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Effect of QOS Class in Delivery Probability of WSN

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Abstract

The paper analyzes the effect of data retransmission in QoS parameters. A novel medium access control protocol which is based on 802.11 is designed, which doesnot have ACK facility from sink node is proposed. The source will only transmit sensed data, while sink or base station will only receive the data. Their operating capabilities are limited to satisfy this requirement.

QoS in a decentralized network with multiple sensors (sources), that do not have the capability to receive acknowledgements from the sink node. Here the nodes will listen to the channel before transmitting. If the channel is busy, then the node will wait until it gets free using binary exponential back off algorithm. The simulation result of basic mac algorithm and modified algorithms are analyzed. It shows that only carrier sensing is sufficient to handle the scenario which gives better result.

The model uses single hop retransmission scheme for WSN data transmission based on 802.11. The sensor nodes will transmit data and base station will receive. The nodes in the networks are divided in to different QoS classes so that different QoS requirements are fulfilled. The experiment is conducted using 802.11 wireless protocol. Nodes participating in the data transfer will perform with varied efficiency. So the nodes in the network can be divided into different qos classes. So that different qos requirements are full filled. The experiment is conducted for different 802.11 wireless protocols. Also application demands different qos requirements.

keywords - Sensor Networks, MAC, CTS, RTS

1 Introduction

This paper compares 802.11 basic protocol with 802.11 modified protocol. In the basic protocol, handshaking signals such as RTS, CTS, Data and ACK are followed. But this requires lot of energy and time for carrier sensing and handshaking signals.

In the present algorithm all these signals are avoided. Initially the channel is sensed for data. If the channel is busy then the transmission is delayed. Here carrier sense is performed and if required binary exponential or some backup algorithm is used in order avoid the colission, if the channel is busy. But once the channel becomes idle then immediately the data is transmitted. Here there is no small length signals like CTS, RTS, Ack. Due to these small duration handshaking signals, it is difficult for the competing nodes to detect the state of the channel. Here large amount of data will travel once the node starts sending.

QoS	Quality of Service
RTS	Request To Send (Packet)
CTS	Clear To Send (Packet)
MAC	Media Access Control

Table 1: Abbrevations

2 Related Work

To resolve the hidden terminal problem present in wireless networks, Karn originally proposed the use of Request-to-send and Clear-to-Send (RTS/CTS) handshaking scheme which is leading to the Multiple Access Collision Avoidance (MACA) protocol [2]. A number of extended protocols using this mechanism have been devised, including MACAW[3], FAMA[4], and others. These schemes all employ the basic RTS/CTS scheme described above, while including some modifications aiming at improving net performance. When low cost networks are considered, they must consume less power and their efficiency must be high. These networks are one hop communication range[6].

If the data is transmitted many times without checking the outcome [7], it wastes lot of energy in the sender side. Here as the traffic increses, hence collision and therefore data loss increases. Multihop routing in wireless sensor network increases end to end delivery [19]. Due to this reason one hop setup is a better idea. 802.11b protocol requires the use of many control packets such as CTS and RTS, whcih is unncessarily consume energy and bandwidth. In 802.11, when the transmitter sends, all the remaining nodes will listen to it, whether it uses the data or rejects it. This wastes lot of energy, if we remove reciever module from all these nodes we can save lot of receiving energy.

In CSMA the nodes with large packets usually win the contention [15]. Due to this reason in the new model only large data frames are sent directly, without CTS/RTS signals. In this model it has an underlying assumption that all hidden nodes are within the transmission range of receivers (e.g. to receive the CTS packet successfully) [16]. The RTS/CTS handshake of IEEE 802.11 does not work well as we expected in theory. It cannot prevent hidden terminal problems completely.

