Congestion aware Adaptive Reverse Routing Strategy for Improving QoS in WSN

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Abstract. General purpose routing techniques for a WSN cannot be capable to give adequate functioning for various communication. This creates low adaptively provided with a general purpose routing technique ensuing in several connections reaching extremely congested. Ant Colony Optimization-Based Fault-Aware Routing (ACO-FAR) is used to balance the load in WSN. In this scheme, the node can calculate the present routes as well as deviation packets via a least congested path [17]. However, this scheme lacking the efficient awareness of bandwidth distribution, guaranteed quality of service in the WSN. To overcome these problems in this paper, Congestion aware Adaptive Reverse Routing strategy (CARS) for Improving Quality of Service (QoS) in WSN is proposed. It is a highly adaptive congestion free routing algorithms that also allocate traffic more equally and reduce network congestion. Reverse routing is used for diminishes the energy utilization and avoid the multiple retransmission in the network. Average delay as well as throughput is the two parameters that are utilized to calculate the performance of routing strategy. Simulation results demonstrate that throughput 36.76% enhanced dramatically whereas preserving 40.31%lesser latency performance.

Keywords: Congestion-aware Dynamic Routing, Energy Efficiency, Load balancing, Reverse Routing, Simulation Analysis, Wireless Sensor Networks.

1. Introduction
WSN is probable to be utilized in better functioning multi systems by future. Numerous elements concern the routine reached by an application on a WSN program. For applications which necessitate thorough transaction between cores, the major element that impresses the entire function of a WSN is constituted by its mechanism [14]. Conventional path protocols have been intended lacking mention to the features of the system traffic. The major motivation was which the transaction traffic cannot be correctly characterized as a result the routing mechanism are planned to offer deadlock freedom under kind of traffic as well as offer better performance.

Application Specific Routing Algorithms for WSN (APSRA) efforts transaction data to enhance the updating when ensuring deadlock-free path for designing WSN system. Although, it cannot receive into report the transaction attributes similar to the transaction bandwidth necessities of dissimilar transmitting charge pairs represented on dissimilar network nodes. therefore, chosen of the tracks to be evade to limit the routing task as well as to assurance deadlock discharge, is expressed out in a unsighted
fashion. It is corresponding to accepting that entire the transactions have the identical bandwidth necessities. This unknowingness might guide to a dreadful dispersion from the travel load more the system. It is mainly accurate whereas the choice of the bandwidth necessities of dissimilar transaction is great [11]. Ant Colony Optimization-Based Fault-Aware Routing (ACO-FAR) is used to balance the load in WSN. In this scheme, the node can calculate the present routes as well as deviation packets via a least congested path. However, this scheme lacking the efficient awareness of bandwidth distribution, guaranteed quality of service in the WSN.

Our paper is aim to recover WSN performance such as network delay as well as throughput. A Congestion Aware Adaptive Reverse Routing strategy for WSN approach is additional valuable to applications that can endure not working release of packets. This congestion control scheme which contains bandwidth aware route chosen is used to balance the traffic load distribution. The section is formed in to two phases. The initial phase introduces the strategy utilized to diminish the total of bandwidth which should be spread between the residual routing. The next phase covers with the trouble of assuring as well as retrieving while collected bandwidth on several connections greater the capacity. Thus this scheme is used to minimize the probable serious congestion situations around these regions so reduce the network delay. Section 2 introduces the related work. Section 3 depicts the Congestion Aware Adaptive Reverse Routing strategy for WSN approach. Section 4 shows the simulator for measuring the performance of CARS. Section 5, concludes the paper.

