Journal of Information & Communication Technology
Vol. 4, No. 1, (Spring 2010) 19-37

Designing of Energy aware Quality of Service (QoS) based routing protocol for Efficiency Improvement in Wireless Sensor Network (WSN)

Mansoor-uz-Zafar Dawood*
Institute of Business &Technology, Biztek, Pakistan

Noor Zaman*
Abdul Raouf Khan*
Mohammad Salih*
King Faisal University Saudi Arabia

ABSTRACT

New advancements in Wireless Sensor Networks (WSN), lead to many novel routing protocols specifically designed by considering QoS and energy efficiency as the main objective, to maximize the whole network efficiency and lifetime. As the issue of Quality of Service (QoS) provisioning in WSN networks has been acquiring increasing importance, particularly in view of the domains of application of these networks i.e., defense operations, emergency rescue missions, Health and Multimedia traffic, where we have need of more accuracy and guarantee for timely data transfer, therefore, to fulfill the requirements of these real time applications associated with wireless sensor networks, it is required that more reliable and dependable energy aware QoS based routing protocol in WSN should be developed for the usage of sensor nodes efficiently.
The objective of this research is to focus on challenges related to the architecture and operation of handling QoS routing traffic in sensor network and designing an energy-aware QoS based routing protocol for Wireless Sensor Network (WSN) which will stumble on least cost, transmission energy, error rate and other communication parameters to enhance the efficiency of WSN performance in Military, Health and Environmental applications.
The tasks of the research project started with the deep Investigation of the problem requirement followed by Designing, Development, Simulation, Modeling and Finally comprehensive analysis of the simulation results. Two approaches, WSN Nodes with normal condition (Before any assumption) and WSN Nodes after Secondary Route & Gateway assumption a part, are used. Both approaches works fine and reduces the congestion of the network along with enhanced energy life, resulting the QoS of the network and increased energy efficiency in sufficient amount

INSPEC Classification : B6150, B1130, C5640, D5020

Keywords : Energy efficient WSN , WSN routing protocol, Location aware, QoS, Quality of service

* The material presented by the authors does not necessarily portray the viewpoint of the editors and the management of the Institute of Business and Technology (Biztek) or King Faisal University, Saudi Arabia.

* Mansoor-uz-Zafar Dawood : dr.mzdawood@biztekian.com
* Noor Zaman : nzaman@kfu.edu.sa
* Abdul Raouf Khan : raoufkhan@kfu.edu.sa
* Mohammad Salih : salihmk@kfu.edu.sa

1. INTRODUCTION

As we know that many new routing and MAC layer protocols have been proposed for WSN network and most of them trying to resolve the resource constrained for unattended wireless sensor environment. The majority of all the protocols mainly concentrate on energy efficiency of sensor nodes, however sensor application have very important role specially in critical applications like the defense and health where the accuracy and guaranteed data transfer timely is an important issue. In the same way with some more specific sensor applications where the data type is mainly image and movie is suppose to be transfer, we required more accuracy and guarantee for timely data transfer. Hence transfer of data in such cases mainly requires QoS aware routing network management in order to ensure efficient usage of the sensor nodes. With this project we will focus on operational and architectural challenges of handling QoS routing traffic in sensor network and propose a new mechanism for QoS based routing protocol.

QoS always have very important role in all types of network , including conventional, wireless ad hoc and wireless sensor network. QoS routing is performed usually through resource reservation in a connection oriented communication in order to meet the QoS requirement for each individual connection. While couple of different mechanisms have been proposed for routing QoS constrained image and video type of data in wire based network [22][23][24][25][26], they cannot be directly applied to wireless network, because of its different architecture, structure and resource constraints. Therefore several new protocols have been proposed for QoS routing in wireless networks taking the dynamic nature of the network into account [27][28][29][30][31]. Some of the proposed protocols consider the imprecise state information while determining the routes [27][28].

While specially in wireless sensor network, many QoS based routing protocols have been proposed but they normally make their primary metrics to energy consumption, and they can be grouped on the basis of the problem they solve, like

Prioritization: Differentiate services on the basis of the definition of classes of traffic (Q-MAC [42] , SAR [48])
Timeliness: Guarantee delivery within a given time (MMSPEED [37], SPEED [38], DEED [40], Data Relaying in Hierarchical WSNs [34])
Reliability: Support probability of delivery (MMSPEED [39], REINFORM [36])
In Network Processing: Improve the performance of the network by processing data along the path from the source to the destination (Q-DAP & LADCA [48])
Scheduling: Coordinate sensors in accessing channel or in sensing the environment (CoCo [41], MAC Coding [45], Scheduling with Quality of Surveillance [39] , EAD [35], QoS Reliability of Hierarchical Clustered WSNs [46])
Node relocation: Change node position in order to increase efficiency (Sink Repositioning [33], SAFER [47])
Generic metric minimization: Improve the performance of the network with respect to some cost function (Energy-Aware QoS Routing [32], Dynamic Routing [43], DAPR [44])

As sensor network have some specific applications like Military and health, where very high precession is required otherwise the complete application becomes useless and all the above work is not fully fulfilling its requirement.