In CSMA protocol nodes with larger packets win the contention [rubin]. In the new model large data frames are sent directly without CTS/RTS signals, as all the nodes are within transmission range of receivers [xu]. The receiving signals power is inversely proportional to d^2 where d is the distance between sender and receiver [36], is within the Freznel zone when the distance is larger, then Receiving signal power is inversely proportional to d^4. (out of freznel zone)

In the open space environment, path loss of a signal is usually modeled as the TWO-WAY GROUND model. Assume d is the distance between receiver and receiver. When the transmitter is close to the receiver (e.g. within the Freznel zone [17]), receiving signal power is inverse proportional to d^2. When their distance is larger (e.g. outside of Freznel zone), the receiving signal power is then inverse proportional to d^4 [17]. When energy aware network [27] is considered then we need to concern over energy consumption model. The energy consumed needed to multiply by d^2 for open space energy model and d^4 for closed one. Here open space model is near to the node while closed is far away.

The simulation considersqos parameter which affect the delivery of data packets in one hop transmission range [6]. If the delivery is 100% then all nodes can be considered same and has no affect in performance of the network. But if some of the packets starts dropping then, it results in data loss which will degrade the quality of information transferred. There are networks were, the sensor will transmit and base station will receive, which are one hop distance away. These type of system requirement multiple retransmission faults which will ensure qos requirements fulfilled [7].

Channel reservation strategies help full to achieve good qos values [5].These types of allocation guarantees high energy efficient and delivery probability networks .

Application in areas such as industrial process automation, aircraft control systems or patient monitoring in hospitals requires predictable quality in terms of message transfer delay and reliability. [8]

Retransmission schemes are useful in improving transmission reliability in wireless network [9].We can rely on hop-by-hop(HBH) and end-to-end(ETE) retransmission schemes to improve the efficiency of the network. Qos based routing protocols support both periodic and event-driven data

reporting [10], that will guarantee minimum reliability required in the data transmission. Wireless sensor networks required to provide different levels of QoS due to various resource constraints [11].In such networks physical infrastructure is not available [12]. So all the nodes co-operate to ensure the proper management of the network. Geographical routing mechanism combined with the QoS requirements to provide multi-objective QoS Routing(MQoSR) [13] for different application requirements

Data transmission in straight line is very usefull in sending data for critical application as simulated in the paper [18]. This type of transfer is more effective in proactive routing[14].

3 CSMA CA

Alg. **1 : CSMA CA**
1. set back_off = 0
2. Use some persistent Strategy
3. Wait DIFS
4. Send RTS
5. Set a Timer
6. CTS received before timeout.
if yes go to 7
else go to 12
7. Wait SIFS
8. Send the Frame
9. Set a timer
10. Acknowledge received before timeout.
if yes go to 11
else go to 12
11. Success,algorithm termiatnes.
12. Increment Backoff.
13. Check Back limit = 1024
if yes go to 16
else go to 14
14. Wait Backoff time
15. go to 2
16. Abort and algorithm terminates.

In the above algorithm , The station [20] [21] need to wait for an time amount equal to DIFS, SIFS and IFS (not shown in the algorithm). SIFS is Shortest interframe space, used for Intermediate response actions. DIFS is distributed interframe space. This is the longest used as minimum delay for asynchrounous frames contending for access. IFS is a single unit delay.

RTS and CTS[22] frames are used to reserve access to the channel. RTS frame contains time for data frame to transmit and recieve acknoweldegement. CTS frame gives the sender the permission to send and instructs the other stations do not send for the reserved duration. Data frames are transmitted only after reservation.

4 CSMA CA - Only Carrier Sense

Alg. **2 : CSMA CA - Only Carrier Sense**
1. set back_off = 1
2. Use some persistent Strategy in carrier sensing
is media is busy
if yes go to 4
else go to 3
3. Send data and algorithm terminates.
4. backoff = 2 * backoff
5. If $backoff > 1024$ abort send

else wait for backoff time and goto 2

In this algorithm the station having data will just perform carrier sense. Once the medium becomes free it just transmits, without worrying about the result.

Sink node will only have the capability to receive the data transmitted by the source node, Which can only has the capability to send data. The source and sink node will have one hop communication range.

