Implementation of Energy Balanced GTEB Dynamic Routing Protocol for Improving Network Lifetime of WSN

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Abstract— In the wireless sensor network, sensors or nodes are generally battery powered devices. These nodes have limited amount of initial energy that are consumed at different rate, depending on the power level. To maximize network lifetime in WSN the paths for data transfer are selected in such a way that the total energy consumed along the path is minimized. GTEB routing protocol is proposed to solve the problem of Energy balance and increase network lifetime by balancing traffic load at two levels, over regions and at the nodes in these regions. The energy balance at the region is achieved using EGT while that at the node level is achieved using CGT. This theory was further improved by implementing the dynamic concept, GTEB needs positioning hardware in the sensor nodes or alternatively, the pre-programing of the node location . Simulation test details shows that proposed system GTEB dynamic mode considerably recuperates network performance by saving the energy and the time.

Key words: Energy balance geographical routing protocol, game theory, GTEB, GPS or positioning hardware

I. INTRODUCTION

Recent advances in wireless communications and electronics have enabled the development low-cost, low-power, multifunction sensor nodes that are small in size and communicate untethered in short distances. These tiny sensor nodes, which consists of sensing, data processing and communicating components, leverage the idea of sensor network.

As technology is increasing the demand for wireless network is also increasing. In WSN, the sensor nodes have a circumscribed transmitted range and their processing and storage capacities as well as their energy resources are also circumscribed. Routing protocol for wireless sensor network are responsible for maintaining the routes in the network and have to guarantee dependable multi-hop communication below these condition.

The main issue in the WSN is the energy efficiency and network lifetime. There are many protocols that were developed to increase in the network lifetime and efficiency but all they could not balance the energy. Geographical routing protocol together with game theory is proposed to balance the energy levels of all the sensor nodes in the network leading to increased network lifetime, GTEB resolves the Energy balance problem in the region level as well as at the node level using EGT. The GTEB protocol is time consuming so the position of the sensor nodes needs to be engineered or predetermined. This allows random deployment in inaccessible terrain or disaster relief operation.

II. RELATED WORK

GRPs are gaining popularity and are being employed for industrial applications such as advanced metering infrastructures for smart grid. A quadrant based directional forwarding scheme, called real-time load balance distribution protocol (RTLD), which limits the forwarding task to a quadrant of the forwarding nodes. However, redundant transmissions in the selected quadrant may occur and some quadrants could be utilized more than others depending on the location of the source. That is why it does not provide global load balance. GTEB distributes the load evenly among the regions as well as selects better nodes in the selected region. These features enable it to be more adaptive to changes in the energy dissipation in the sub regions, as well as other parameters of the network such as node densities. Both, RTLD and GTEB offer a RLEB but through different means. GTEB does RLEB as well as NLEB, but RTLD only does RLEB. It is interesting to explore the impact of the combination of RLEB and NLEB on the network performance by comparing with the RLEB only protocol. For example, if the network is dense, there can be more sub-regions and a lower number of participating nodes in forwarding. Another common problem in WSNs is over utilization of nodes around sinks. GTEB can detect the energy hole problem areas and does not forward any traffic towards such areas. A real-time power aware routing protocol (RPAR) is to find balance between end-to-end delay and energy consumption using transmission power adjustment. RPAR is considered as a NLEB only protocol. Therefore, GTEB is compared with RPAR to understand the impact of the combination of RLEB and NLEB on the network performance over a NLEB only protocol. Game theory was proven to provide versatile solutions for dynamic and distributed networking problems. CGT is used in GRPs for various problems related to end-to-end delay optimization, task allocation, relay selection, and network congestion. EGT is emerging as an important tool to solve dynamic networking problems due to changes in energy state, channel state and topology. EGT is implemented to solve the packet forwarding problem when a network consists of heterogeneous nodes operating in networks with different authorities. This shows that the forwarding cooperation among authorities can evolve and provide stable communication. In this paper, both CGT and EGT are utilized simultaneously for energy balance in geographical routing to prolong the network lifetime.

