A Survey On Energy Aware Routing in WSN

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Abstract

Sensor network is a distributed event-based system that differs from traditional communication network. Transporting information in the network with the quality of service and more efficiency is the goal. Collecting environment information is a major application of sensor network. There are many types of routing in wireless sensor network such as flat-based routing, hierarchical-based routing, location-based routing and quality of service based routing depending on the network structure. Our objective of this research is to analyze the various energy aware routing protocol to analyze how these protocol improves QoS. In this research we considered various researchers contribution to illustrate the importance of load balancing and clustering in WSN to achieve Quality-of-Service.

Keywords : WSN, Energy Aware Routing, SPEED, QoS

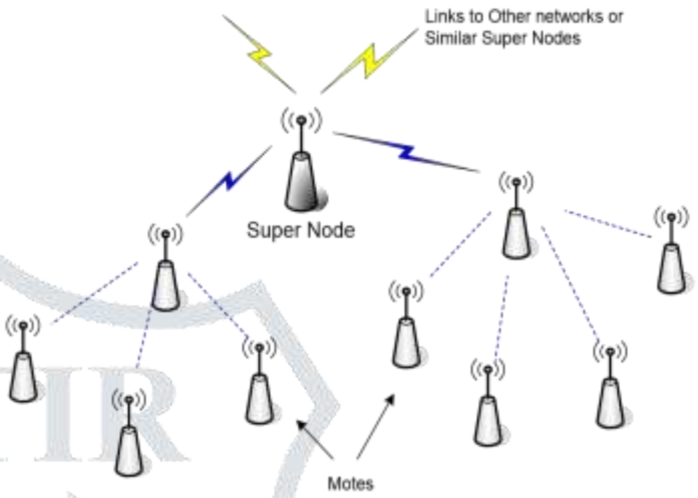

Fig 1.1 Wireless Sensor Network

1 Introduction

A wireless sensor network [1] is a group of specialized transducers with a communications infrastructure for monitoring and recording conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions.

A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The microcomputer processes and stores the sensor output. The transceiver receives commands from a central computer and transmits data to that computer. The power for each sensor node is derived from a battery.

Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible. The sensing electronics measure ambient conditions related to the environment surrounding the sensor and transform them into an electric signal. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. A large number of these disposable sensors can be networked in many applications that require unattended operations.

2 Background

In WSN many energy efficient protocols have been specifically designed, where energy awareness is an essential design issue. To meet the new challenges, innovative protocols and algorithms are needed to achieve energy efficiency, flexible scalability and adaptability and good networks performance. A constraint of batteries is a big issue in WSNs. WSN will generally comprise of a multi-hop routing scheme. This and other routing challenges were discussed and brought to the front, as should be considered when designing any new routing protocols or algorithms. So one of the biggest issues in sensor networks is limited energy of network nodes; so making good use of energy is necessary to increase lifetime of networks.

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Wireless sensor network is a collection of nodes organized into a cooperative network. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion. The position of sensor nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations. This also means that sensor network protocols and algorithms must possess self-organizing capabilities. The unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are embedded with an onboard processor. Instead of sending the raw data to the nodes responsible for the fusion, they use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data.

Many exciting results have been recently developed for large-scale sensor networks. These networks can form the basis for many types of smart environments such as smart hospitals, battlefields, earthquake response systems, and learning environments. While these potential applications remain diverse, one commonality they all share is the need for an efficient and robust routing protocol.

3 Related work

Galvez, J. J. et al[2] proposed a distributed load-balancing protocol(GWLB), according to this protocol the forwarder nodes coordinates each other to reduce congestion by rerouting the traffic flows from busy nodes to free nodes. In addition, this protocol organizes reroutes it reroutes the traffic from congested to uncongested domains by achieving better capacity utilization and higher network throughput. In this distributed scheme where gateways coordinate and exchange information about their associated nodes and their demands. For that purpose, the mesh network is divided into domains; each domain can be defined as set of sinks served by gateway in which it receives internet traffic. Each domain is assigned with a specific capacity and it is compared against the load in the particular domain. The load is represented as the demands of the sinks. If the load exceeds the tolerable capacity then the zone is measured as congested. To avoid the congestion, the proposed protocol reroutes the traffic. This proposal does not need any extra computation resources at mesh nodes

Li Hongkun et al[3] analyzed the selection of a path with the least cost in terms of probable end-to-end delay (EED) in a multi-radio multi-channel WMN. The novel EED metric cnsiders the transmission delay and queuing delay of the buffer due to MAC layer. In addition to reduce the end-to-end delay, the EED metric absolutely offered load balancing routing. They designed a common approach to estimate the multi-radio achievable bandwidth (MRAB) for a path enchanting the impact of intra or inter flow interference and channel multiplicity into consideration. A practical scenario is considered in which an end-to-end path may consist of both multi-radio hops and single-radio hops with multiple channels which they do not interfere with each other but the interference problem exist within the same channel. They developed a sub-path based iterative approach to model the complex interactions among inter-flow interference, intra-flow interference and simultaneous transmission due to space and channel diversity. The MRAB is combined with the EDD to form the metric weighted end-end delay (WEED). This metric better capture the effect of interference and channel diversity. This work also proposed a distributed WEED based routing protocol for MR-MC wireless networks.

