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AN EFFICIENT DELAY AWARE ROUTING PROTOCOL FOR REAL TIME SYSTEMS IN WIRELESS SENSOR NETWORK

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ABSTRACT

Many of Applications have got much attraction of Wireless Sensor Networks (WSNs) due to its multi features with low cost and are getting more and more advancements. Usually in WSN, nodes are deployed in a region to sense the events and send the sensed data towards the sink(s) or a base station through single/multi-hop communications. However, real time systems have its specific QoS requirements which are different from usual WSN applications as the data packets must be delivered in time deadline. In this study we propose an efficient delay aware routing protocol (EDARP) in order to enhance the QoS parameters and to satisfy the end to end delay and reliability requirements of real time WSNs applications. Delay-aware routing protocol (DARP) sustains a continuous speed of data delivery to provide the best communication in real-time. The proposed protocol is compared with state of art protocols for different simulation scenarios and the results show that EADRP has got better performance in terms of end to end delay and reliability.

Keywords: *Wireless Sensor Network, Real Time, Reliability, Routing Protocol, QoS*

1. INTRODUCTION

The Latest developments in wireless sensor network (WSNs) infrastructures, less energy consuming, low cost sensor nodes and microcontrollers allow a high quality monitoring application ranging from a small area to huge geographical regions. A WSN typically consists of large number of nodes deployed in a region which sense the area for events and send the data to a base station or sink through multi-hops [1][2]. The sensor nodes in WSN application can be static or movable depends upon the requirements of application and the environment. These nodes can be deployed by two deployment schemes, regular deployment and random deployment. In the former scheme the sensor nodes are deployed based on predetermined topology while in the later method the nodes are deployed randomly such as to throw the nodes from a plane in a specific area [3]. An effort of providing real time data communication has been carried out; however application specific requirements regarding dynamic changes due to heterogeneous environment are not considered and they have mostly focused on congestion control [4].

Most of WSN protocols depend on the nature of application and their objectives change according to various application. [5] For example, several WSN applications have requirements of real-time data transmission and cannot afford more delays, as data received with much delay will be impractical e.g., a fire detection application may depend on on-time updating of temperature to be alert of the present fire situations [6,7][8][9] while a non-critical soil monitoring application can send data reports on hour bases. Consequently, a delay-aware routing protocol must satisfy the requirements of end to end delay at the cost of low energy[10]. Therefore, characteristic and features of nodes with all requirements in the architecture must be considered in the design of new routing protocols[11]. In the literature researcher have proposed various routing protocols; however these protocols focused the maximization of network lifetime, most of them are not providing any guaranteed performance of QoS in terms of minimization delay which is a requirement in real-time, delay-sensitive and critical applications. A routing protocol must be able to consider the below features which will be discussed in detail in Section 2, real time communication, reliability. A new Efficient and delay-aware routing

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protocol (EDARP) is proposed in order to address the above mentioned QoS parameters. DARP enhances the communication delay by selecting a best and optimum path, improves reliability performance by enabling the nodes to know their multiple paths towards sink node.

Further we discuss this paper in different sections. An introduction of different routing protocols of WSN is discussed in Section 2. Section 3 explains the proposed EDARP protocol and the process of its all phases. Section 4 presents the simulation results of the proposed. And finally Section 6 discusses the conclusion of this paper.

2. ROUTING PROTOCOLS IN WSN

In WSNs there are three types of routing protocols in WSN, Flat Routing, Hierarchical routing and Location based routing [6]. In flat-based routing, every sensor node in the network has the same functions and roles equally. On the contrary hierarchical routing, nodes play diverse functions in the network. However location based routing use nodes' locations to the direct the data in network. A routing protocol can be called adaptive when it is able to control specific performance parameters to adjust the changes as according to the network situations. A routing protocol should have the capability to establish performance metrics which are utilized to compute quality of links or paths with the aim of minimizing packet deliver loss ratio and to fulfill the requirements of applications. It should also be able of re-computing the paths in case of dynamic changes in the network [14].

In previous works, routing protocols have been focused a lot but as they vary with the nature of different applications and network architecture. A solution is to be sought for clustering in wireless and Ad hoc networks since these methods are mostly tempting for dense and large scale applications. In Hierarchical based routing there are two tiers or more than two tiers scheme, the upper tier and lower tier. Sensor nodes placed in upper tier in upper tier perform as backbones and are known as CHs while sensor nodes located in lower tier are responsible for sensing and the data is transferred to Base stations through CHs [15]. [16] Stated that multi-tier WSNs networks are more scalable and provide more benefits over single tier networks in terms of enhanced reliability, low cost and improved coverage. Numerous algorithms in clustering have been explored, in routing framework and independently in the previous works. Some of them have been reviewed in this section. LEACH [15] is clustering routing protocol that utilizes randomized variation of CHs role to equally divide the energy capacity among the network nodes. [17]LEACH works very well for monitoring applications constantly with periodic data gathering to a centralized station. LEACH is founded on the amount of suppositions that limits its efficiency in different applications, such as single hop communication in authors' view.

