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Enhancement Mechanism of the Channel for Wireless Sensor Network

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ABSTRACT. Wireless sensor network contains set of self-organized sensors which are trademark by confined energy of preparing and constrained battery vitality. It is used in various correspondences and enterprises viewpoints. Sensors hubs check the activities and send it to multi hub steering to the expected collector jump for making the handling these activities. The routing is developed by utilizing responsive and proactive directing conventions. Clog happens because of information stream passing which supersedes the most extreme limit of channel and the limit line of every jump. The Quality of service (QoS) of the sensor arrange application will be decreased, because of losing the information due to the. This paper considers the blockage probability with a particular ultimate objective to diminish its occasions in Wireless sensor network (WSN) and settle it, and after that proposes a balanced and an altered steering convention to be specific Congestion Control Algorithm (CCA) which is used to reduce the clog in the event that it happens in wireless sensor network.

Keywords: Wireless sensor network, congestion, multi routes, reactive routing protocol, proactive routing protocol.

1. Introduction
In WSN a huge number of sender sensor hops transfer the data and packets to one or multi receiver nodes by using different multiple routes [1]. Many problems occur as a result of consisting of multi-node routing, one of this problem is a congestion, which occurs because of simultaneous transferring, time differences physical channel conditions and overflow of buffer [2]. It considers as the most problem and challenges in wireless networks as compared with wired network due to the channel sharing feature [3]. However, giving high QoS affirmation in WSN additionally forces numerous difficulties. Essentially, sensor hubs are intended to be generally small, battery-fueled and ease [4]. These plan attributes make them inclined to suffer from low buffer, data transmission and handling control thus constrain their execution to a specific degree. In WSN data are lost due to many reasons which can be summarized into:

A- Data collision.
Many hops in the same transmission area try to transfer data at the same time which results in interfering in transmission and minimize the performance of the whole network.

B- Overflow of the buffer.
For each hop in WSN there is a buffer which is used to keep the packets which needs to be transferred, so if the receiver node receives a huge amount of data this will results in congestion of this channel [5].
The packets in WSN are lost in different locations which can be summarized into:

- Sender congestion: which occurs in the source side.
- Receiver congestion: that occurs in the sink node.
- Forward congestion: which results from forwarding packets from one node to another.

Already numerous examinations have been made on congestion control in wireless sensor network systems. These studies proposed arrangements in various layers like network, physical, transport layer and furthermore cross layer to recognize and diminish congestion. These works can be characterized into following kinds which are classified depends on different types of base like: multi route, clustering, buffer, rate and priority.

In multi route type, the data is distributed between the different route to be transferred [6]. In clustering, the data is distributed between various sets to be recovered and transferred. In buffer type the amount of the transferred packets is adapted based on the size of the buffer. In priority type, various priorities are given to the data and the processing of these data are done depending on these priorities.

2. Related works

This section presents the main studies which studies the congestion management protocols:

The rates controlled - reliable transformation RCRT proposed by [7]. Which is classified as a transformation routing protocol which settles the congestion by setting and assigning the data rates. The congestion detection, rate management, and assignment happen at the receiver. The main disadvantage of this algorithm is the slow conourse amount of data and the disability to differentiate flow constrained in bottleneck areas.

Algorithm is proposed to route packets around the congestion areas and scatter the excessive packets along multiple paths together with idle and underneath loaded nodes. Utilizing the concept of potential in classical physics, our Traffic-Aware Dynamic Routing TADR algorithm is designed through constructing a hybrid virtual capability area the use of depth and normalized queue length to force the packets to influence clean of obstacles created via congestion and eventually move toward the sink. TADR scheme has low overhead appropriate for large-scale, dense sensor networks as shown in figure 1.[8]

![Figure 1: Illustration of TADR procedure [8]](image)

The component detection algorithm (CODA) Proposed by Wann et al [9]. Routing protocol which contains 3 prime stages. Detection of Congestion is depended on the existing one buffer occupation, set of links, previous, and current channel loading statuses. The routing protocol selects the sampling process at a specific time period for the local channel controlling, so that it will reduce the energy consumption. According to the congestion detecting procedure, each hop sends the signal node by node, the broadcasting message, which broadcasts to the sender directly or moves in the opposite direction towards the sender. Based on the local network status, the message is far propagated. In order to produce a successful receiving of the Acknowledgement system (ACKs) packets, the sender keeps its transmission rate. Furthermore, the waste of the ACKs packets, the sender adapts its
transmission rate accordingly. CODA routing protocol uses Carrier-sense multiple access (CSMA) for Medium Access Control (MAC) layer and uses practical carrier sense to reduce unobserved node problem, which is not energy efficient algorithm, because it results in more energy consuming [10].