2. LITERATURE REVIEW

Wireless Sensor Network (WSN) is a wireless network consisting of small nodes with sensing, computation, and wireless communications capabilities [3]. Each sensor collects data from the monitored area (such as temperature, sound, vibration, pressure, motion or pollutants). Then it routs data back to the base station BS [5]. Data transmission is usually a multi- hop, from node to node toward the base station.

Communication architecture of WSN, almost the same as of conventional networks, only the difference is because of mobility, It consist five layer instead of seven layer like the conventional model but it contain three different plane, Task Management Plane, Mobility Management Plane and Power Management Plane.

Mobility makes different WSN from the conventional network type and mobility also causes the main issues in WSN routing. When a mobile node needs to initiate communication with a certain destination terminal, a routing operation is necessary to find a route from the source to the destination [12]. The conventional on demand routing protocols ask for network wide flooding to discover routs [12, 17]. As wireless sensor networks consist of hundreds to thousands of low-power multi functioning sensor nodes, operating in an unattended environment, with limited computational and sensing capabilities so Sensor nodes are equipped with small, often irreplaceable batteries with limited power and computation capacity and the service is bound to the data and to the application QoS vs QoI (Quality of Information) [1], QoSu (Quality of Surveillance) and data delivery can be continuous, event-driven, query-driven, or hybrid. An important concern is the QoS of network.

3. QUALITY OF SERVICE (QOS) IN WSN

Requirements of QoS in WSN are different from wired networks. E.g. traditional end-to-end QoS parameters may not be sufficient to describe them. As a result, new parameters are used to measure the QoS performance in WSN [50]. The existing researches related to the QoS in WSN can be classified in three categories [49]: traditional end-to-end QoS, reliability assurance, and application-specific QoS.

QoS always have very important role in all types of network , including conventional, wireless ad hoc and wireless sensor network. QoS routing is performed usually through resource reservation in a connection oriented communication in order to meet the QoS requirement for each individual connection. While couple of different mechanisms have been proposed for routing QoS constrained image and video type of data in wire based network [22][23][24][25][26], they cannot be directly applied to wireless network, because of its different architecture, structure and resource constraints. Therefore several new protocols have been proposed for QoS routing in wireless networks taking the dynamic nature of the network into account [27][28][29][30][31]. Some of the proposed protocols consider the imprecise state information while determining the routes [27][28]

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As sensor network have some specific applications like Military and health, where very high precision is required otherwise the complete application becomes useless and all the above work is not fully fulfilling its requirement.
WSN networks Characteristics such as loose network state information, dynamically varying network topology unrestricted mobility of hosts, unrestricted mobility of hosts , limited availability of bandwidth, and battery power make QoS very demanding.

4. WSN ROUTING

The IEEE 802.11e MAC protocol specifies an enhanced distributed channel access mechanism (EDCA mechanism) with adjustable parameters, providing differentiated access to wireless stations. The EDCA protocol is discussed in [51, 52, 53, 54, 55, 56] in order to enhance its performance. A modified EDCA protocol with dynamical contention control mechanism (DCC) for real-time traffic in multi-hop ad hoc network is discussed in [51]. A simple adaptation scheme is proposed in [52], where the access point adapts the contention window based on the network conditions.

The main problem of the original EDCA is that the values of the main parameters of each Access Categories queue (AC) (such as contention window limits) are static and do not take into account wireless channel conditions. An approach to split the conflict windows per AC into different sub-windows is presented in [53]. This method decreases channel collisions and maintains low delay and high throughput.

5. QOS-BASED ROUTING

QoS based routing in WSNs is a very challenging problem due to the inherent characteristics which differentiate such networks from other wireless networks such as ad hoc networks and cellular networks [8,16]. In recent years, many algorithms have been proposed for the routing issue in WSNs. The routing protocols can be classified into flat-based, hierarchical-based and location-based according to the network structure [9, 17]. The energy efficient routing algorithms in wireless networks have received considerable attention in the last few years. The minimum energy routing problem has been addressed in [11, 18, 13]. The minimum total energy routing approaches in these papers are to minimize the total consumed energy. The maximum network lifetime routing problem has been addressed in [12, 14, 10, 15, 19, 20, and 21].

QBRP is QoS based routing protocol, which simultaneously meets, the application requirements for low latency, high delivery reliability, uniform energy consumption and fault tolerance. It takes advantage of the interactions among sensors to provide a better QoS solution for WSN [57]
Sequential Assignment Routing (SAR) is first WSN routing protocols that introduces the QoS in the routing decisions. The objective of SAR algorithm is to minimize the average weighted QoS metric throughout the lifetime of the network. Another QoS routing protocol for WSNs that provides soft real-time end-to-end guarantees was SPEED, which can provide congestion avoidance when the network is congested.[58]
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The key issues of developing (QoS) efficient routing protocol include: **a)** Reliability, **b)** Data Redundancy, **c)** Unbalance traffic, **d)** Energy Balance, **e)** Multiple Sinks, **f)** Packet Criticality, **g)** Network Dynamics, **h)** Severe Resource Constraints, **i)** Real-time, **j)** Mobility, **k)** Multiple Traffic Time.