III. SYSTEM DESIGN

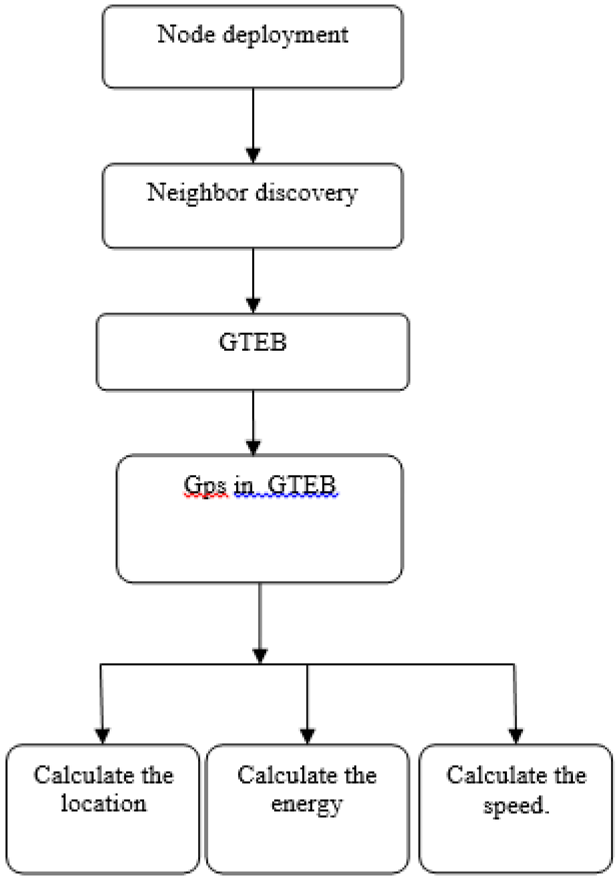

Fig. 1: system design of GTEB

1) Node deployment: The Node Deployment is an algorithm that is used to topographic the nodes in the network in the given area of x*y.
2) Neighbor Discovery: Neighbor discovery is a process of discovering the neighbor node, depending on the distance from the source to neighbor nodes within 100m of distance from source towards destination direction and its residual energy that falls within the broadcast range.
3) GTEB Algorithm: This algorithm is a combination of EGT and CGT. In region level energy balance (RLEB), evolutionary game theory (EGT) is used, the objective is to balance the energy consumption around a sender such that all sub-regions around the sender will participate fairly and deplete their energy at the same time. After selecting the participating region, node level energy balance (NLEB) employed by classical game theory (CGT) is required to select the most favorable forwarding node in this sub-region. This process is iterated until it reaches the destination.
4) GPS in GTEB: the Global positioning system(GPS) will find the location of the sensor nodes so as to select the best node for transmission. By calculating the location, energy and speed of the nodes it is very much easy to select the best node and transmit the data without the consumption of much time.