Due to elimination of handshaking signals base station has only receiving module. while senders having only transmitting and data sensing modules, which is used for media busy check and data collection operations. Due to this arrangement, we can save lot of energy consumed due to handshaking protocols. Since the data frame is large length the statuions can sense the media effectively. Here is to be noted that CTS, RTS signals, they are not occupy the channels fully, they will apear in the media only for some smaller duration. Since the stations cannot sense the media effectivly due to small packet length. Due to this reason there is high chance of collision. Here simultaneous transmission is more and hence more collions, more energy consumption.

4.1 Classification of QoS Classes

1) Single QoS class: Here all nodes in the deployments are treated equal. No classification is performed and so there is not necessary to run classification algorithm. At the nodes belongs to one class.

2) Double QoS class / Two QoS class: Nodes are classified into 2 QoS classes. If the high delivery probability nodes are allocated QoS1 which transmits higher priority data while nodes in the QoS2 class will be able to transmit the data which can tolerate losses. The total deployments is divided into two class of nodes, based on delivery probability they achieved in the Trail phase. It is assumed that the nodes belong to qos classes are equally divided equally, wrt radio range of the nodes, So that each node will find its next hop node with in its radio range.

3) Multi QoS class: Here more than 3 QoS classes are used. The data are of varying quality. The data which tolerate zero loss are send over high priorities class QoS1, while loss tolerable data is transmitted over the nodes having QoSn. Here the total nodes are divided into many qos classes. Applications running in the nodes may require different delivery probabilities.

4.2 802.11 Protocol

Before the transmitting the data, the node will sense the medium. In 802.11 with carrier sense, it will just sense the media and send the packet in 802.11 CTS/RTS signals are exchanged before actual data transmission, as described in the paper [1]

Alg. **3 : 2 QOS class**
Phase1: QOS-class-construction
1) Transmit data and receive data(Trail Data Transfer)
2) Calculate avg_dp
3) If $(avg\_dp > 0.65)$ then
Place the node set(S,R) at qos1
4) If $(avg\_dp < 0.65)$ then
Place the node set(S,R) at qos2
5) If $(avg\_dp > 0.25)$ then
Do not use that node pair in the experiment
Phase2: Real Data Transfer
1) If $(required\_qos\_dp > 0.65)$ then
Use the nodes having qos1
2) $(required\_qos\_dp < 0.65)$ Then
Use the nodes having qos2

Qos class	Delivery Proability
1	90 - 100
2	80 - 90
3	70 - 80
.	.
.	.
10	0-10

Table 2: Multi Qos Class

In the multi-QoS class the division of nodes based on delivery percentage whichis performed as shown in the above table

Alg. **4 : Algorithm Proper Node Selection**
Assumption-In every region, sufficient nodes are available which satisfy all the mentioned QoS class
1) The data generated by the sensor node needs to be transmitted to the base station which is at one hop distance away
2) The source will calculate the QoS class required
3) Suitable QoS class node is searched in the neighboring list (nqos1)
4) The data is forwarded to node(nqos1)
5) nqos1 will send data to the base station

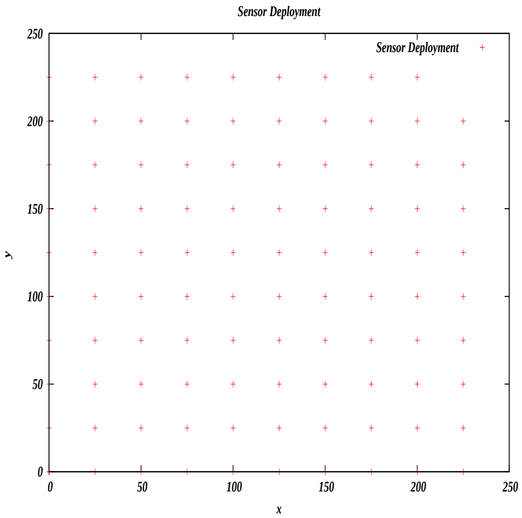

Fig. 1: Node Deployment

5 Simulation Arrangement

1.Deployment.

2.Schedule following activities every milli second.
a. Data Sense.
b. Data Send.

5.1 Deployment

The nodes are deployed in the 1st quadrant in a 250m * 250m area as seen in the diagram 1

The simulation is performed at n =100. And next it will be repeated for n=200,300 upto 500 nodes.