2. Related work
Local congestion evading is typically happening at a fraction of nodes in an area. Congestion is drastically minimizing the performance as well as principally affects several exacting transaction pairs. This scheme is assist to resolve limited congestion with dealing dissimilar area size, depend on Divide-Conquer method as well as routing pressure. This scheme evades congestion in each local area with maintaining routing force of each local area lowest [1]. A process variation delay and congestion aware routing (PDCR) method is enclosed no synchronous WSN design. PDCR is adaptative, least expenditure, as well as ascendible. This method outperforms dissimilar adaptiative routing algorithms in the latency as well as dissemination throughput for different traffic rules [2]. WSNs can attain superior operation than bus schemes for chip multiprocessor schemes. An efficient adaptative routing can assist diminish route congestion via load balancing. The remodel path congestion data is utilized to depict hidden spatial congestion data as well as recover the efficiency of pathway election. Route congestion awake election approach that concurrently conceives switches congestion as well as channel congestion. Also argument forecast method which utilizes the charge of modify in the buffer level to forecast probable switch debate [3]. Selection strategy (SS)is a necessary element of an adaptative path method which determines the routine of the WSN. A SS is utilized for choosing the greatest yield channel since the accessible channels depend on the network condition. Destination intensity as well as congestion aware (DICA) which utilizes both local as well as area congestion details from neighbouring also two hops absent neighbours on the pathway to receiver according to the switch as well as channel details. This scheme disseminates traffic extra evenly throughout the network. This scheme enhances the throughput as well as minimizes the latency with overhead [4]. A low-distance route based multicast technique for WSNs that utilize partitioning, better receiver prescribing as well as the even odd twist pattern adaptive routing method for both the multicast as well as unicast information. In addition, the method raises non-congested routes information to avoid making extremely congested fields. This is achieved by considering the congestion condition of the input ports. This scheme provides less delays as well as minimum highest energy utilization for dissimilar message insertion ranks [5]. A self-reconfigurable channel information buffering method as well as circuit design for next-generation WSNs. It provides better for energy capability as well as throughput. Throughout congestion, the buffering method recognizes adaptive flow assure with reconfiguring the channel buffers. The congestion is relieved, information communication summarizes from the primary buffer phase, thus recovering throughput. In addition, it attains energy utilization via co design strategy [6]. Incorporating congestion-aware multicast routing with network coding, the WSN is capable to powerfully deal weighty multicast injections. A broadcast heavy Hammer cache consistency scheme attains decrease delay [7]. Dynamic traffic guideline to enhance the WSN functions as well as chip patterns. It can be
employed for logical attribute incorporation in an open-loop way with interjecting traffic based on its run-time represented features. It can furthermore be functional in a closed-loop mode with including traffic entirely adaptive to the traffic as well as network nations [8]. Single-cycle multi hop asynchronous repeated traversal (SMART) by a proficient node-bypass method, also enhancing the WSN clock frequency takes down the amount of hops which can be got around in a single cycle. It cooperating on-chip wireless connections, a look-ahead bypass-appeal method as well as congestion-free transmit routing method. It is probable to allow less delay as well as energy well-organized data transfers in the WSN [9]. An arbitration method which contributes to diminish congestion delay in nodes as well as the node delay. This method is well-matched with avoid and baseline pipeline in nodes. [10]. An adaptive routing mechanism depend on limited traffic load entropy is utilized for attain better operation. The introduced node circuits are depend on the compacted data process by MOUSETRAP similar to evolution indicating scheme that programmable wait factors for the corresponded latency are utilized so as to accept inactive as well as active latency versions. Repeated manage circuits to enduring passing mistakes are moreover intended as well as assessed. This scheme is used to evade the readjusting phase overhead [12]. This scheme utilized for minimizing the switch delay. This scheme discovers the more taking functions beside the significant route of the switch, as well as introduces the techniques to minimize the overhead [13]. The throughput is enhanced with data-aided valuation method by means of transmit choice, channel then transmit obligation [15]. Frequency Band Suppression and Throughput Enhancement approach is assists for minimizing idleness as well as rises the bandwidth additional proficiently [16].

3. Bandwidth-aware routing algorithm
In this paper, we propose a Congestion aware Adaptive Routing strategy (CARS) for improving QoS in WSN. The reverse routing of this strategy is to launch a path with evade the highest amount of retransmission messages that attempts to diminish the packet losses in the network. Here, the network G(n,l) contains n number of nodes as well as l represents the network channels. The transmission diagram, CG =G (T, C), here T is the position of jobs as well as C represents the set of transactions. Every transaction ci,j= (ti ,tj ) ∈ C. For a transaction c ∈ C, the operation B(c) precedes the bandwidth necessity that represents the least bandwidth which must be apportioned with the system to gather the presentation constraints for transaction c. As we are distributing among adaptative routing, the necessary bandwidth for transaction c is divide more several paths.