Choi, K. W et al[4] proposed a load-aware routing scheme for wireless mesh networks (WMNs). This load-aware routing scheme can balance the load and thus enhance the overall network capacity. This routing scheme maximizes the degree of user satisfaction using the dual decomposition method. In this proposed scheme, for maintaining the load control, the entire network is divided into multiple clusters. A cluster head of each cluster estimates the traffic load of its own cluster. When the estimated load gets higher, the cluster head increases the routing metrics of all the routes passing through that particular cluster. Based on the routing metrics, the traffic takes a diversion to avoid overloaded areas and achieves global load balancing. This proposed scheme need an uninterrupted adaptation of the link costs to the traffic load, which may lead to instabilities and link/node failures.

Aron et al[5] presented a distributed topology control algorithm by considering the problem of topology control in a hybrid WMN of heterogeneous wireless devices with varying maximum transmission ranges. The distributed topology control algorithm calculates the optimal transmission power to maintain network connectivity, to reduce the transmission power to cover only the nearest neighbours and to extend the network lifetime. The algorithm takes decision based on the locally gathered Information and it scales well for large WMNs. The execution consists of three phases. In phase 1, it establishes the accessible neighbourhood topology, in phase 2, it constructs the minimum-energy Local topology view and in phase 3, it determines the Transmission power. This three phased topology control algorithm is executed distributively per node. A node uses only the locally available information to determine the nodes that should be its logical neighbours at any given time. The objective of this algorithm is to develop a minimum-energy distributed topology control which ensures a reduction in the amount of energy consumed per node during transmissions and without loss of connectivity.

Panagiotis Kokkinos et al[6] proposed a class of novel energy-efficient multi-cost routing algorithms for wireless mesh networks and evaluate their performance. In multi-cost routing, a vector of cost parameters such as hop count, residual energy and transmission power of a node i on link(i,j) is assigned to each network link, from which the cost vectors of candidate paths are calculated using appropriate operators. These parameters are combined in various optimization functions for selecting the optimal path. The performance of proposed energy-aware multi-cost routing algorithms is evaluated under two models such as network evaluation model and dynamic one-to-one communication model. In the network evaluation model, the network starts with a number of packets that have to be transmitted and an amount of energy per node and the objective is to transmit the packets in the smallest number of steps or transmit as many packets as possible before the energy is depleted. In the dynamic one-to-one communication model, new data packets are generated continuously and nodes are capable of recharging their energy periodically over an infinite time horizon for achieving maximum steady-state throughput, the packet delay and the energy consumption. The performance results showed that the energy-aware multi-cost routing algorithm increases the lifetime of the network and provides better overall network performance than the other approaches.

Awad et al [7] proposed a cross-layer algorithm to minimize the end-to-end transmission energy subject to a packet delay deadline constraint. The optimal transmission energy, rates and the optimal route are computed to minimize the end-to-end total transmission energy in a delay constraint wireless mesh network. The assumption of a cross-layer optimization framework is proposed, with the constraint of all successfully received packets must have their end-to-end delay which is smaller than their corresponding delay deadline. Different control parameters are optimized across the protocol layers such as network and physical layers in the proposed algorithm. It was considered as an exhaustive search algorithm for the determination of the optimized-mesh network parameters. These parameters were used as the path selection parameters in the network layer, the modulation and the transmission energy in the physical layer. In addition to the optimal solution, a suboptimum solution is also proposed by dividing the network into small subnetworks. For each path in the subnetwork, all the cross-layer parameters and the optimum route are calculated by searching through all the paths in the subnetwork.

Prakash, T. N. S. S., et al[8] proposed a Energy Draining Rate Based (ERDB) routing model by modifying the existing AODV protocol. This proposed ERDB-AODV protocol chooses the next relay traffic by considering the remaining battery capacity and the energy draining rate of the node. In this proposed model, remaining energy and energy draining rate is included as an additional metric for the selection of a path including the hop count metric. The primary factor for path selection is hop count and secondary factor is remaining energy of node and its energy draining rate. The nodes with high energy draining rate and low energy capacity should be avoided for relaying traffic to increase network life time. These two aspects may take long path to reach destination but it will assure successful data transfer without node failure.

In this paper [9], the author show the study of four multicast routing protocol with energy efficient perspective. Among four routing MAODV is tree based protocol, TEEN, SPEED and MMSPEED are cluster based routing protocols for individual effectiveness in different performance parameter. As per result MAODV and TEEN are not scalable protocols because MAODV maintain a routing table and TEEN is more appropriate for small networks due to its threshold vale problem, SPEED and MMSPEED provides QoS as well as lower energy consumption because they need minimum information for routing.

