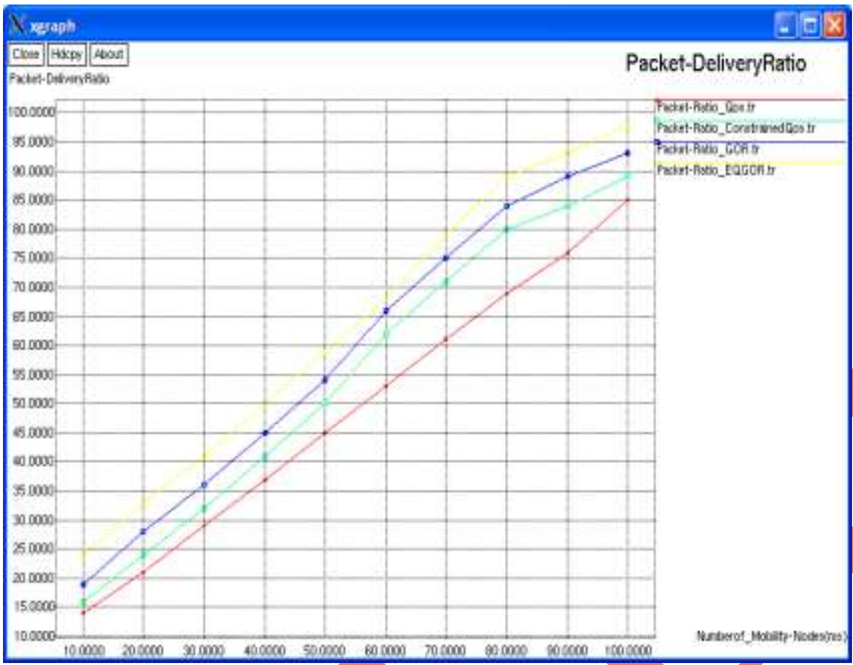
(1) End-End Delay

In x-axis number of nodes and y-axis Delay



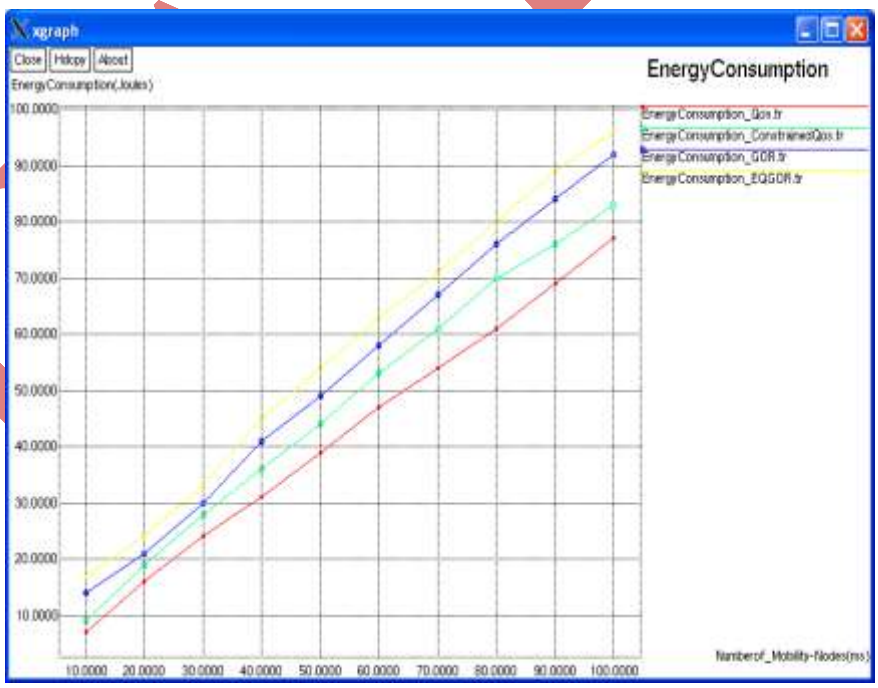
(2) Packet Delivery Ratio

In x-axis number of nodes and y-axis Packet Delivery Ratio



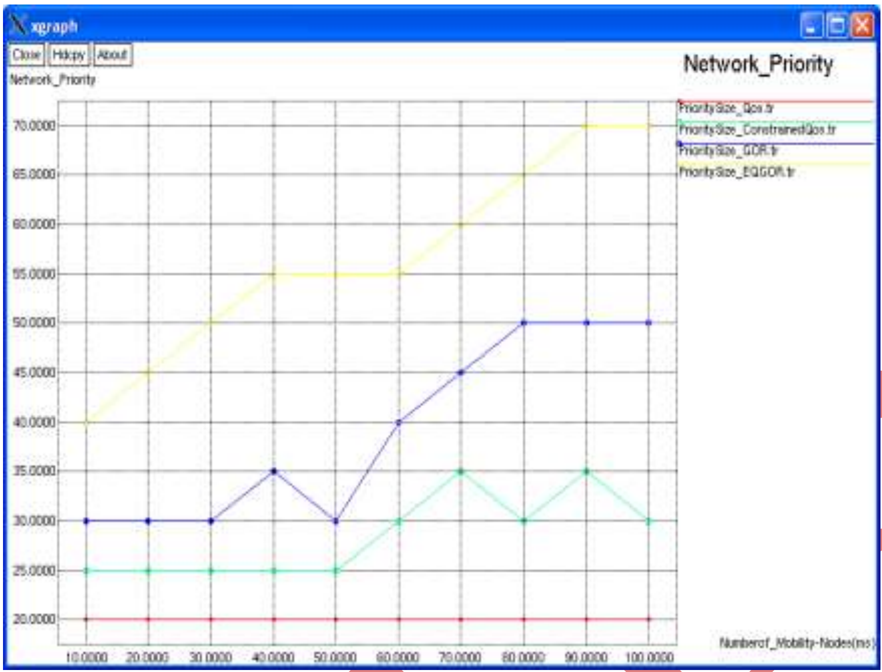
(3) Energy Consumption

In x-axis number of nodes and y-axis Energy Consumption



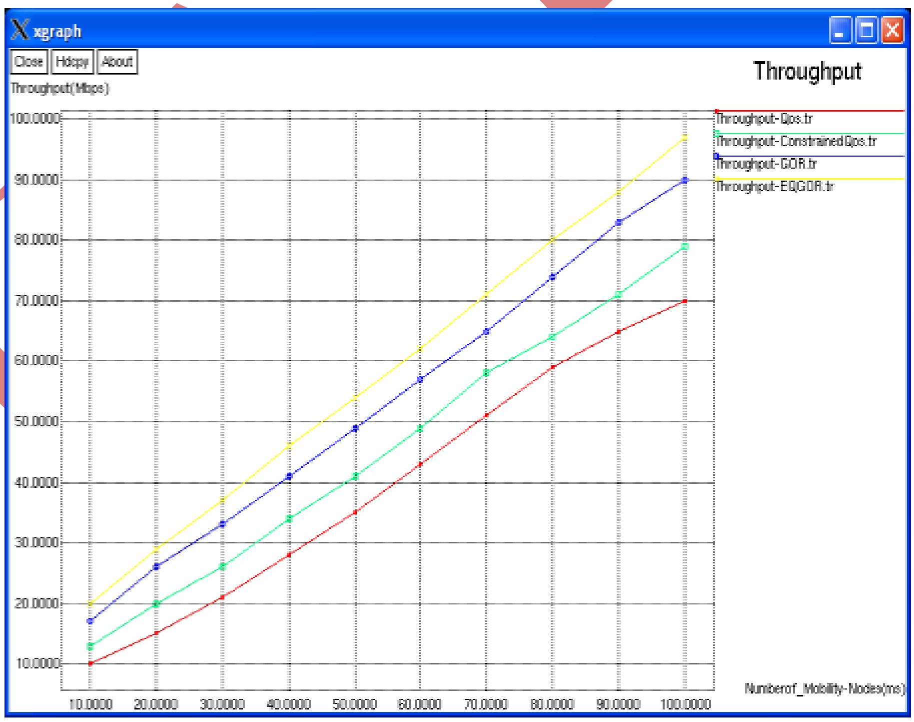
(4) Network Priority

In x-axis number of nodes and y-axis Network Priority



(5) Throughput

In x-axis number of nodes and y-axis Throughput



VI. CONCLUSION

Development of effective optimization algorithms is the key to improve the utilization of the limited resources of WSN s (energy, bandwidth, computational power). Using Quadratic Assignment technique with EQGOR protocol and the proposed algorithm we can avoid the time delay and we can increase the throughput of each mobile sensor node with mobility. Simulation results shows that EQGOR protocol achieves better energy efficiency than Geographic routing and blind opportunistic protocols in all the cases while maintaining very good routing performance. Further work to improve the algorithm includes the addition of routing network with clustering formation of multiple destination nodes. Any IDS entering into the WSN or if already available mobile sensor misbehaves in the system then those nodes can be easily detected through the enhanced protocol with gateway of clustering network. So we can quickly detect IDS of the nodes and improve as well as save the battery power, energy consumption, throughput ,end to end delay, network lifetime and also limitation of mobile sensor nodes is removed successfully. And in this paper, we have made an effort to put these works into perspective and to present a holistic view of the field. There is significant amount of scope for future work in these areas.

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