![Figure 1. Topography](image-url)
Figure 1 illustrates topography. Assume transaction sender to receiver needs a bandwidth of 100 MB/sec as well as the routing permits the minimal paths from sender node to receiver node (4 paths).

3.1. Load Evaluation
The balance load situation is identical to water flowing in a Pipe. Because the highest flowing of the complete WSN is insufficient to the connection ability as well as the node before the connection will expand into the traffic jam. Properly, efficient channel bandwidth $lL$ since a transaction $c$ calculated as follows.

$$EB(c, l) = \frac{|CT(c, l)|}{|\mu(c)|}$$

Here represents the specify smallest routes included with the routing operation to transaction $c$, as well as $CT(c, l)$ is the communicate throughout connection set which represents the set of routes of $c$ that include the connection $l$. Then compute the combined bandwidth $CB(l)$ that is given below.

$$CB(l) = \sum_{c \in c} EB(c, l)$$

Utilizing these functions, the bandwidth-aware routing algorithm satisfies the tracing constraint

$$\forall l \in L \Rightarrow CB(l) \leq Cap(l)$$

Such as the transmission load of channel $l$, should not exceed its capacity ($l$). The link load analysis is executed to recognize connections in that combined bandwidth exceeds the link capacity. In this situation we utilize the bandwidth reallocation. It attempts to allot alternative paths in this a scheme that load is disseminated approximately equally between links. Thus we get deadlock-free routing function.

3.2. Load Bandwidth Reallocation
This scheme creates a set of routes with offering more adaptivity to transactions features with better transaction bandwidth. Though, it is probable that the combined bandwidth on system connections exceeds the ability of these connections during utilizing Path2dis, otherwise we using the Paths2en. The algorithm of BRT is illustrated below. Here, the input attributes are the set of connections, threshold, set of path as well as set of transactions. The output denotes the routing paths. For every connection $l$ as well as for every transaction $c$ that has as a minimum one path utilizing $l$, as well as two list known as Path2dis, Paths2en for more than one path. Path2dis consist of entire paths for $c$ that should be disconnected as they use network links whose load exceeds the threshold. Paths2en consist of those paths which can be utilized by other transactions as they utilize connections whose load is lower the threshold. Then, the listpaths2dis is read as well as routing paths going to it are disconnected from P. Certainly, disconnected a path induces rearrangement of the bandwidth allocated on it to the other paths going to paths2en. Therefore, the path disconnection stops while there is as a minimum one path in paths2en that comprises a connection whose load exceeds the threshold.

Algorithm:
Band_Realloc (L: set of trans, C: set of conn, P: set of path, thr: Threshold)
While (CB(l) > thr) do
For $l \in L$
For $c \in C$: PT(c, l) {
If |P(c)| > 1
For $P \in P(c)$
If $l \in P$: CB(l) > thr
Path2dis
Else

3.3. Energy Efficient Reverse Routing

Usually, traditional strategies to launch a routing with fewer route request messages that attempts to reply utilizing a several route replies to increase energy utilization throughout the transmit of control packets. But, this strategy to evade drop of route replies as well as enhance the function of routing.

In this strategy, we believe the present energy state of a node as well as speed of energy utilization at particular invariable time (IT) period. This speed of energy utilization calculation is given below.

\[ S_{EU}(t) = \frac{A_{RE}(t-1) - A_{RE}(t)}{IT} \]

Where \( A_{RE}(t) \) is the approximate remaining energy calculated at time \( t \) as follow:

\[ RE(t) = \max \left\{ E_{\text{present}}(t) - \sum_{k=1}^{N_{\text{packets}}} E_{\text{Tx}}(k), 0 \right\} \]

Here, \( E_{\text{present}}(t) \) represents the present energy as well as \( E_{\text{Tx}} \) denotes the energy that will be utilized to communicate the \( N \) packets residual packets in the buffer.

