Improving QoS of TCP/IP Sensor Networks Using Novel Gateway Approach

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Abstract
Wireless Sensor Networks (WSNs) are extensive systems made out of little sensor hubs with constrained PC assets able for social event, information preparing and imparting. Remote sensor systems are made out of an expansive number of radio-prepared sensor gadgets that independently frame a system, through which sensor hubs are fit for detecting, handling and imparting among one another. Ubiquitous registering in WSNs from the viewpoint that detected information can be utilized rather than the client without any gateway transforming available information. Ubiquitous Sensor Network for Development (USN4D) incorporates in its layers components which provide sharp information dispersal and large restriction of data to meet the prerequisites of creating view. For the creating ubiquitous sensor network TCP/IP protocol is implemented for efficient utilization of available resources with low power and available bandwidth. The main objective of this research is to improve the performance of the ubiquitous wireless sensor network environment by adopting TCP/IP protocol stack in wireless sensor network. The Efficient Clustering concept is employed here to increase the access control and also to increase the QoS parameter of the network. The new type of gateway approach is used to make the clustering more efficient which also leads to increase the lifetime of the ubiquitous network. The duty of the sender is to send the data to the base station and the duty of the base station is only to receive the data which was sent by the destination. But in this multi-hopping method the intermediate hop nodes are continuously working for the process of data transmission. Thereby the energy efficiency of that intermediate hop nodes are gradually reduced throughout the data transmission and drained completely at the particular point. If it is drained before the end of the data transmission then the communication is affected and the data were lost. If the sensors are working till the end means also the energy consumption which is taken for this transmission is very high then that will generally reduce the energy efficiency of the network likewise the life time of the wireless sensor network is also reduced which automatically leads to reduce the QoS parameters of the network. To overcome these kinds of drawbacks in the network,

Keywords: Ubiquitous Sensor, QOS (quality of service), TCP/IP network, Onboard Gateway Approach.

Introduction
In the wireless sensor network, large number of sensors are deployed in the particular region with the base station. To calculate the performance of the network they are determined by the Quality of service parameters. The general quality of service parameters are Total remaining energy, Average remained energy, Energy differences, packet delivery ratio, average end to end delay, average number of hops, control packet overhead, throughput, data packet sent, data packet received, Total transmission time, Total delivery time, total number of intermediate nodes, minimum number of intermediate nodes, maximum number of intermediate nodes and the threshold values. The network performance is calculated with the help of this parameters. Here the communication is carried out in the way that, one among the ordinary node will act as the sender and the base station is the sink. The network performance is calculated with the help of these parameters. The duty of the sender is to send the data to the base station and the duty of the base station is only to receive the data which was sent by the destination. But in this multi-hopping method the intermediate hop nodes are continuously working for the process of data transmission.

Related Work
To increase the network life time the concept of clustering is introduced. To increase the network life time the sink relocation concept is introduced [1]. By using the forward aware factor in the wireless sensor network the energy efficiency of the network is increased [2]. The Lifetime-Balancing Data Collection Protocol for Heterogeneous Wireless Sensor Networks reduces the delay and increasing the energy [3]. By proper node localization with the Probability Density Function Targeting Energy-Efficient Node Deployment method the energy efficiency is increased [4]. Energy Efficient Grid Based Clustering and Routing Algorithms for Wireless Sensor Networks increases the lifetime of the network [5].

Proposed System

TCP/IP Protocol Stack

Sensor networks as a family member of wireless networks should be integrated with TCP/IP network to provide meaningful services. To present a new solution to connecting ubiquitous sensor networks with TCP/IP network. After the integration of sensor networks and TCP/IP networks IP based designing model is adopted for analyzing the sensor ID since the internet user and sensor network does not have information about working model by hiding the sensor ID. Since it deploy virtual IP addresses in gateway rather than bring any modification to sensor networks protocols, sensor networks can still freely choose the optimized routing protocol which is Node-Centric or Locate ion-Centric based. Furthermore, Internet users can easily and directly access some special sensor nodes via virtual IP addresses. Sensor networks which are physically located in different locations may use totally different routing protocols for their specific applications. If these sensor networks have gateways which have virtual IP addresses, then it is very easy to integrate them into one virtual network without modification on existing protocols.