a. Reliability

Since messages travel multiple hops it is important to have a high reliability on each link, otherwise the probability of a message transiting the entire network would be unacceptably low. Significant work is being done to identify reliable links using metrics such as received signal strength, link quality index which is based on "errors," and packet delivery ratio. Significant empirical evidence indicates that packet delivery ratio is the best metric, but it can be expensive to collect. Empirical data also shows that many links in a WSN are asymmetric, meaning that while node A can successfully transmit a message to node B, the reverse link from B to A may not be reliable. Asymmetric links are one reason MANET routing algorithms such as DSR and AODV do not work well in WSN because those protocols send a discovery message from source to destination and then use the reverse path for acknowledgements. This reverse path is not likely to be reliable due to the high occurrence of asymmetry found in WSN. [6], and that become cause of lower QoS.

b. Data Redundancy

WSNs are characterized by high redundancy in the sensor data. However, while the redundancy in the data does help loosen the reliability/robustness requirement of data delivery, it unnecessarily spends much precious energy. Data fusion or data aggregation is a solution to maintain robustness while decreasing redundancy in the data, but this mechanism also introduces latency and complicates QoS design in WSNs[2] .

c. Unbalance traffic

In most applications of WSNs, traffic mainly flows from a large number of sensor nodes to a small subset of sink nodes. QoS mechanisms should be designed for an unbalanced QoS-constrained traffic.

d. Energy Balance

Load must be evenly distributed among all sensor nodes, in order to achieve long live of network, so that the energy at a single sensor node or a small set of sensor nodes will not be drained out very soon. QoS support should take this factor into account.

e. Multiple Sinks

There may exist multiple sink nodes, which impose different requirements on the network. For instance, one sink may ask sensor nodes located in the northeast of the sensor field to send a temperature report every one minute, while another sink node may only be interested in an exceptionally high temperature event in the southwest area. WSNs should be able to support different QoS levels associated with different sinks[2].

f. Packet Criticality

The content of data or high-level description reflects the criticality of the real physical phenomena and is thereby of different criticality or priority with respect to the quality of the applications [1]. QoS mechanisms may be required to differentiate packet importance and set up a priority structure.

g. Network Dynamics

Network dynamics may arise from node failures, wireless link failures, node mobility, and node state transitions due to the use of power management or energy efficient schemes. Such a highly dynamic network greatly increases the complexity of QoS support [2].

h. Severe Resource Constraints

The constraints on resources involve energy, bandwidth, memory, buffer size, processing capability, and limited transmission power. Among them, energy is a primary concern since energy is severely constrained at sensor nodes and it may not be feasible to replace or recharge the battery for sensor nodes that are often expected to work in a remote or inhospitable environment. As a result, these constraints impose an essential requirement on any QoS support mechanisms in WSNs: simplicity. Computation intensive algorithms, expensive signaling protocols, or overwhelming network states maintained at sensors are not feasible.

i. Real-Time

For some applications, messages must arrive at a destination by a deadline. Due to the high degree of uncertainty in WSN, it is difficult to develop routing algorithms with any guarantees [26]. Such a highly dynamic network greatly increases the complexity of QoS support.

j. Mobility

Routing is complicated if either the message source or destination or both are moving. Solutions include continuously updating local neighbor tables or identifying proxy nodes which are responsible for keeping track of where nodes are. Proxy nodes for a given node may also change as a node moves further and further away from its original location.

k. Multiple Traffic Types

Inclusion of heterogeneous sets of sensors raises challenges for QoS support. For instance, some applications may require a diverse mixture of sensors for monitoring temperature, pressure, and humidity, thereby introducing different reading rates at these sensors. Such a heterogeneous environment makes QoS support more challenging.

6. RESEARCH ISSUES

Quality of Service (QoS) issues in WSN networks receiving growing importance, mainly in view of the domains of application of these networks i.e., defense operations and emergency rescue missions.

From above discussion we came to know that many new routing and MAC layer protocols have been proposed for WSN network and most of them trying to resolve the resource constrained for unattended wireless sensor environment. There is a need to mainly concentrate on energy efficiency of sensor nodes, with QoS especially in critical applications like the defense and health where the accuracy and guaranteed timely data transfer is an important issue. In the same way with some more specific sensor applications where the data type is mainly image and movie is suppose to be transfer, we required more accuracy and guarantee for timely data transfer and to fulfill the requirements of these real time applications associated with wireless sensor networks, it is required that more reliable and dependable energy aware QoS based routing protocol for WSN for the usage of sensor nodes efficiently.

7. RESEARCH OBJECTIVES

In this research, we focused on challenges related to architecture and operation of handling QoS routing traffic in sensor network and designed an energy-aware QoS based routing protocol for Wireless Sensor Network (WSN) which find least cost, transmission energy, error rate and other communication parameters to enhance the efficiency of WSN performance in Military, Health and Environmental applications.