5.2 Data Sense

The data will be sensed by all nodes. After sensing the data they will store it in their memory. When there is sufficient data is sensed then packet is formed and the sensor is said to be activated.

5.3 Data Send

Once the sensor is activated it is ready to send data to base station. For this the station need to wait till the channel becomes free. The path is creation is not needed since the abse is at one hop distance.

5.4 Simulation Parameters - common to both algorithm

The parameters need to be considered are specified in [23] . Sensor nodes will consume enrgy when they are transmit, receive and sense for data. While calculating total energy spent during radio life, E_{tot}, [24] Enegry used for at transmitter ciruit , reciever circuit , sensing for data and during sleep. Here we need to consider percentage and the energy consumed in these operations.

$E_{tot} = E_{tx}P_{tx} + E_{rx}P_{rx} + E_{sp}P_{sp} + E_{sense}P_{sense}$
where
E_{tx} Energy Consumed for Transmision,
E_{rx} Energy Consumed for Reception,
E_{sp} Energy Consumed for Transmision,
E_{sense} Energy Consumed for Reception,
P_{tx} Percentage of time for Transmision,
P_{rx} Percentage of time for Reception,
P_{sp} Percentage of time for Transmision,
P_{sense} Percentage of time for Reception

The energy consumed is per second for convinience of calculation. In the literature, the standard unit energy, Joules is often used. One Watt-hour equals 3600 Joules.

Sensor nodes are configured to certain energy levels [25]. When the node performs its lifecycle operations energy is deducted from energy reserve.

In the simulation certain delay parameters are considered [26] They are :

1. Carrier sense delay
2. Backoff delay
3. Transmission delay
4. Sleep delay

5.5 Parameters used in the simulation

Particulars - description	Value
Programing Language	Java
range of a node	250 meters
packet size	500 bits
datarate - Trans rate	2Mbps
speed - prop delay	$2 * 10^8$ m/s
Simulation Time	5 Seconds
Area of Deployment	250m * 250m
Quadrant	1
Recv Power	175mW/sec
Trans Power	175mW/sec
Sensing Power	1.75mW/sec
Sleep Power	0.175mW/sec
Initail Energy	5000W-sec