IV. SELECTION OF SUB-REGION AND NODES

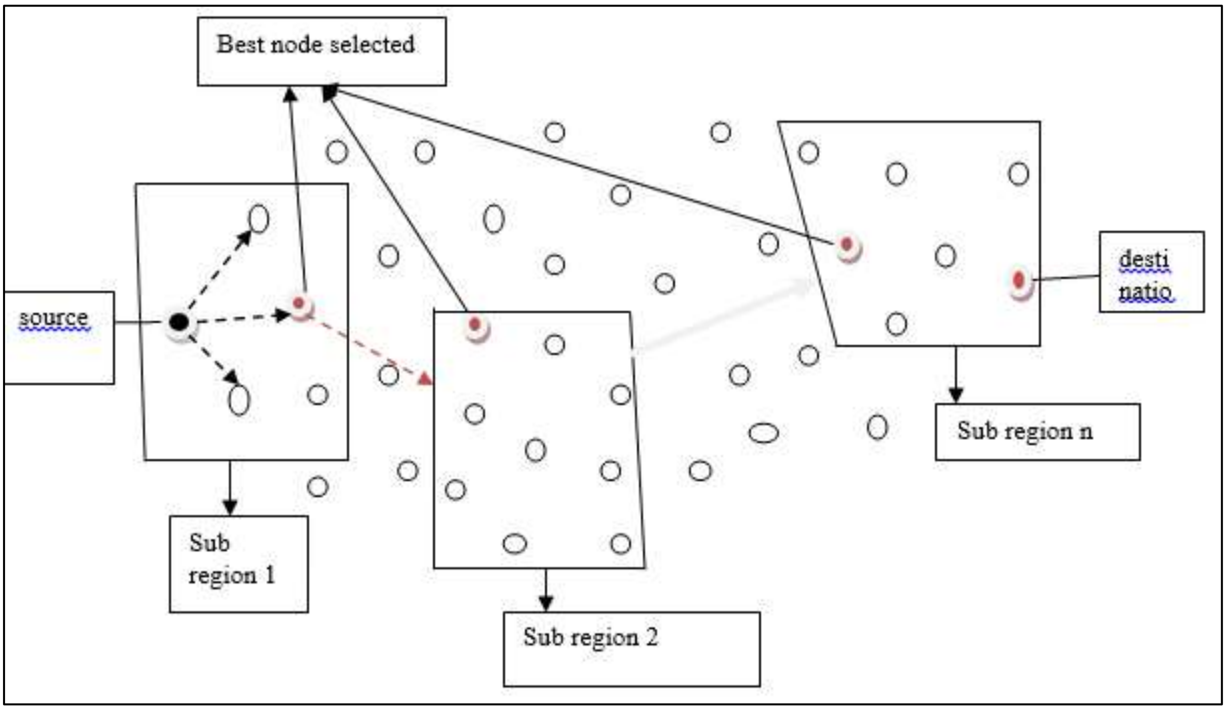

Fig. 2: sub-region and node selection

The GTEB protocol considers geographical routing in a stationary network. The proposed GTEB protocol is designed to provide energy balance to uniformly and randomly deployed multi-hop WSNs with homogeneous nodes where the transmission range is *r*. The problem of achieving a network wide energy balance is broken down into the following two sub-problems: RLEB at sub-regions and NLEB within the sub-region. The energy balance at the region level is achieved using EGT and the energy balance at the node level is achieved using CGT. In the above figure, the selected region is shaded and the selected forwarding node is labeled. Based on EGT, a sender forwards a packet to its neighborhood. The information, provided by the packet, will allow the surrounding nodes to identify whether they are in the forwarding sub-region. Then the nodes in the selected sub-region will play non-cooperative classical game to identify which one will be the potential forwarding node. One of the potential forwarding nodes in that sub-region, who wins the game becomes a sender node and plays its own evolutionary game to select the next forwarding region in order to balance energy consumption in its own surrounding. The transmission range of a sender is divided into *K* forwarding sub-regions based on the network density.

V. PERFORMANCE ANALYSIS

A. Throughput:

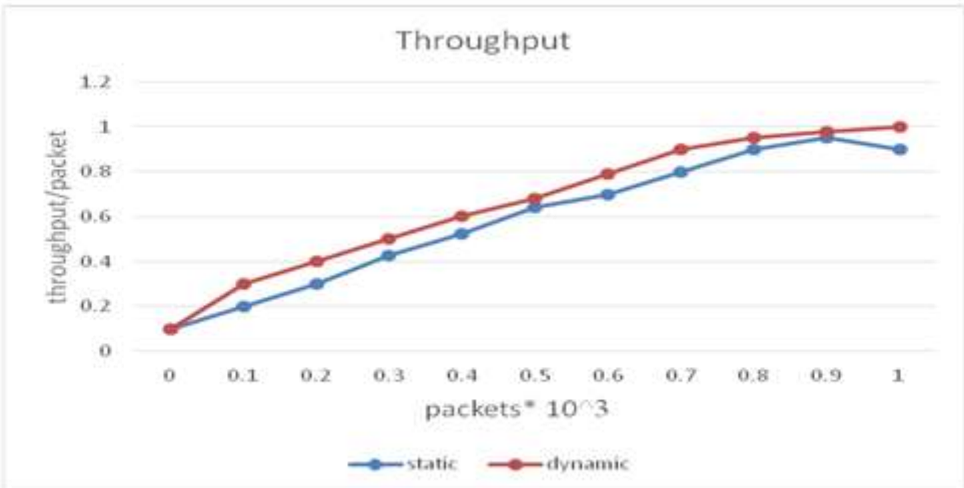

Fig. 3: Throughput

Figure depicts the throughput with respect to packets of GTEB with static and dynamic mode, dynamic mode results in slightly higher throughput as compared with the static mode due to the less packet drops in GTEB dynamic and hence the throughput is almost equal to static for higher volume of data communication. This approach improves the throughput level of the system, as the sending packets are more.