Onboard Gateway Approach

After receiving the packets from sensor networks, gateway first bases on packet’s Sensor ID/Location to find out the created packet, then through the mapping between the created packet and the original packet gateway can easily find out the original packet. By analyzing the original packet, gateway can get the User IP and then create the new packet. Before sending this new packet, gateway will delete the corresponding original and created packets to save the storage space of the database. In this mechanism, the onboard gateway is used to assist TCP sources to decouple the performances of congestion control and error control in TCP. The onboard gateway serves to eliminate congestion and assign bandwidth resource while the TCP source acts to retransmit the lost packets only. The onboard gateway has the duty of collecting information about the bandwidth delay product (BDP) of the satellite link and the number of TCP flows as well as carrying out a fair assignment of the bandwidth to each flow. The window size of each TCP source is defined by the onboard gateway, does not reduce in case of packets dropping. Because the sum of window sizes of all active TCP sources in the onboard network equals to the BDP, the utilization of network resources can be maximized resulting in avoidance of any congestion. As this onboard-gateway-based mechanism (OGBM) is only concerned in the onboard network, it is well compatible because it dispense with the need for modification of the protocols in the satellite and ground networks

Topology Discovery

The topology is constructed based on the Top-Disc Algorithm (TDA) using own path cost metric. In route discovery process, the request from the source is sent to the destination. The acknowledgement received by the source from the destination for the topology discovery process. TDA is derived from the simple greedy log(n)-approximation algorithm to find the set cover. TD differs from the trivial approaches in its response mechanism. Only a subset of nodes is selected to respond back to the topology discovery queries. The union of neighborhood lists of the selected subset of nodes forms the approximate topology of the network. The subset chosen is such that each node in the network is either a part of the subset or is a neighbor of a node in the subset. Thus the subset is a dominating set for the network and should have minimum cardinality for optimal consumption of resources. A coloring algorithm that finds an approximate solution to the above problem in a distributed manner and compares well to a centralized solution of the same.

The different colors and their definitions are given below. White node represents yet undiscovered node, or node, which has not received any topology discovery packet. Black represents cluster head node, which replies to topology discovery request with its neighborhood set and grey node which is covered by at least one black node i.e. it is neighbor of a black node.

Clustering

There are mainly two architecture are present in the network for the process of data transmission. The first one is the flat architecture which the sensors directly send the data packets.
to the Base station. In this kind of network during the process of communication the energy consumption is increased because the data has to travel long range to reach the Base station. To overcome this drawback the concept of clustering is introduced. Here the energy aware clustering method consists of four main divisions. They are cluster head creation, cluster formation, gateway creation and the cluster retransmission in the cluster. Cluster Head Creation- The cluster head is chosen dynamically according to the network formation. In the maximum conditions the centralized sensors are chosen as the cluster head. Cluster formation- The cluster head sends the request to the neighbor nodes to form its own cluster. Here the gateways are helpful for the inter-cluster communication. In the clustering function the same sensor is working as the cluster head for the entire data transmission. Due to this continuous functioning process the cluster head drain out its own energy and it causes delay and lack of energy efficiency. To overcome this drawback we proposed the cluster head retransmission in the energy aware clustering process. In this energy aware clustering method the threshold value are fixed. If the cluster head sensor reaches the threshold value then automatically the cluster retransmission is occurred inside the cluster. By the process of cluster head retransmission the energy efficiency of the network is saved comparatively. Here the threshold value is denoted as “h”.

**Data aggregation**

Here the cluster head nodes performs the action of data aggregation which means collecting the data from the ordinary nodes after collecting all the data its sends to the base station or to the neighboring cluster head with the help of the gate ways.

**Cluster formation**

In general, the cluster is referred as the formation of the group of nodes in the network. Various protocols used for cluster formation. They are mobility based, non-mobility based. The mobility based scheme is sub divided into direction based and non-direction based protocol. Direction based protocol is used for cluster formation in this paper. The TD algorithm is used for cluster formation. The node which initiates the topology discovery request is colored black and broadcasts a topology discovery request packet. All white nodes become grey nodes when they receive a packet from a black node. Each grey node broadcasts the request to all its neighbors with a random delay inversely proportional to its distance from the black node from which it received the packet. When a white node receives a packet from grey node, it becomes a black node with some random delay. In the meantime if it receives any packet from some other black node, it becomes a grey node. Again the random delay is inversely proportional to the distance from the grey node from which the request was received. Once nodes are grey or black, they ignore other topology discovery request packets.