The simulation results of designed QoS based routing protocol are analyzed

- o To investigate the performance of WSN (QoS) routing protocol
- o To design new (QoS) efficient routing protocol for WSN
- o To increase the life cycle/ reliability of WSN
- o To enhance the (QoS) efficiency of WSN
- o To enhance the (QoS) for real time data transfer in WSN

8. RESEARCH DESIGN METHODOLOGY ADOPTED

The project design methodology is based upon the following activities

a. Deep investigation: For better understanding of the problem issues and to achieve reliable solution, deep problem investigation and literature review was done.

b. Designing & Development: In this phase, solution of the identified problem developed for onward analysis and efficiency reliability measures during modeling and simulation phase. For further improvement of the solution, the proposed solution was reconsidered, based on the analysis of the results of simulations.

c. Modeling & Simulations: As Simulation is "the process of designing a model of a real system and conducting experiments with this model for the purpose either of understanding the behavior of the system or of evaluating various strategies (within the limits imposed by a criterion or set of criteria) for the operation of the system." [16]. Therefore Modeling & Simulation is the main part of this research in which application of different simulations techniques were developed.

d. Analysis of the results and Final Submission
In this phase, a comprehensive analysis of the simulation results was carried out for the concrete solution of the problem.

9. PROBLEM STATEMENT NETWORK MODEL

Routing in WSNs have a primary task for transfer of data from source (sensor node) to the sink, in case data is available for transfer in resulting of any physical event occur or time driven query run at the sensor node. Initially routs defined by the nodes then nodes becomes able to send or receive the data by using those routing paths.

9.1 Problem Statement

An ample number of different routing protocol had been designed by the researchers, all protocols lays under different categories, based up on the network application and topologies. On the basis of topologies routing protocols may lays on following types.

1. Flat routing Protocols
2. Hierarchal routing Protocols
3. Location based routing Protocols

Among all topologies based routing protocols, hierarchal routing protocol technique is more popular regarding the power saving of sensor nodes. This technique works on the formation of several clusters (a sub network within network). Cluster are responsible to transfer data from node to the sink, while direct data sending approach from each node is not supported with this method. Clusters communication works on the basis of cluster leader which can be known as cluster head. Communication with sink can be done with the help of cluster head, they collect data from neighboring nodes and send it to another cluster head, who is responsible for any other cluster, this mechanism continuous until the data reaches to the sink. the current energy efficient routing protocols including LEACH, PEGASIS and HEED is also designed on the basis of clustering. The main issue with this method is cluster heads normally remain active for more time than other nodes in the cluster and resulting they lose their energy before other nodes. Another important concern is that it is hard to maintain the energy level of all sensor nodes at same level, and if cluster head loose it energy first then in that case, it is possible that we might lose one segment of network from our main network topology. Even though those routing protocols works fine up to a limited size of sensor network, but they are not suitable for large amount of networks, as they broadcast the message to find out their neighbors and also to form new clusters by finding new cluster heads. In this process they lose an ample amount of energy , and even assumptions which they made or not possible normally in real, such as LEACH assumes that all nodes are homogenous and equal in power while it is not in actual.

Hence it is high need to design an QoS based energy efficient routing protocol with assumptions which will be more closer to real, we are proposing a new QoS based protocol which will be more energy efficient than the existing one protocols.

9.2. Network Model

Our assumption for sensor network such as, sensor nodes are randomly distributed over an area of 200 x 2000 meters with following network properties.

1. Network is static and nodes are distributed in random format, while area is divided in equal square grid format while we consider randomly one region.
2. There exists only one base station, which is deployed at a fixed place in the center of the Area.
3. The energy of sensor nodes cannot be recharged.
4. Sensor nodes are not aware about their location.
5. The radio power can be controlled, i.e., a node can vary its transmission power.
6. Unusual sources events.

Above all assumption are on wide scope, assumption fifth is becoming the cause of energy saving, as nodes will be aware about their location and sink too, hence the amount of energy which normally network always use to find out the initial location will be save. This amount will be very considerable as a whole for small and large sensor network and become reason for enhancing its energy level.

10. TESTED TOPOLOGIES AND SCENARIOS

The entire simulation tests were conducted by using a very well known simulator by the research community NS2, by applying different topologies and different approaches. The few of those topologies are shown as under all topologies were basically cluster based topologies, sensor nodes were distributed within a area of 200 meters and then tested their routing capabilities in two ways, initially it was tested with a normal distribution, where the quality of data transfer and the nodes life were comparatively low than the second case because of the congestion of the routing path. While in second phase the same nodes were tested by applying our suggested approach which is actually based on two folds. Which are such as with first approach we proposed a secondary path for any un usual event is occurred (Consider the different events of battle field), in other words un usual events handled with the secondary paths while the regular events with regular routing paths. While with the second part of our approach is in case the energy level of any cluster head or gate way (G) is near to end it will change its status to a normal node while the secondary node which was already mentioned as a secondary cluster head will become the main and the transfer of data will be continue after a bit delay without losing its data. The second approach for the routing was tested more excellent in terms of it power saving and its QoS of data transfer, which we discussed with coming section of results with the help of simulation graphs. The entire scenarios and our proposed solutions scenarios are shown in following figures ranges from Fig 1 to Fig 7.