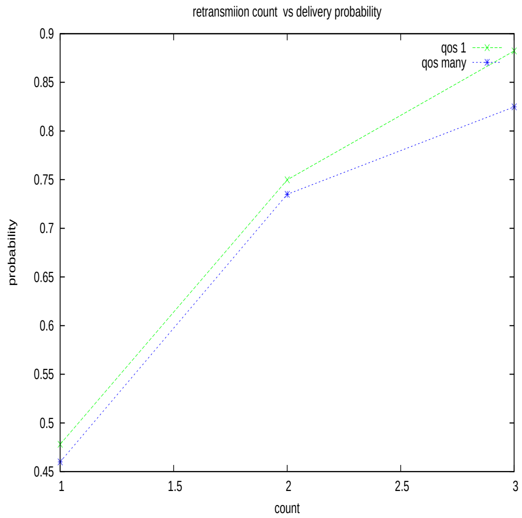

Fig. 2: Re-transmission count and Delivery Probability

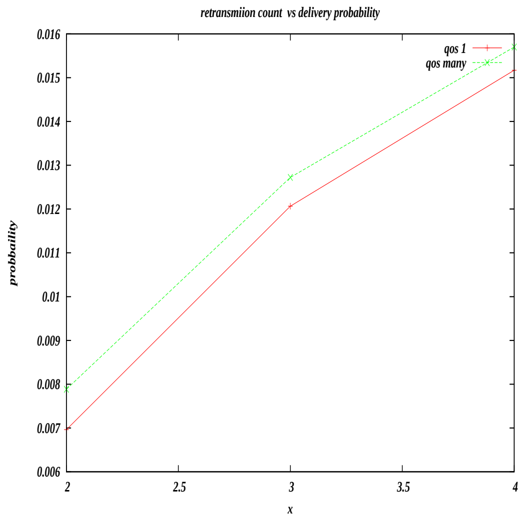

Fig. 4: Re-transmission count and Delivery Probability - Run-2

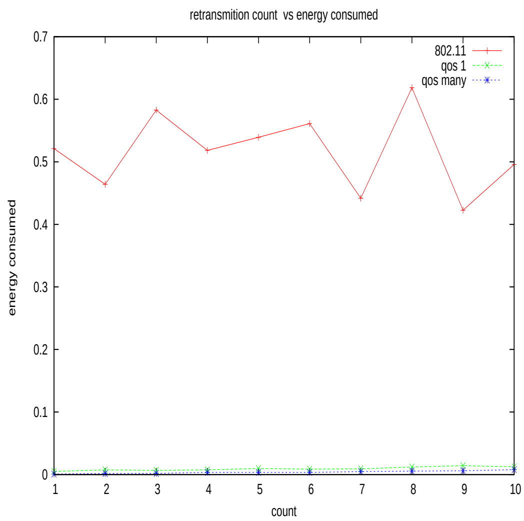

Fig. 3: Re-transmission count and Delivery Probability - Run-1

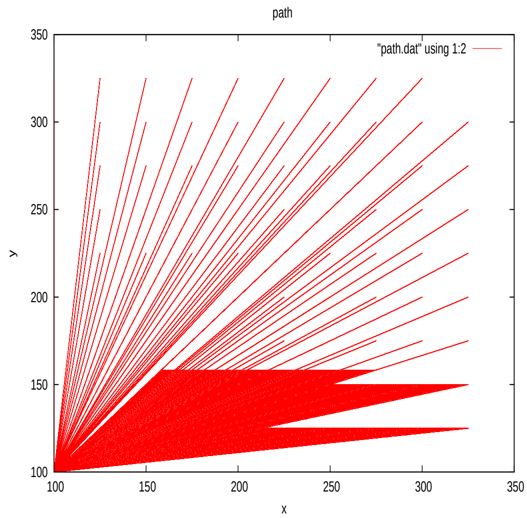

Fig. 5: All Data will Reach to the base station

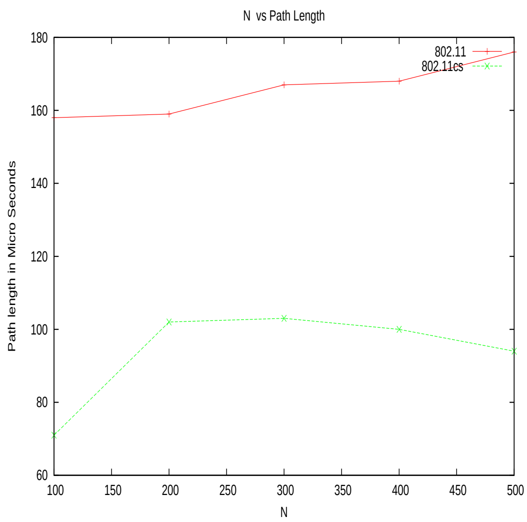

Fig. 6: Path time from sensor to base station in the simulation

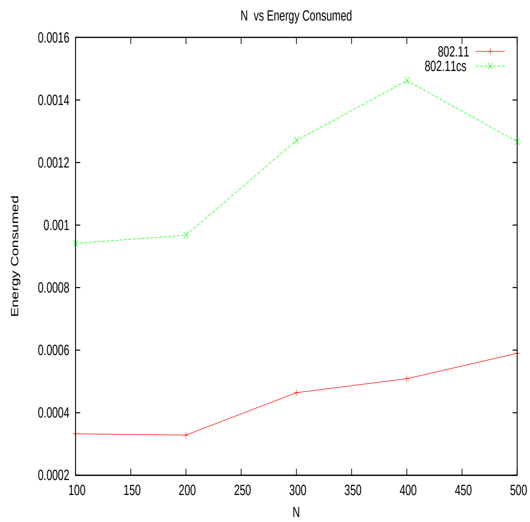

Fig. 8: Energy Consumed after Simulation

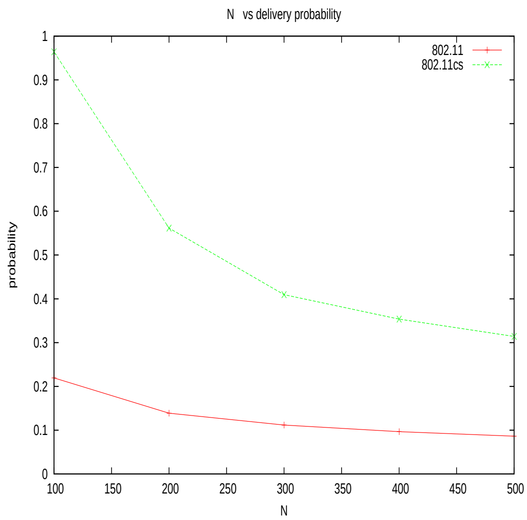

Fig. 7: Delivery Probability

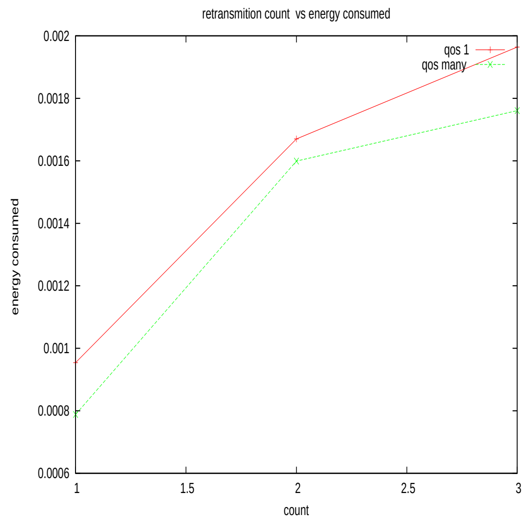

Fig. 9: Re-transmission count and Delivery Probability

6 Simulation Results

Nodes will reach base station in one hop distance that is direct transmission. The number of nodes in the network is increased to 500 and path length, probability and energy consumed in the simulation is measured and graphs are drawn.

Fig. 2 shows how dp is affects by the packet retransmission when single qos class and multiple qos classes are considered. The experiment is repeated and the 802.11 protocol is added at Fig. 3. The experiment is also conducted for another set of reading at Fig. 4.

Graph shows how retransmission count effects the delivery probability. As the retransmission count increases, the dp increases because, at least one packet among duplicate packet will successfully delivered to the destination node. The analysis is conducted for run1 and run2. Fiq shows energy consumed in packet retransmission. The energy consumed is constant across all retransmission. Since it is single hop communication, the diagram shows, all the deployed.