**Cluster Head Formation**

At the end of the TD topology discovery process, the sensor network is divided into n clusters and each cluster is represented by one node, which is called the cluster head. The cluster head is able to reach all the sensor nodes in the cluster directly because they are all within its communication range. On behalf of using the cluster and the cluster head concept in the network we can increase the tolerance of the network. The network monitoring are also increased by using this concept.

**Network Formation**

In the Efficient clustering method, the sensor deployment is carried out by the Network formation, Region Division, Number of node calculation, Coverage area calculation, and Probability calculations for regions.

**Number of region**

<table>
<thead>
<tr>
<th>Number of region</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sensors</td>
<td>100</td>
</tr>
<tr>
<td>Base Station</td>
<td>1</td>
</tr>
<tr>
<td>Sensors in region A</td>
<td>20</td>
</tr>
<tr>
<td>Sensors in region B</td>
<td>24</td>
</tr>
<tr>
<td>Sensors in region C</td>
<td>24</td>
</tr>
<tr>
<td>Sensors in region D</td>
<td>20</td>
</tr>
</tbody>
</table>

The sensors present in the edges between two regions are 12. The total coverage area of the network is 1200*1200. The X-coordinate is 1200sq. The Y-coordinate is 1200sq. The regions are equally divided into four parts. The area allocated for individual region is 500*500. The number of dead nodes after the deployment is 10. In that 8 nodes are present in the regions and 2 nodes are present in the edges.

**The General Formula for the Probability of the regions is given:**

\[
\text{Probability of region} = \frac{\text{Sensors in region}}{\text{Total number of sensors}}
\]

**Probability of region A:** Sensors in region A is 20 and the total number of sensors are 100. So the probability of region A is given as,

\[
\text{Probability of region A} = \frac{20}{100} = 0.20
\]

**Probability of region B:** Sensors in region B is 24 and the total number of sensors are 100. So the probability of region B is given as,

\[
\text{Probability of region B} = \frac{24}{100} = 0.24
\]

**Probability of region C:** Sensors in region C is 24 and the total number of sensors are 100. So the probability of region C is given as,

\[
\text{Probability of region C} = \frac{24}{100} = 0.24
\]

**Probability of region D:** Sensors in region D is 20 and the total number of sensors are 100. So the probability of region D is given as,

\[
\text{Probability of region D} = \frac{20}{100} = 0.20
\]

These are the process for the node deployment method. The random process is carried out. According to the probability of the region, the sensors which are present in the edges are allocated in this process. In this network, there are 10 sensors are dead after the deployment. In that 10 sensors 2 sensors are from the region A, 2 sensors are from the region B, 2 sensors are from the region C, 2 sensors are from the region D, and balance 2 sensors are present in the edges.

\[
\text{Probability of region} = \frac{\text{Sensors in region}}{\text{Total number of sensors}}
\]

**Probability of region A**

- Probability of region A = \( \frac{20}{100} = 0.20 \)
- Probability of region B = \( \frac{24}{100} = 0.24 \)
- Probability of region C = \( \frac{24}{100} = 0.24 \)
- Probability of region D = \( \frac{20}{100} = 0.20 \)
The probability Calculations without the dead sensors:

Probability of region A without the dead sensors: Sensors in region A is 20, the total number of sensors are 100 and the number dead sensors present in the region A is 2. So the probability of region A without the dead sensors is given as,

\[
\text{Probability of region A} = \frac{\text{Sensors in region A} - \text{dead sensors}}{\text{Total number of sensors}} = \frac{20 - 2}{100} = 0.18
\]

Probability of region B without the dead sensors: Sensors in region B is 24, the total number of sensors are 100 and the number dead sensors present in the region A is 2. So the probability of region B without the dead sensors is given as,

\[
\text{Probability of region B} = \frac{\text{Sensors in region B} - \text{dead sensors}}{\text{Total number of sensors}} = \frac{24 - 2}{100} = 0.22
\]