Figure 1
Simple Topology (Nodes distributed in simple fashion)

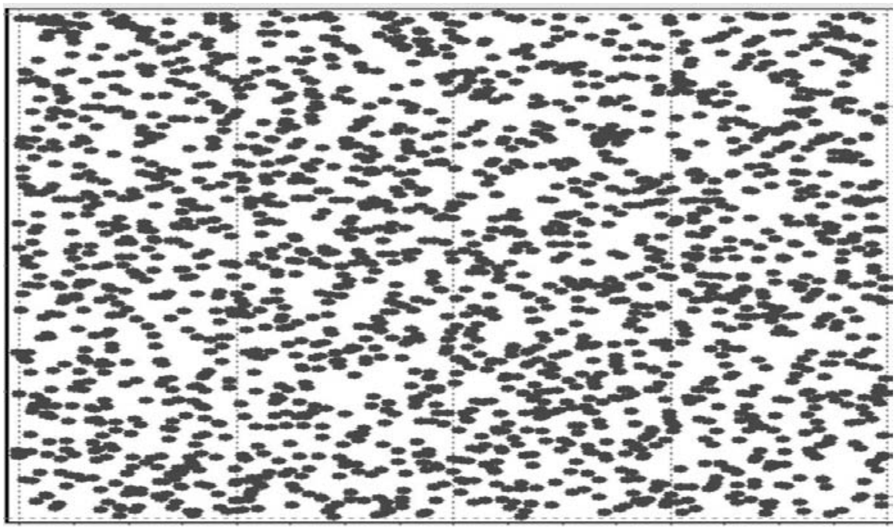


Figure 2
A Section of Sensor Nodes with it Gateway

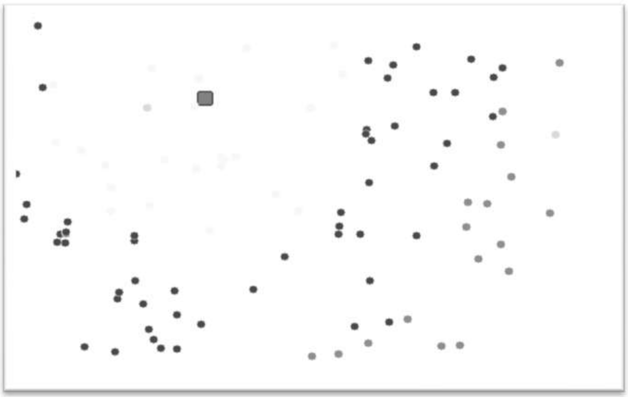
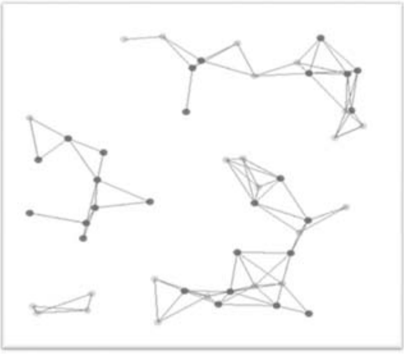


Figure 3
A Section shows the routing paths of Sensor Nodes



Figures ranging from 1-3 are showing the distribution of the sensor nodes in three different fashions. As in Figure 1 shows overall entire sensor node distribution for the entire area of 200X 200 meters. While the Figure 2 is showing a selected area or a cluster only, and the Figure 3 is showing the initial possible paths of the routing within the sensor nodes.

Figure 4
Congestion Caused by unusual events with routing paths.

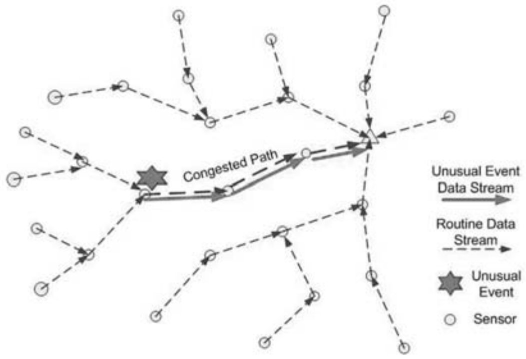
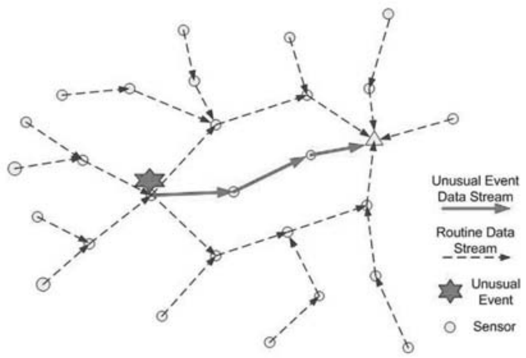


Figure 5
Different Routs for un usual and routine event.



Figures 4 & 5 are showing the normal data paths and congestion caused by the un usual event occurrence. While the figure 08 particularly showing our proposed approach in which two different routing path are suggested such as the primary path which is normally assigned for normal data carrying under the normal event occurrence case, however the another routing path is shown with red color is assigned to rout the data resulting if any usual event is occurred.