Proposed another routing algorithm to reduce the congestion in WSN, this method uses different factors to reduce the congestion which are: energy, cost in order to search a specific route to the receiver hop. To obtain reliability, this algorithm sends number of packets by using various routes. The main disadvantage of this algorithm is that consuming a great energy because of these packets.

A hidden-hop collision, which is based on (MAC), is proposed in Koubaa et al., proposed a modified algorithm which divides the available nodes into various sets (clusters) in order to reduce the interfering between the overlapping sets. This algorithm has been used for IEEE 802.15.4/Zigbee, the parameter which had been used of to check the performance of the algorithm is only constrained to three performance metrics which are: (probability of succeed packets, energy consumption, and throughput) without taking into account another important parameters that can also Lead to Wireless Sensor Network’s performance minimization, which is called congestion.

3. Problem Statement
The problem of this research is how to search and select the most appropriate routing path for unit-cast data in order to minimize the congestion in the physical channel and if in any route congestion occurs how to minimize the congestion by utilizing rate adaptation approach.

4. The Proposed Congestion Control Algorithm
The congestion control approach which has used in the CCA consists of supposed an ways to many congestion issues which are: finding the best receiver depended on the present channel congestion, finding the most appropriate route to send data, make data rate allocation on the specific path in order to reduce congestion problem, make adaptation for the transferred data in order to minimize the congestion. The illustration of the process as the following: When a hop needs to send data to specific hop, it will broadcast Route request packet. Every hop that receives this request will check if the rate of data can be placed in its buffer and it will forward the Route Request only if it can store it. Each receiver which receives this Route Request will reply with Route Reply to the sender hop. When the Route Reply is received at route intermediate hop, they will forward it only if the rate of data packet can be buffered by them. When the Route Reply is received at the sender hop, it will select the closest receiver to send data. If packet send through the selected route, each packet has a specific field which is used to mark 1st packet, intermediate packets or last packet in the stream. When the 1st packet in the stream is set, all the available intermediate hop keeps the data rate and it resets depended on the specific conditions: a- packet with last packet is set to one. b- Intermediate data packets do not receive at a specific period of time.

All sensor hops have changed data packet rate depended on the used application which uses on it. So, sensor hops must keep the rate. In Route Request, CCA uses a rate value and the intermediate hops broadcast Route Request and Route Reply only if they can accommodate the data rate which has requested. For every sensor hop there is a buffer (queue) for storing the packets from each hop and the queue size is assigned depended on the data rate requested. If the hops send data more than their specific rate, then data packets should be lost only for that hop and this will not impact all other hops data traffic through it. Sometimes because of the processing at hop, the buffer kept for a data flow may become full. For each buffer, the expected data packet service period is calculated when assigns and when hop data service period is more than predictable data service period, than one of two responses is used. The first one, if the memory for buffer sufficient is obtainable, then buffer size is exceeded and the predictable data service is modified and updated. The second decision, if the memory for buffer sufficient is not obtainable, then ACK data packet to the source is checked with minimize the field of rate in order to minimize the data rate.

By using the adaptive rate algorithm, the channel congestion is reduced. When route congestion occurs if there is a number of hops which competes for using the same physical channel. If the period timetable depended on MAC layer is defined at higher layer, then the hop can utilize it to calculate if
the rate exception in Route Request can be gotten from forwarding the Route Request. By this way CCA algorithm can be used to do keeping the considering of the channel congestion.