Probability of region C without the dead sensors: Sensors in region C is 24, the total number of sensors are 100 and the number dead sensors present in the region A is 2. So the probability of region C without the dead sensors is given as,

\[
\text{Probability of region C} = \frac{\text{Sensors in region C} - \text{dead sensors}}{\text{Total number of sensors}} = \frac{24 - 2}{100} = 0.22
\]

Probability of region D without the dead sensors: Sensors in region D is 20, the total number of sensors are 100 and the number dead sensors present in the region A is 2. So the probability of region D without the dead sensors is given as,

\[
\text{Probability of region D} = \frac{\text{Sensors in region D} - \text{dead sensor}}{\text{Total number of sensors}} = \frac{20 - 2}{100} = 0.18
\]

The probability for the region A and the Region D is low when compared with the probability of the region B and the region C. Then there are 10 sensors are present in the edges but two sensors are dead sensors in that edge sensor. So that 2 sensors are neglected. So now there are 8 sensors are present at the edges.

The sensors which are present at the edges between the region A and the region B are three sensors. The sensor 94, 95 and 96 are the edge sensors. In that the sensor 95 is the dead sensor. So the balance 2 sensors are allocated to region A. The sensors which are present at the edges between the region A and the region C are three sensors. The sensor 97, 98 and 99 are the edge sensors. All this three sensors are active sensors. In this, the sensor 97 and 98 is allocated for the region A and the sensor 99 is allocated for the region C.

The sensors which are present at the edges between the region C and the region D are three sensors. The sensor 88, 89 and 90 are the edge sensors. All this three sensors are active Sensors. All these sensors are allocated for region D because of the less probability. The sensors which are present at the edges between the region D and the region B are three sensors. The sensor 91, 92 and 93 are the edge sensors. In that the sensor 92 is the dead sensor. In the balance 2 sensor, one sensor is allocated for the region D and another one sensor is allocated for the region B.

Now, The total number of sensors allocated for the region A without the dead sensor is 22. The total number of sensors allocated for the region B without the dead sensor is 23. The total number of sensors allocated for the region C without the dead sensor is 23. The total number of sensors allocated for the region D without the dead sensor is 22.

Parametric Analysis

The main parameters which are concentrated by using this protocol was Total remaining energy, Average remaining energy, Energy differences, Packet delivery ratio, Average end to end delay, Average number of hops, Control packet overhead, Throughput, Data packet sent, Data packet received, Simulation end time, Total delivery time, Total number of hop, Maximum number of hops and the minimum number of hops.

Results and Discussions

The Calculation for various parameters are given which leads to increase the QOS of the network.

The delay difference between the WSN network and the TCP/IP clustered Ubiquitous network is given.

The Energy consumption between the WSN network and the TCP/IP clustered Ubiquitous network is given.
The data loss between the WSN network and the TCP/IP clustered Ubiquitous network is given.

The Packet Delivery Ratio between the WSN network and the TCP/IP clustered Ubiquitous network is given.

The Routing Overhead between the WSN network and the TCP/IP clustered Ubiquitous network is given.

Conclusion

The main objective of this research is to improve the performance of the ubiquitous wireless sensor network environment by adopting TCP/IP protocol stack in wireless sensor network. The Efficient Clustering concept is employed here to increase the access control and also to increase the QoS parameter of the network. The new type of gateway approach is used to make the clustering more efficient which also leads to increase the lifetime of the ubiquitous network. To connect different type of network with increased quality of service (QOS) parameters novel onboard gateway approach will be adopted in ubiquitous network which uses TCP/IP protocol. The parameters which are used to increase the life time and the QOS parameters are Total remaining energy, Average remaining energy, Energy differences, Packet delivery ratio, Average end to end delay, Average number of hops, Control packet overhead, Throughput, Data packet sent, Data packet received, Simulation end time, Total delivery time, Total number of hop, Maximum number of hops and the minimum number of hops. Compared with the Existing Wireless sensor network, the proposed network produce high QOS (quality of service parameters) which also increased the life time of the ubiquitous sensor network.

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