Impact of Traffic Heterogeneity on SEARCH Routing Algorithm for WSN
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Abstract:
Routing is an attractive area in wireless sensor networks for attempting to make it more efficient in terms of energy and other constraints imposed by revolutionary technologies. After emergence of Internet of Things, the new challenges also identified in which one of them are heterogeneity in terms of data rate (or traffic generation rate). Various kind of Heterogeneity like energy, link and computational was handled by many researchers but the consideration of data rate or heterogeneity was not attempted. This paper does an attempt to incorporate the traffic heterogeneity in existing routing algorithm SEARCH and studied its effect. The simulation results show that performance of an existing routing algorithm like SEARCH is affected and it is not able to handling traffic heterogeneity in a proper way.

Keywords: Wireless Sensor networks, Routing, Traffic heterogeneity.

I. INTRODUCTION
Recent developments in sensing technology along with computing and networking become a reason for advent of revolutionary technology like IOT (Internet of Things). Consideration of heterogeneity and interoperability of various subsystems has become inevitable. The fundamental units of IOT are WSN (Wireless Sensor Network). Earlier WSN was used to monitor the various phenomena by considering the homogeneous nature of the network. WSNs having applications in areas form day to day life activities, healthcare sector to agriculture sector [1]. In WSN the sensor nodes are used to deploy randomly or fixed (need prior location information) to monitor particular events. Our life becomes smarter and so our cities also need to be smart. IOT making possibilities for simple day to day activities get monitored and objects get connected [2]. And IOT becomes possible because of WSN. The sensors employ in WSN unit of IOT, may have different capabilities in various aspects. In other word we can say that heterogeneity is unavoidable in such case. Sensor node does work of sensing and monitoring of physical phenomenon and then these data must send to sink. How these data will reach to sink node in energy efficient manner will depend on the routing approach adapted. One of the famous ways of sending data is clustering based routing. In clustering based routing sensor nodes are grouped into different clusters and the data are sent to CH (Cluster Head). The cluster head aggregates the data and finally send it to sink node (or Base) Station. In clustering Based routing schemes in WSN have assumptions that all nodes are equipped with equal resources (initial energy, transmission range, data generation rate, computational capabilities etc.). The various kind of heterogeneity handled by previous work are mainly energy, link and computational.

The heterogeneity of data generation rate in WSN is an interesting area. Haibo Zhou, et al. [3] proposed a novel stable selection and reliable transmission protocol for clustered HWSN to consider the residual energy and energy consumption rate of nodes. Li Xiaoya, et al. [4] considered a network model, which having different energy consumption rate for half of the nodes deployed in sensor field and shown that how well known routing algorithm, LEACH [5]. Energy consumption of node is directly related with packets sent by data to node and distance with receiving node.

Most of the routing protocols developed earlier made consideration of homogeneous network model. In homogeneous network model, there are equal distributions of resources among nodes. Many routing schemes also considered that heterogeneous kind of environment. But most of them concerned with unequal distribution of initial energy (Energy heterogeneity) and different transmission range (Link heterogeneity). The variation in energy consumption rate (Traffic heterogeneity) considered by very few. The network model, considered traffic heterogeneity is inspired by IOT.

The routing protocols developed for homogeneous environment are not able to exploit the heterogeneous environment. The well known clustering based protocol LEACH developed with assumption of homogeneous environment. The SEP [6] tries to incorporate the provision for taking advantage of energy heterogeneity in routing protocol. In [7] the impact of traffic heterogeneity considered for both protocol i.e. LEACH and SEP. Both schemes, LEACH and SEP having fixed thresholding value for CH selection of nodes. Although, the SEP considered the two type of thresholding value for CH selection one is for normal sensor nodes and energy heterogeneous nodes. SEARCH [8] adopts a stochastic approach for CH selection. It varies the values of threshold by boosting or deteriorating on the basis of range of the nodes.

In this paper, we have analyzed effect of traffic heterogeneity of nodes’ in clustering based routing protocol, especially for SEARCH. The rest of this paper is organized as follows. In Section II, an overview of the proposed system model has been presented. In Section III, the incorporation of the traffic heterogeneity in routing protocol (SEARCH) is done, and its effect is studied. The simulation results have been discussed in Section IV. And finally concluding the paper is in section V.

II. SYSTEM MODEL
To study the effect of traffic heterogeneity in WSN routing protocol, the SEARCH has been considered as base algorithms. This protocol suggests better way of CH selection than SEP and LEACH in presence of energy heterogeneity among the nodes. In our assumption everything is same but...
approach and different packet length is assumed for prolonging reliable period of the network.