Figure 6
Primary Gate way (G) for receiving response of the sensor nodes.

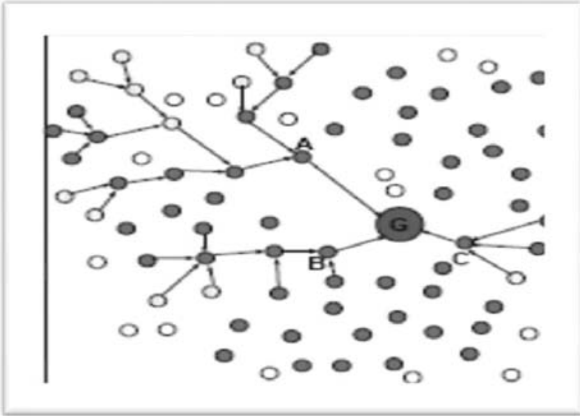
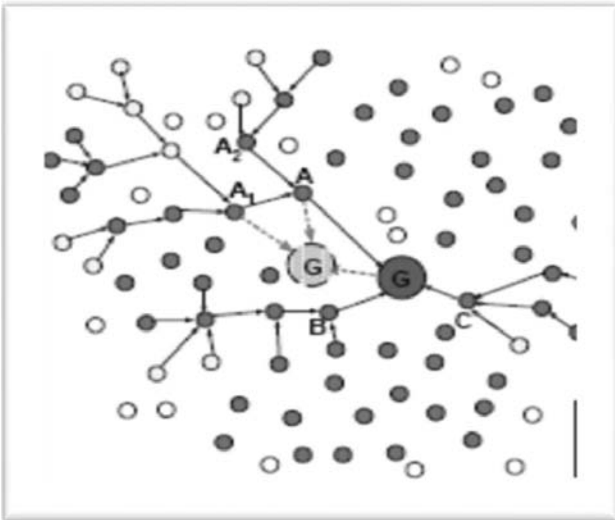


Figure 7
Secondary Gate way (G) for receiving response of the sensor nodes.



Figures 6 & 7 are showing two different approaches such as with Figure 6, its initially shows that the primary or first Gateway G is active for receiving the data in case of any event is occurred (until it has a reasonable amount of energy). While the with second case in Figure 7, it shows that in case if primary Gate way G is losing its energy and near to its dead level then the secondary Gate way as mentioned in the figure will be active as play its role as of primary G. Hence data transfer will be continue after a bit delay.

11. SIMULATION

11.1 Simulation Parameters

Simulation parameters were taken in account as shown in Tables 1 and 2

Table 1
Simulation Parameters.

Network area	200m*200m or 400m*400m
Number of sensor	100 or 400
Sensor distribution	Uniform random
Location of Sink	Center of area
Radio range	40m
MAC layer	IEEE 802.11
Unusual event sources	4
Routine data sources probability	p
Failure rate	f
Time-out constant ξ	$1/r$
Delay for retransmission M	0.02s
Data rate of unusual events	λ_U
Data rate of routine data	λ_R

Table 2
Simulation Parameters.

Network Filed	*(200 x200) in meters*
Node numbers	*100~400*
Cluster radius	*r 30 m*
Sensing radius	*rs 10 m*
Initial energy	*2 J*
Data packet size	*50 Bytes*
Broadcast packet size	*25 Bytes*
Ethreshold	*0.01 J*

As with earlier section, we already discussed that the entire simulations were done with the help of NS2 simulator, hence with this section few screenshot of the NS2 simulator during simulation available as shown in Figure 8. Screen shot show the animated tool NAM, which is commonly used for NS2 simulator for showing the graphical simulations and also helping for generation trace files. NAM is a graphical interface in which simulation controlling events are also available such as, to stop run, fast forward or slow motion available as under, during the active session of wireless simulation.

Figure 8.1
Screen shots of NS2 simulation for wireless sensor network

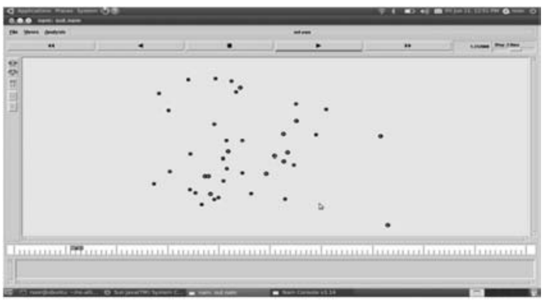
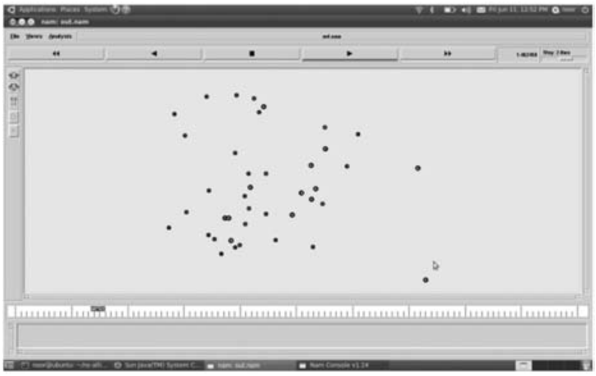