5. Design and implementation of Congestion Control Algorithm
This paper proposed a CCA and design the predictable data rate which is counted depend on period timetable and present data rate utilization in the hop and buffer size and rate adaptability in this paper. Let the number of present scenarios through hop be M and the data rate kept for each cycle Dr. Let the speed of each hop represented as number of processed packets per time is $S_o$. Let the packet size $p_t$ Let the waiting period $W_p$. Predictable transferred data rate of data $P_t$ is represented as eq. 1.

$$p_t = (S_o - W_p/S_o)/(M * S_o)$$ (1)

The buffer size $B_r$ to meet the rate requested $D_r$ is given as eq. 2.

$$B_r = B_i + D_r * P_t$$ (2)

$B_i$ is the primary buffer size assigned for each cycle.
When the packet loss is occurred at the buffer, directly the data rate should be minimized by a minimizing value.
Let the number of data packets wasted for a cycle be $M_I$ over a time of $T$ and the value of the new minimized data rate $D_red$ is obtained as following as eq. 3:

$$D_red = D_r - (M_I/T)*X$$ (3)

Given that $X$ is a constant number either 0 or 1 and it be matched to get coveted value of rate control. For number of application great minimization in data rate is not possible for such case $X$ can be given minimum value.
If there is enough buffer size is ready in state of minimizing data rate, the buffer for each cycle is expressed as equal 4.

$$B_r = B_i + D_r * P_t + M_I/T*X$$ (4)

6. Network Simulation and Main Assumptions
To check the performance of proposed CCA algorithm, the routing protocol has implemented the solution by using network simulator-2 (NS-2), at each period time of 10 sec, each 20 nodes produced packet with data rate of 20 to 50 as configured at a traffic rate of 5 sec. The proposed CCA has compared with TADR protocol mentioned in previous studies. This paper measured the following parameters the main parameters which are used in this paper are explained in table 1, as follows:

| Table 1. NS2 Simulation Parameters |
|-----------------------------------|
| Simulation Parameters      | Value       |
| Number of nodes            | 250         |
| Simulation Time (sec)      | 90          |
| Traffic pattern            | CBR         |
| Frequency                  | 2.4 GHZ     |
| Transmission range         | 200m        |
| Transport layer            | UDP         |
| Queue Length               | 70          |
| Packet rate                | 20 to 50    |
| Size of Packet             | 512 bytes   |
| Number of receiver (Sink nodes) | 5       |
7. Performance metrics
So as to contrast the proposed CCA execution with other directing conventions as far as adequacy, distinctive parameter measurements were utilizing (d. The purposes behind the determination of many parameters which were throughput, Ratio Packet Delivery, delay, and the quantity of dropped bundles for conventions assessment).

Because of their significance in any information correspondence organize assessment. All conventions should be assessed against these measurements to check their execution. Throughput demonstrates a conventions' effective conveyances for a specific time [11]. This implies the higher the throughput the better the conventions execution. A high ratio of packet delivery implies a high effective parcel conveyance rate, which mirrors the proficiency of the proposed directing convention. Postponement speaks to the base time for conveying packets [12]. Few dropped parcels mean an excellent steering convention and less overhead implies that the proposed directing convention can build the quality without decreasing system performance.

8. Results
8.1. Throughput
As presented in Figure 2, the throughput for both CCA and TADR decreases as the number of nodes rises, mainly because the increase in network size raises the number of intermediate nodes and the inter-node distances. Thus, the number of packets received by the destination node will be smaller. At the start of the simulation, the throughputs for the two algorithms exceeded 250 Kbps, and this value exceeded 200 Kbps until the number of nodes of the network reached 100, after which it fell to 70 Kbps. The most extreme throughput was noted in CCA. The contrast amongst CCA and TADR ran from 12 to 60 Kbps when the quantity of hubs was little (25 and 50); when the quantity of hubs expanded (100 and 150) the distinction between the calculations was 108 to 111 Kbps, which implies the execution of TADR was essentially not as much as CCA. CCA surpasses the calculation in this parameter, which empowers it to be connected in substantial systems.

![Throughput for CCA and TADR versus number of nodes](image)

**Figure 2. Throughput for CCA and TADR versus number of nodes**

8.2. Packet Delivery Ratio
As presented in Figure 3, when the network is small at the beginning of the simulation, the two algorithms have maximum Packet Delivery Ratio value, which falls as the number of nodes rises. When there is an increase in the number of hops, there is greater likelihood of link failure, lowering the percentage value of the corrected received packets against the sent packets. The variation between the two algorithms is 1 to 2%, and both generate a Packet Delivery Ratio that exceeds 95%. CCA exhibits a higher Packet Delivery Ratio than TADR this raises the percentage value the received packets. As a result, these outcomes demonstrate that the mechanisms are suitable in large networks.