The reliable periods of WSN network operation are stable period and somewhat the usable period. In stable period all the nodes are alive and work smoothly. In this period network operates with its full sensing capabilities. It covers till first dead node is emerging. Usable period includes the rounds from first dead node emerging to half alive nodes surviving. In the usable period the sensing capabilities of WSNs comes to medium level. In the weak sensing period, the rounds cover from half alive nodes surviving to the end of WSNs operating. Sensing capabilities of WSNs decreases sharply in this period.

In figure 1 first order radio model considered in order transmitting a b-bit message over a distance d, the energy spent by the radio is given by

\[ E_{Tx} = \begin{cases} 2 \cdot E_{ele} + b \cdot E_{fs} \cdot d^2 & \text{if } d < d_0 \\ 2 \cdot E_{ele} + b \cdot E_{mp} \cdot d^2 & \text{if } d \geq d_0 \end{cases} \]

Where \( E_{ele} \) is transmitter energy dissipation or the receiver circuit dissipation, \( E_{fs} \) and \( E_{mp} \) depend on the transmitter amplifier model (free space or multipath). The \( d \) is the distance between the sender and receiver and

\[ d_0 = \sqrt{E_{ele}/E_{mp}} \]

The energy spent to receive a b-bit message is given by

\[ E_{Rx} = b \cdot E_{ele} \]

Here, number of sensor nodes deployed in particular region of interest are 100. Size of ROI is 100m x 100m. Table 1 displays the details of simulation parameters of system model considered. Here traffic heterogeneity and energy heterogeneity both are considered.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Number of Sensor Nodes</td>
<td>100</td>
</tr>
<tr>
<td>FOI</td>
<td>Field of Interest (100m x 100m)</td>
<td></td>
</tr>
<tr>
<td>BS Location</td>
<td>Location of Sink Node (Base Station) (50m, 175m)</td>
<td></td>
</tr>
<tr>
<td>( E_{ele} )</td>
<td>Radio electronics energy</td>
<td>50 nJ/bit</td>
</tr>
<tr>
<td>( E_{DA} )</td>
<td>Energy dissipation per bit for data aggregation</td>
<td>5 nJ/bit</td>
</tr>
<tr>
<td>( E_{fs} )</td>
<td>Radio amplifier energy (free-space model)</td>
<td>10 pJ/(bit.m²)</td>
</tr>
<tr>
<td>( E_{mp} )</td>
<td>Radio amplifier energy (multipath)</td>
<td>0.0013 pJ/(bit.m³)</td>
</tr>
<tr>
<td>( E_o )</td>
<td>Initial normal node energy</td>
<td>0.25 J</td>
</tr>
<tr>
<td>l</td>
<td>Packet bit length</td>
<td>2000 bits</td>
</tr>
<tr>
<td>b</td>
<td>Traffic heterogeneity factor</td>
<td>3</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>Energy heterogeneity factor</td>
<td>3</td>
</tr>
</tbody>
</table>

In this section before incorporating traffic heterogeneity, we have simulated SEARCH protocol without traffic heterogeneity in the same condition of system model discussed in section II.

Figure 2 shows the simulation of SEARCH (Stochastic Election Approach for Heterogeneous Wireless Sensor Networks) is done in the presence of only energy heterogeneity. The \( m=0.3 \), the fractional value of heterogeneity parameter m is considered.
Figure 3 shows the plot of SEARCH algorithm after incorporating traffic heterogeneity i.e. SEARCH-TH (SEARCH with Traffic Heterogeneity). Here the same value of fractional m is taken but the traffic heterogeneity are applied on both type of sensor nodes i.e. energy heterogeneous nodes and normal sensor nodes. The numbers of nodes are same in both cases.

IV. RESULTS AND DISCUSSION

In results of figure 1 and figure 2, the node deployment in the field of interest (FOI) is kept fixed along with above mentioned fractional variation. Emergence of dead nodes occurs early after incorporating the traffic heterogeneity. This indicates that stable period is decreased after incorporation of traffic heterogeneity for m = 0.3. In figure 2 the stable periods come below 500 rounds in comparison of earlier case when there was no traffic heterogeneity. The stable period for SEARCH algorithm without traffic heterogeneity and the only energy heterogeneity is more than 500. This indicates that SEARCH algorithm is not capable to handle the traffic heterogeneity in a proper way. The decreasing, stable period observed in algorithm incorporated with traffic heterogeneity due to the length of packets transmitted is directly proportional to energy consumption rate of sensor nodes.

V. CONCLUSIONS

The traffic heterogeneity is possessing new challenges for existing routing algorithms of WSN. It needs to handle by using some different approach. The long weak sensing period for second case is observed. It indicates that the routing protocol losing its control over network operation. Since more stable period means more control of routing algorithm over WSN network operation. The future scope of this paper is that the traffic heterogeneity incorporation may be varied for different group of nodes. The development of a new routing algorithm to handle such issues in a proper way will be in its extended version of paper.

VI. REFERENCES