Figure 8.2
Screen shots of NS2 simulation for wireless sensor network

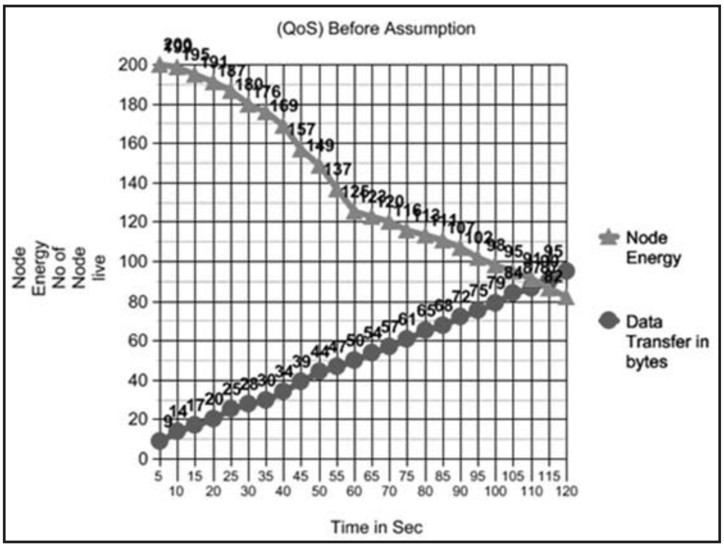


11.2 Results with Graphs

Case I: WSN Nodes with normal condition (Before any assumption):

The WSN QoS routing was tested in four different phases, with first phase it was tested with the normal random distribution of the sensor nodes over an area of 200X200 meter without any assumption. In this case the entire area is divided in to clusters and the Gate way G is placed in the center to collect the data in case of any event occurs. Graph 01 shows the result for this simple distribution where the no of the live nodes remain almost 82 out of 200 sample node after a certain period of time, while the network becomes able to transfer the data of 95 Bytes. The less data and the more number of sensor nodes died due the congestion in the network as shown in Graph 1.

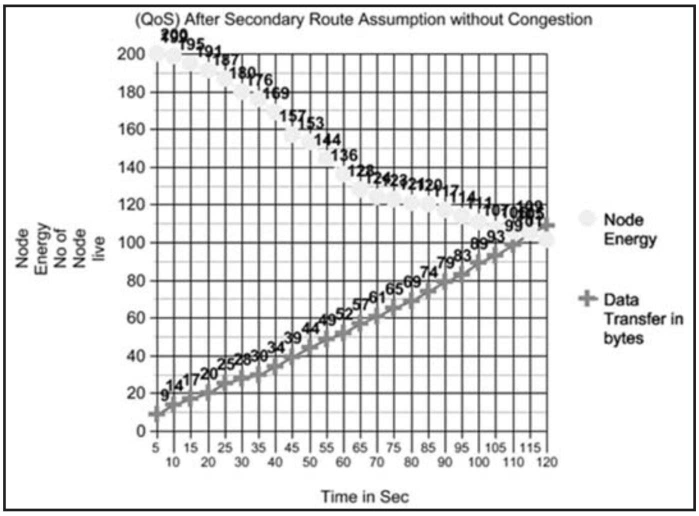
Graph 1
Simulation Results under normal conditions without any assumption



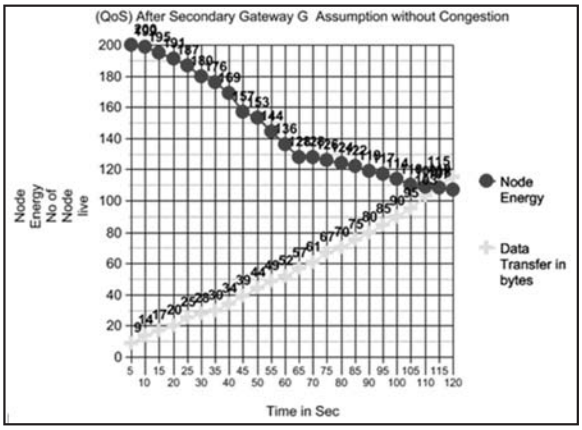
Case II: WSN Nodes After Secondary Route & Gateway G assumption a part:

In second case we try to apply our two assumptions one by one, the result after assumption first is shown in Graph 2, while the result after the assumption second is shown in Graph 3. With the first assumption we assigned two different routing paths in case any un usual event is occurred (consider the case of the battle field), the secondary path will be active without disturbing the primary path or without creating any congestion with the earlier path. As the congestion caused the loss of energy of sensor node lives along with it decreases the data over all data transfer rate which again reduce the QoS of the network. The result shows that after a certain time of operations a more good number comparable with case first were alive which were 109 nodes out of 200, while the data rate also increased up to 101 Bytes. This change is occurred because of assigning secondary path for un usual events.

Graph 2
Simulation Results After Secondary Route assumption for un usual events.



