MODIFIED ETX-AODV TO IMPROVE PERFORMANCE OF LOW POWER IOT NETWORKS

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Abstract: Internet of things (IOT) is the technology that is turning the heads these days owing to their vast scope in the day to day applications. IOT is normally supported by the sensor nodes that sense the data and pass it to devices to take necessary actions. The sensor nodes are however battery constrained and the routing protocol used by them needs to be optimized to increase their lifetime. This paper proposes modification to expected transmission count (ETX) based ad hoc on demand distance vector (AODV) routing protocol for the network consisting of sensor and relay nodes. The proposed modification was analyzed in network simulator and compared with the existing scheme based on packet delivery ratio, remaining energy and throughput of the network. These parameters have shown an improvement over the existing scheme.

Keywords: IOT, ETX-AODV, PDR. Energy efficiency

I. INTRODUCTION

Internet of Things (IoT) [1,2] is a network of things or objects that will extend today's Internet by allowing interaction among objects, such as sensors, radio frequency identification (RFID) tags, home appliances, and vehicles through a wireless network. IoT provides object-object interaction and brings thousands of every day-use objects under the same network. For instance, integrating Wi-Fi or short range radio technologies (e.g., Bluetooth), a weight scale device can display weight on iPhone, send weight information to doctor, subscribe to diet services that get weight information and accordingly send diet recommendations. Integration of sensor networks with Internet, as part of IoT, facilitates a large number of smart network applications such as health care support for remote areas, air pollution monitoring, environmental monitoring, and traffic congestion control etc. [3]. Among the most promising technologies for the IoT paradigm, RFID and Wireless Sensor Networks (WSNs) are the most common and appropriate [4, 5].

IoT, as network of sensors with the capability to sense, process and communicate, have been gradually more used in different fields together with engineering, some mission critical application in military, healthcare and environment, to smartly monitor distant locations at little cost. Sensors in such network are responsible for functions like data aggregation, in-network data processing, sending and receiving data, etc. This shows that they have to efficiently utilize their resources, together with memory usage, CPU power and, more essentially, energy, to raise their life span and efficiency.

This paper aims at improving the lifetime of the nodes in low power IOT network. The related work about the energy efficient routing for such networks has been presented in Section II of this paper. Section III presents the proposed technique and results have been shown in section IV. Finally the conclusion has been presented in section V of this paper.

III. LITERATURE REVIEW

This work [6] presents an enhancement to the Lightweight On-demand Ad hoc Distance-vector Routing Protocol—Next Generation (LOADng) for IoT scenarios. The proposal, named LOADng-IoT, is based on three improvements that will allow the nodes to find Internet-connected nodes autonomously and dynamically, decreasing the control message overhead required for the route construction, and reducing the loss of data messages directed to the Internet. Based on the performed assessment study, which considered several number of nodes in dense, sparse, and mobility scenarios, the proposed approach is able to present significant results in metrics related to quality-of-service, reliability, and energy efficiency.

In this paper [7] the authors present a new approach called E-RPL; it is an enhancement of the Routing Protocol for Low power and lossy networks (RPL). Comparing to RPL, E-RPL decreases the number of control messages. The new protocol proposes also a new flexible multi-constrained objective function (OF) that can integrate several metrics including energy, delay and bandwidth to define the end-to-end path between the sink and a given node. The simulation results show a remarkable improvement of energy consumption, routing overhead, and end-to-end delay.

In this paper [8], the authors have proposed an OF named `EEQ' that protects the node which has already excessively consumed its energy for forwarding sensed data towards the root node. The EEQ computes the rank of a node using three energy related parameters: i) expected number of transmissions, ii) consumed energy, and iii) active queue length. Under low and high intensity traffic loads, they have simulated various scenarios for OF0, MRHOF, and EEQ. The simulation results show that for high intensity traffic, EEQ has less overhead of control messages as compared to OF0 and MRHOF, resulting in energy conservation.

This paper [9] proposes an approach for IoT route selection using fuzzy logic in order to attain the requirements of specific applications. In this case, fuzzy logic is used to translate in math terms the imprecise information expressed by a set of linguistic rules. For this purpose, four Objective Functions (OFs) are proposed for the Routing Protocol for Low Power and Loss Networks (RPL); such OFs are dynamically selected based on context information. The aforementioned OFs are generated from the fusion of the following metrics: Expected Transmission Count (ETX), Number of Hops (NH) and Energy Consumed (EC). The experiments performed through simulation, associated with the statistical data analysis, conclude that this proposal provides high reliability by successfully delivering nearly 100% of data packets, low delay for data delivery and increase in QoS. In addition, a 30% improvement is attained in the network life time when using one of proposed objective function, keeping the devices alive for longer duration.

The authors in [10] proposed AODV to achieve reliability in Low Power Networks. In proposed network architecture, sensor nodes do sensing and relay nodes collect the data from sensors and other relays, and transmits the data to sink. In routing mechanism, expected transmission count (ETX) are included for path computation. ETX is reliability related metric, which helps to transmit the data in reliable link, by estimating the quality of links. ETX is calculated based on packet delivery ratios (forward packet delivery ratio and reverse packet delivery ratio).

The authors in [11] propose a congestion-aware routing protocol (CoAR) which utilizes the selection of an alternative parent to alleviate the congestion in the network. The proposed mechanism uses a multi-criteria decision-making approach to select the best alternative parent node within the congestion by combining the multiple routing metrics. Moreover, the neighborhood index is used as the tie-breaking metric during the parent selection process when the routing score is equal. In order to determine the congestion, CoAR adopts the adaptive congestion detection mechanism based on the current queue occupancy and observation of present and past traffic trends. The proposed protocol has been tested and evaluated in different scenarios in comparison with ECRM and RPL. The simulation results show that CoAR is capable of dealing successfully with congestion in LLNs while preserving the required characteristics of the IoT applications.