In graph 5 , shows all paths are converges at base station.

In graph 6, the path time is 70 micro second to 110 micro second for 802.11cs while for 802.11 it is much higher(180). Here data will reach immediately to the base station. This reduces data loss due to TTL or packet life time.

In graph 7 , delivery probability is the probability of data reaching to the base station, which is 0.9 to 0.3, for the new algorithm.

In graph 8, shows energy consumption is constant and much lower for the new algorihm, which is increases as number of nodes increases in case of new algorithm.

7 Conclusion and Future Work

In this paper, 802.11 basic protocol with simplified carrier sense without handshaking signals such as CTS, RTS is presented. In the proposed scheme, each node only sends data after sensing the channel. If the channel is busy then it waits using binary exponential backoff algorithm. It will make reattempt up to 10 times. After wards the transmision is aborted and this will marked as transmission error.

In the new scheme ackonwldgement is not required because once the data flows in the channel, other competing station immediately come to know the state of the channel is busy. So they will refrain from transmission. This scheme saves lots of energy as seen in the energy consume graph.

The MAC retransmission scheme for 802.11 protocol is simulated and results are analyzed. Each node retransmits the packet so that at least one copy will be received at the base station. All QoS classes datas are served and they must be ensured to deliver properly at the base station, depeding on their priority. The simulation is done for various QoS classes based on 802.11 scheme and their results are analyzed

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