Graph 3
Simulation Results After Secondary Gate way (G) assumption

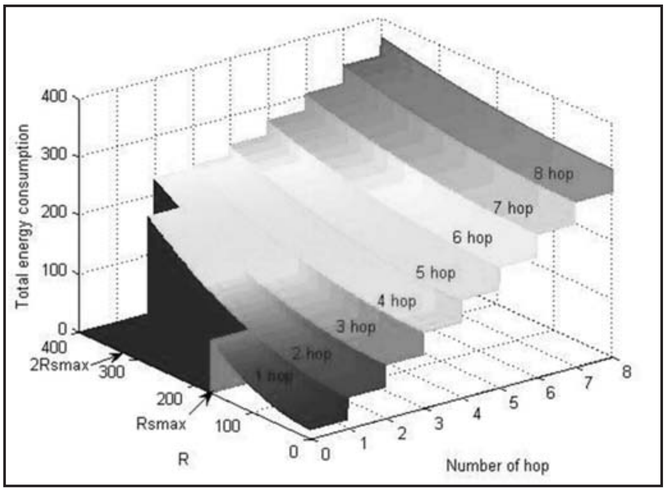


In same way with second approach, whose results are shown in Graph 3, we consider a secondary Gateway G , in case the first Gateway is near to dead because of its energy drain after a some time period, the secondary Gateway G will be active and within a sometime it will starts its operations. This is the main mechanism through which we try to solve the main issue, in which if the G is died it means all the sensor nodes has to go for new gateway and the entire search for G and its routing should be done again, and that needs more energy loss. The results show an impact of this approach which can be view thorough Graph 3. Where after a operation of certain time the more number of node were live as of 115 out of 200 and also a more data transfer rate of 115 Bytes.

Number of Hopes VS Energy Consumption

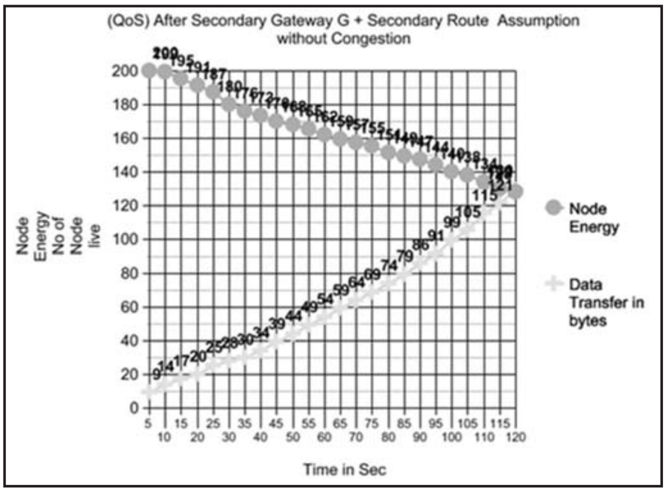
Graph 4 shows the result for entire energy loss process for all hopes with the help of different colors, it shows that during the initial hopes the energy level of the nodes were sufficient enough and it was shown with blue color. However when the numbers of hopes were going to be increased the energy level also drastically going down as shown it with graphs in different colors which were indicated in light blue and then yellow and finally towards red, which is the last level of energy and almost total energy were lost at this stage, while nodes almost died at this stage. [59].

Graph 4
Simulation Results show Energy Consumptions over number of hop.



Case III: WSN Nodes after Secondary Route & Gateway G assumption together: With case III, we applied our both assumptions together at a time and test the results through simulations. Results show a good difference when we apply both assumptions together, as shown in Graph 5. By applying both assumptions together it helps a lot in reducing its congestion and also enhances its energy efficiency level, resulting a good number of sensor node were remain live after a same certain period of time with a good data transfer rate which is as shown in the Graph 5. The number of the live nodes was 129 out of 200 while the data transfer rate was 121 Bytes. The overall results shows a significant difference if compare it with its normal case where the no of the nodes which were remain live after a certain time period of operation with data transfer rate was , 82 nodes with 95 Bytes of data, while after applying the both approaches the number of live nodes become 129 with a difference of 47 nodes with a data transfer rate of 121 with a difference of 26 Bytes. Which shows a significant change towards its energy efficiency and its QoS comparable with its normal case.

Graph 5
Simulation Results After the Secondary Route and Secondary Gateway assumption



12. FUTURE WORK

Due to distributed nature of WSN networks and their deployment in remote areas, the application of WSN become more meaningful even for very hard and valuable application's installations. In future we proposed another project based on wireless sensor network, which will focuses on reliability and security of huge pipeline infrastructures including Oil and Water infrastructure for the Kingdom of Saudi Arabia.

13. CONCLUSION

In this project we considered two different assumptions and apply them together at the same time. In our considerations we assigned a secondary route for any unusual event if occurs, and the secondary Gateway G in case of primary gateway losing its life because of the drain of its energy. Our both approaches works fine and reduces the congestion of the network along with enhances it energy life, resulting the QoS of the network along with its energy efficiency increases in sufficient amount, as shown and discussed with the graph and result sections.

15. ACKNOWLEDGEMENT

We must acknowledge Deanship of Scientific research, King Faisal University Saudi Arabia for funding this research and provided all kind of support as and when needed.

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