III. Modified ETX-AODV

The proposed Modified ETX-AODV aims to improve the reliability and energy consumption of the network. To optimize the number of connections a relay node has with the sensor nodes, the relay nodes will connect the sensor nodes for which RSSI is maximum. This will ensure that distance between the sensor nodes and relay nodes is minimum.

Once the connectivity with the relay nodes is ensured, the relay nodes will start the broadcasting process as defined in the normal AODV. In the proposed scheme, the relay nodes located in the same ring will not forward RREQ packet to the other relay neighbor nodes which are in the same ring. The RREQ packets will be broadcasted from outer to the inner rings only.

When the RREQ packet reaches the sink node located in the center of the network, the sink node will execute the RREP phase. Since the RREP packet is unicasted among the nodes, (the congestion is less as compared to the RREQ broadcasting phase) it will give apt measure of reliability when the ETX is computed for RREP packets. Thus, when the RREP packet reaches the respective relay nodes, the ETX will be computed as:

$$ETX = 1/\text{Reverse } k$$

The relay nodes will choose the path having maximum ETX value. Now the sensor nodes can gather their data at the respective relay nodes and relay nodes will forward the data via inner relay nodes to the sink node.

IV. RESULTS

The performance of both the schemes was analyzed based on packet delivery ratio, remaining energy and throughput of the network.

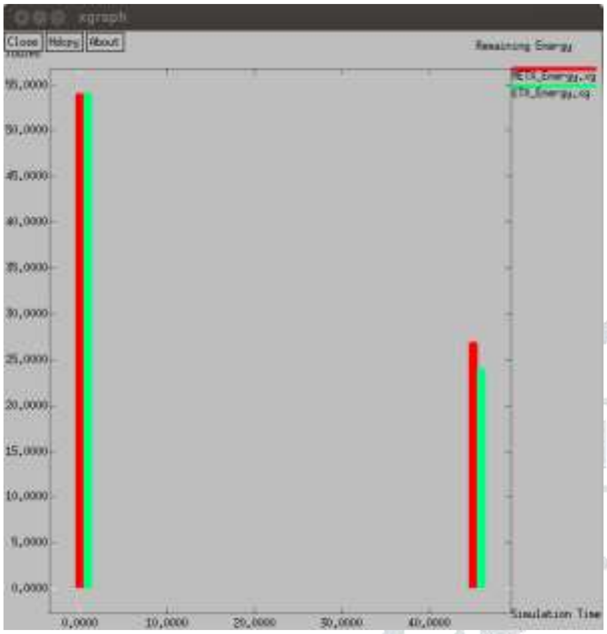

Figure 4.1: Remaining Energy Comparison

This figure shows the value of remaining energy obtained for both the schemes. The initial average energy of the network was 54 Joules. The energy remaining for the proposed scheme was 26.79 Joules and for the existing scheme was 23.85 Joules.

Figure 4.2: PDR Comparison

This figure shows the value of packet delivery ratio obtained for both the schemes. The value of packet delivery ratio was less for both the schemes initially, this was because of congestion created during the broadcasting phase. The final value packet delivery ratio for the proposed scheme was 95.7 and for the existing scheme it was 93.8.

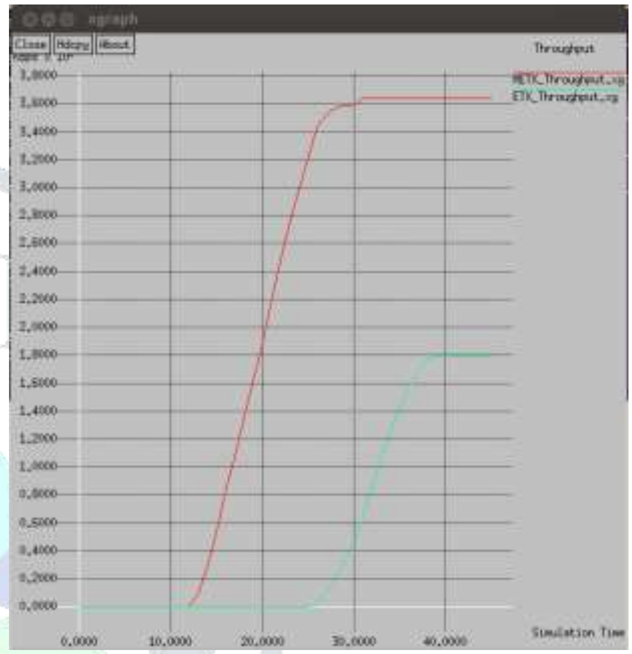

Figure 4.3: Throughput Comparison

This figure shows the value of throughput obtained for the schemes. The value of throughput was 3641 Kbps for the proposed scheme and 1792 Kbps for the existing scheme.

Parameter\Scheme	ETX-AODV	METX-AODV
PDR	93.8	95.7
Remaining Energy	23.85 Joules	26.79 Joules
Throughput	1792 Kbps	3641 Kbps

Table 4.1: Results Comparison

V. CONCLUSION

The study evaluated the ETX-AODV and Modified ETX-AODV in network simulator. The proposed scheme allows the relay nodes to broadcast towards the inner side and not to the relay nodes in the same ring (as it would eventually lead to formation of the longer paths). This reduces congestion in the network and is the reason for the less packet drops and higher throughput of the network. This reduced broadcasting also consumes less energy in the network. Thus, the improved parameters help us to conclude that the proposed scheme outperforms the existing scheme.

This work considers the concept of the relay node because the number of source nodes are more. In such scenarios, the concept of the clustering can also be considered in the future work.

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