[15] Proposed a new evolutionary based routing protocol (ERP) to improve the unwanted actions of Evolutionary Algorithms in to order to handle clustering routing problems in WSN by defining a novel fitness function which integrates two clustering features, separation error and viz. cohesion. Its main purpose is to improve the network energy while requiring more modifications in awareness of node heterogeneity.

3. PROPOSED PROTOCOL (EDARP)

In this section, EDARP protocol is proposed to consider the QoS parameters of WSN which, end-to-end communication delay, reliability and energy consumption. The key feature is to design a model to provide real time communication by using the number of hops (NH) parameter. Furthermore we consider the residual and expected energy of node to achieve the efficient energy. EDARP also adopts a retransmission scheme of lost packets based on error rate to improve reliability. The EDARP algorithm offers a real time data delivery by using number of hops. In EDARP, transmitting packets are divided in three types: (1) Updated Control messages (UCM), 2) packets retransmission request (PRR), 3) Actual data packet (ADP). Every node in the network gets information about their neighboring nodes by receiving the UCMs for example node ID (NID), NH towards sink and location of the nodes. UCMs received by nodes dynamically update the related information of their neighboring nodes. If a node doesn't receive ADP successfully it requests the sender node for the lost packet by sending the PRR to retransmit. The source node transmits the ADP to sink through hop-by-hop retransmission.

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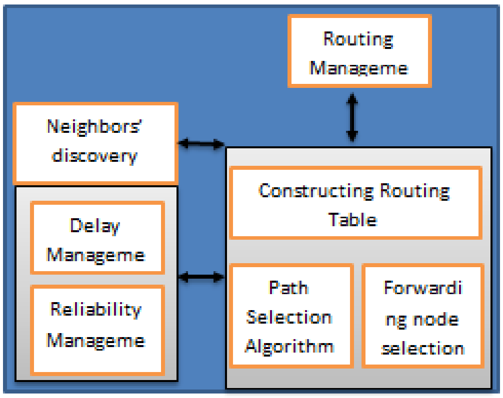

Figure 1: EDARP Protocol Block Diagram

3.1 REAL TIME TRANSMISSION

In this section we do analysis of the routes for data transmission and select the best relay sensor node that have minimum end-to-end delay in order to perform the transmissions in real time. There are two routes in figure 2 to send the data to the sink, if we consider only energy constraint here then route 1 will be decided for the data to be sent towards sink but will have much end to end delay which in this case we do not select as our focus is on minimizing the delay factor in order to have on time transmission. So here route 1 will be selected according to less NH value. If we select route 2 its better in terms of energy it will have less energy cost but as it is far from the sink in case of number of hops so it will have much end to end delay. So in order to have minimum delay route 1 will be selected in this case. The EADRP protocol selects the routes on the basis of required delay Dr Value. It can be calculated as following

$$D_{ave}(x,S) = Db + Dt + Dpr = RTT / 2$$

$$D_p(x,s) = NH_{(x,s)} / NH_{max} \quad (1)$$

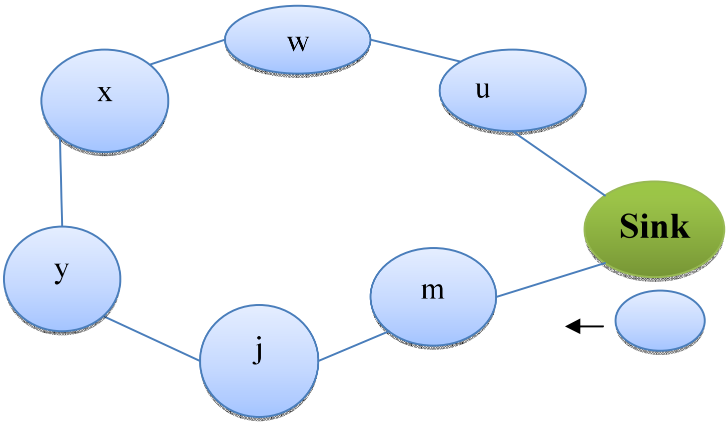

Figure 2: Example Minimum latency Sensor Node

Route 1 : Cx,w ,Cw,u,Cu,sink

Route 2: Cx,yCy,j,Cj,m,Rm,sink

Equation (1) is considered for the selection of routes when the transmitting node wants to send a packet from node x to sink s where Dm denotes the minimum end to end delay from node x to sink and channel is represented by C. The routing depends on optimal forwarding decision that takes into account of the link quality, packet delay time and the remaining power of next hop sensor nodes.