![Figure 3. Packet delivery ratio for CCA and TADR versus number of nodes](image)

8.3. Delay
As presented in Figure 4, the delay value increases with the number of nodes. At the beginning of the ns2 simulation, both exhibit low delay, with a difference in excess of 0.080 sec. With small network size, there is a distinct difference between them. CCA reports a shorter delay than TADR, and the difference between the increments in CCA slightly changes. The improvement through CCA is 0.88 to 0.117 sec, but this improvement decreases to 0.56 to 0.67 with more than 100 nodes.

![Figure 4. delay for CCA and TADR versus hops number versus number of nodes](image)
8.4. Dropped packets number
As presented in Figure 5, there is an increase in both algorithms in the number of packets which have been dropped as network size increases. When the hops number is higher, there is greater likelihood of link failure. The rate of dropped packets in CCA is small, but it increases with any increase in the number of nodes. The ratio of packets which have been dropped in CCA is lower than in TADR by 5 to 8 packets.

![Figure 5. Increase for CCA and TADR to number of dropped packets.](image)

9. Conclusion
In this paper, the CCA congestion control algorithm has been explained in detail. As shown in the result of simulation, the proposed CCA protocol has less congestion than other congestion control algorithms. Because of the minimizing of the channel congestion, the packets loss is minimized and the whole network throughput is exceeding. Furthermore, CCA algorithm uses is utilized to extend the sensor lifetime. The approach offers a high level of flexibility to suit the requirements of wide range of target application. It uses the transmission of short preambles to indicate the priority of transmission.

References
[1] Xie, D., Sun, Q., Zhou, Q., Qiu, Y., and Yuan, X. 2013 An Efficient Clustering Protocol Wireless Sensor Networks Based on Localized Game Theoretical Approach. *International Journal of Distributed Sensor Networks* 8, pp.1-11.
[2] Rashed, M. G., Kabir, M.H., Rahim, M.S., and Enayet U Sk. 2011. CBHRP: Cluster based hierarchical routing protocol for wireless sensor network. *Computer Science & Engineering an International Journal (CSEIJ)* 1(3), pp. 1-11.
[3] Zhang, J., Shen, X., Zeng, H., Dai, G., Bo, C., Chen, F., Lv, C. 2012 Energy-efficient and localized lossy data aggregation in asynchronous sensor networks. *Int. J. Commun. Syst.* http://dx.doi.org/10.1002/dac.1384.
[4] Chen-Xu, Yun L, Zhen Z J, Cheng, Zi-Yao, 2012 High energy-efficient and privacy-preserving secure data aggregation for wireless sensor networks. *Int. J. Commun. Syst.* http://dx.doi.org/10.1002/dac 2412.
[5] Zilong Li, Weixia Z, Tao Qi, 2011 A cross-layer congestion control strategy in wireless sensor network. *In: Proceedings of IEEE IC-BNMT.*
[6] Kumar, R., Crepaldi, R., Rowaihy, H., Harris, A.F., Cao G., Zorzi M., Thomas F., 2008 Porta LMitigating Performance Degradation in Congested Sensor Networks. *IEEE Transactions on Mobile Computing* 7 (6), pp. 53-59.
[7] Paek J., Govindan R., 2004 RCRT: Rate-controlled reliable transport for wireless sensor networks in Proceedings of the 5th ACM Conference on Embedded Networked Sensor Systems (SenSys).

[8] Kumar R C, Vijayalakshmi B, Pandian C S, Ramesh C 2016 Improving Throughput and Energy Efficiency by Pctarprotocol. Wireless Sensor Network JSR 1 (8).

[9] Tao, Yuu, 2010 Enhanced congestion detection and avoidance for multiple class of traffic in sensor networks IEEE Trans. Consum. Electron. 56 (3).

[10] Heo et al. 2011 Energy aware routing for real-time and reliable communication in wireless industrial sensor networks. IEEE Transactions on Industrial Electronics 56 (1), pp. 3.

[11] Abdulsahab, G.M., Khalaf, O.I., Sulaiman, N., Zmezm, H.F. and Zmezm, H. 2015 Improving ad hoc network performance by using an efficient cluster-based routing algorithm. Indian Journal of Science and Technology 8 (30), pp. 1–8.

[12] Khalaf, O.I., Bayan M. S 2019 An overview on wireless sensor networks and finding optimal location of nodes. Periodicals of engineering and natural sciences 7 (3), pp. 1096-1101.