B. Network Lifetime:

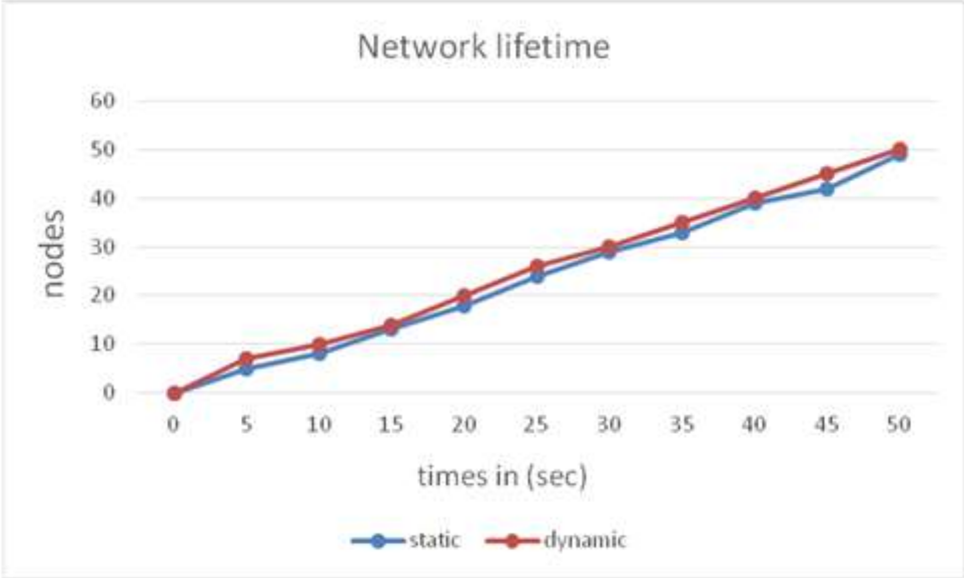

Fig. 4: network lifetime

From the Figure, it is observed that only the selected nodes of Sensor Network is utilized and hence achieves more living nodes as compared with GTEB Static for long time simulation leading to longer network, because GTEB dynamic focuses energy density and shortest path as well for communication.

C. Route Discovery Delay:

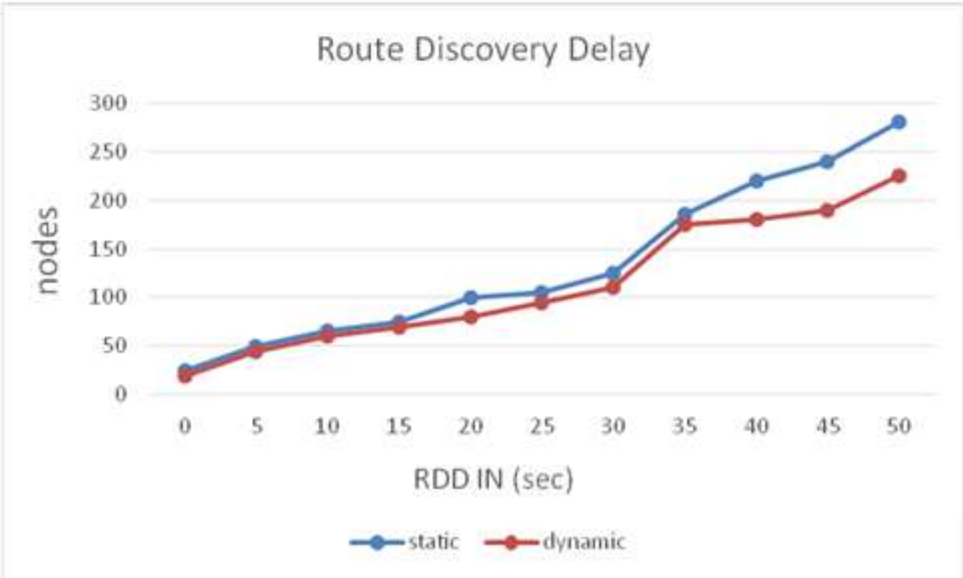

Fig. 5: Route discovery delay

Figure depicts the route discovery delay of GTEB static and GTEB dynamic with respect to time. It is observed that GTEB dynamic discovers the shortest path earlier as compared with the GTEB static. It is happening because of continuously pre-calculating the best shortest path. It is also observed that as density of nodes increases, the route discovery time approaches static mode because considerable time is required to calculate the Energy Density in condensed nodes. GTEB prime objective is to discover the best shortest path with sufficient energy density to forward packets to sink. That is the reason it consumes less End-to- End Delay to forward the packets to destination as compared with static mode.

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