Input: source node (x) routing table information of NH(x,s)
Output: route selection based on minimum delay
1) Initiate
2) Broadcast route requests
3) Each node receives message stores the value of number of hops (NH) towards sinks
(4) If New NH < already stored NH
(5) Update the value
(6) Else reject
(7) For each path do
(8) While (Dp(x,s) <= Dr) then
(9) Transmit the packet
(10) End while
(11) Wait for the time threshold (TT)
(12) If PRR received
(13) Go to step 8
(14) Else
(15) If destination is sink node
(16) End the transmission
(17) Else
(18) Go to step 8
(19) End if
(20) End for

EDARP Algorithm

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Parameters	*Value*
Network area	*100m × 100 m*
Number of nodes	*10 -100*
Sink	*1*
Transmission rate	*250kbps*
Mac type	*802.15.4*
Simulation time	*1000s*
Traffic type	*Constant Bit Rate (CBR)*
Packet size	*32*

4. METRICS OF PERFORMANCE EVALUATION

In order to evaluate the proposed EDARP Protocol simulation are performed on the following metrics.

4.1 END TO END DELAY

En to end delay is defined as the time as the average time spent in the transmission of data from a source node to sink node on the optimum selected path [18] and most of the latest researches have focused this parameter for quick and on time packet delivery [19]. Here average time delay is considered from sender x to sink s is represented by D_{ave} which is the combination of maximum delays which can be occurred processing, queuing, propagation and retransmission in the network.

$$D_{ave} = \frac{1}{NH}\sum_{x}^{n}(D_s - D_x)$$

Where D_s is the packet time delay received at sink node and D_x is the packet time delay at sender node when transmitting packet.

4.2 PACKET DELIVERY RATIO

Delivery ratio of Packets is a QoS parameter which can be used to evaluate the performance and data transmission of in a network and considered as one of main measurement parameter of network reliability and robustness. It is the ratio of successful packet delivery at the time of transmission.

5. EXPERIMENTAL RESULTS

In this section the simulation tool NS2 is used to evaluate the performance of our proposed approach and the results are shown in figure 3 and figure 4 for improved end to end delay. In our approach we adopt a network model that contains a large number of static nodes deployed in 100 m × 100 m Area and distributed uniformly. The energy of sink is assumed as infinite and nodes with same

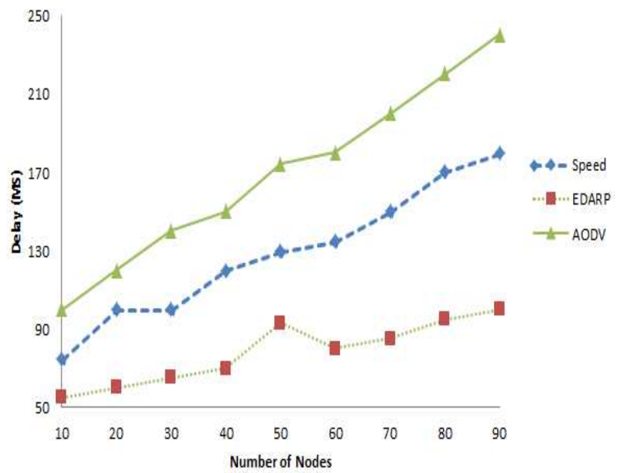

Figure 3: End To End Delay With Different Number Of Nodes

energy initially. A node failure or node dead occurs when its energy gets below the threshold value and unable to sense or send the data. The network

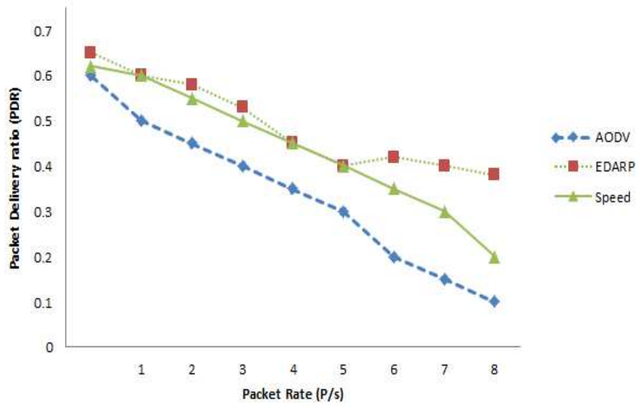

Figure 4: Packet Delivery ratio

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connections are assumed to be active and every sensor node is able to communicate with the neighboring nodes. The bandwidth of the network is taken as 250Kbps. The comparison of end to end delay performance and packet delivery ratio is compared with state of art techniques Speed protocol and AODV as shown in figure 2 and figure 3. In this experiment we have taken different number of nodes and have noted the end to end delay of the simulation. The results show that the proposed protocol has better performance as compare to these approaches.

6. CONCLUSION

WSNs have been focused mostly for energy betterment and enhancement and have many protocols and techniques proposed in order to solve this issue. However, in this work we propose an efficient delay aware routing protocol in order to overcome on the issue of real time and reliable data delivery for sensitive and critical WSNs applications. In our proposed protocol we target QoS parameter delay and reliability and solve it using small number of hops value and calculating the cost function in order to select the relay node and best with minimum end to end delay. The proposed protocol is examined and evaluated for the performance by carrying out the simulations of different scenarios and compared with state of the art protocols speed and AODV.

Conflict of Interest:

The authors declare no conflict of interest

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