In this paper [10], the first adaptation of the SPEED geographic routing algorithm in a 6LoWPAN scenario is presented and its experimental validation in a real test bed is shown as compared with the AODV protocol. in this the main aim is avoiding route creation time and showing reduced memory occupation the result shows that 6LoWPAN context SPEED shows a negligible bigger round trip time with respect to AODV while saving time in route creation and routing table memory occupancy. Moreover SPEED supports soft real-time, load balancing and flow shaping mechanisms making itself an effective solution in supporting packet routing in 6LoWPAN networks.

In this paper [11], the authors are mainly focus on minimizing end to end latency and energy efficiency as primary design objective of routing protocol for wireless sensor network without overshadowing the other design factor. In this article they present survey of low latency, energy efficient and time critical routing protocol like TEEN, APTEEN, SPEED, RAP and RPAR. The result shows that latency and energy efficient routing protocols like TEEN, APTEEN, RAP, RPAR and SPEED minimized latency and conserves energy with desire protocol.

In this paper [12], the author presents an improved strategy of SPEED protocol for the requirement of node mobility in Wireless Mesh Sensor Network. The main aim behind this is to improve Neighbor Beacon Exchange Scheme and the Stateless Nondeterministic geographic for-warding (SNGF), and this strategy makes SPEED protocol applicable to WMSN, and increases the support of the mobility of the sensor node. The result shows that Wireless Mesh Sensor Network Based SPEED protocol improving SNGF and Neighbor Beacon Exchange Scheme algorithm, and by adjusting the information exchange frequency of the mobile node with neighbor nodes and the probability of forwarding node choice, increases the node mobility support.

In this paper [13], data aggregation has been added to the conventional technique in SPEED algorithm. The idea involves virtual configuration of sensors and specification of an individual ID to the created data by the sensors in each region, then data aggregation in relay node is done by ID. In this article data routing in sensor networks is data aggregation or data fusion (SPEED+). Using data fusion technique, we can lower the data volume to a large extent. Due to this the data processing costs less energy than sending them. The results shows that in the energy consumption the traditional SPEED protocol consumes less energy than the proposed protocol and the rate of the controlling the overhead is equally same as the proposed protocol. In future each region have several sensors not needed all in the region, so algorithms could be developed to activate and deactivate the sensors like GAF algorithm.

In this paper [14], the author present a novel Fault-tolerant real-time routing protocol called FT-SPEED. In FTSPEED, Void announces scheme is proposed to prevent the Packets reaching the void through other routing path. In this article authors are develop the fault tolerant speed and again comparison with the SPEEED itself and MMSPEED. In FT-SPEED. Simulation results show that, compared with SPEED and MMSPEED, FT-SPEED could handle the void problem much more effectively. In this they are mention that MMSPEED supports packet delivery reliability by multipath, it still may also fail when the packets reach the void. SPEED handles the above void problem as it handles congested areas. When the packets reach the void point node, they will be dropped and a backpressure beacon is sent to notify the source node stop sending packet to it.

In this paper [15], authors investigates the data transport problem for reporting delay-sensitive events in wireless sensor-actuator networks (WSANs). We specifically tailor the protocol design according to the features of WSANs and propose POWERSPEED, a real-time data transport protocol for WSANs to achieve energy-efficient data transport for delay-sensitive event reporting. In this article the author compare the geographic routing protocol (GRP) and POWERSPEED protocol for evaluation for WSANs. Results show that POWER-SPEED avoids the overhead of control packets by estimating the downstream path quality (in terms of delay) with only spatiotemporal historic data of the upstream path quality, which is obtainable without exchanging additional packets.

POWER SPEED selects the next-hop neighbor based on the downstream path quality and the latency-bound requirement of packets.

This paper [16], energy efficient routing are classified into four main part: hierarchical, query based, location based and Qos based. The classification initially proposed by Al-Karaki is expanded, in order to enhance to describe which issue in each protocol illustrate the energy efficiency issue. The result shows that the problem of accurate delivery of the data from the source to the destination is solved by QoS protocols that ensure optimized QoS metric such as delay bound, energy efficiency, and low bandwidth consumption while achieving energy efficiency in wireless sensor network.

4 Conclusion

In this research paper, we conducted research on various energy aware routing protocols and identified the limitations and how those protocol organized routing based on energy parameters. In this article we have discussed, one of the important issue that is energy consumption problem in WSN. This research presents the importance of energy or power in WSN and how efficient routing will impact on the energy utilizations. We organized this research by describing energy aware routing protocol and the limitations of energy aware protocol. In related work we presented various routing protocols and limitations to illustrate importance of energy balancing in WSN. As there are many energy efficient routing protocols exist, it is very difficult to compare them directly since each method has different assumptions and has different means to achieve the goals.

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