Next we measure the required remaining lifespan (\( t \)) computation is given below.

\[ R_{\text{lifespan}}(t) = \frac{A_{RE}(t)}{S_{EU}(t)} \]

Therefore, reverse routing evades the highest amount of retransmissions and diminishes the energy utilization of the network.

4. Performance evaluation

The performance of the CARS is analyzed by using the Network simulator (NS2). The nodes are distributed in the simulation environment. The parameters used for the simulation of the CARS are tabulated in Table 1. The simulation of the proposed scheme has 30 nodes are deployed in the simulation area 500×500. The nodes are communicated with each other by using the Transmission Control Protocol (TCP). The traffic is handled using the Variable Bit Rate (VBR). The radio waves are propagated by using the propagation model two-ray ground. All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the proposed scheme is evaluated by the parameters packet loss ratio, average delay, throughput and residual energy.

| Parameter                | Value       |
|--------------------------|-------------|
| Number of node           | 16          |
| Routing scheme           | CARS and ACO-FAR |
| Traffic model            | VBR         |
| Simulation Area          | 500×500     |
| Channel                  | Wireless Channel |
| Transmission range       | 250m        |
| Communication Protocol   | TCP         |

This analysis of Figures 2–5, the x-axis notes the traffic load that is changed from 0 to 0.6. The y-axis acts the tempered value for every execution condition. Figure 2 equates the function of the residual energy of wireless nodes. The figure 2 demonstrates that the 20.40% increases the energy of CARS method when compare to the ACO-FAR. To exploit a lifespan, the residual energy is a significant operation parameter. The proposed scheme efficiently chooses the next node connection with regarding...
the residual energy information. As a result, we manage greatly residual energy less than heavily traffic load intensities; it assures a longer node lifespan.

![Figure 2. Residual Energy of CARS and ACO-FAR](image)

The execution evaluation of throughput is shown in figure 2. The figure 2 demonstrate the CARS method 36.76% increases when compare to the ACO-FAR method. Generally, the throughput represents the range of productive information release via transaction channel. The throughput is typically evaluated in bps. In this scheme, the throughput is specified by the fraction of data obtained at the receiver nodes to the entirety rendered data. The above process are repetitive till the load on every connection does not greater the threshold. This process exhausts if the path removal step needs to eliminate a path that is unique for a definite transaction.

![Figure 3. Throughput of CARS and ACO-FAR](image)

Packet drop represents the fault of one or extra communicated packets to get at their receivers. As the proposed traffic load raises, the nodes flow out of the energy otherwise capability for data communications as well as data packets are possible to be losses. Thus, the packet drop possibility rises linearly by the load of traffic. 31.65% reduces packet drop ratio when compare to the ACO-FAR method.
Figure 4. Packet Dropped Ratio of CARS and ACO-FAR

Figure 5. Latency of CARS and ACO-FAR

Figure 5 demonstrates the latency of CARS and ACO-FAR. Here, in CARS the network of traffic load raises the data communication latency is slightly increase. But, ACO-FAR method latency is 40.31 % increased owing to does not allocate the route properly. The CARS method using multiple paths based on the connection capacity thus reduces the network congestion in the network.

4.1. Routing Overhead
Routing Overhead is depicting the sum number of control packets communicated for yielding a data route per data packet. It is received through computing the ratio among the sum numbers of control packets transmit to the sum number of control packets obtained.
Figure 6 illustrates the proposed strategy CARS has lowest routing overhead than the existing strategy ACO-FAR. Since, the CARS choose the relay based on reverse routing. So, avoid the congestion in the network. But, ACO-FAR increase the routing overhead because of it does not select the congestion aware routing.

5. Conclusion
Congestion aware Adaptive Reverse Routing strategy for WSN designs to enhance the QoS performance in terms of latency and throughput. The section is formed in to two phases. The first phase presents the strategy utilized to diminish the amount of bandwidth that must be redistributed among the residual routing paths. The second phase deals with the problem of checking as well as recovering when combined bandwidth on some connection greater the capacity. Thus this scheme is used to eliminate potential heavy congestion situations around these regions so reduce the network latency. To confirm the proposed algorithm, via simulation finished to show it’s achieve ability as well as authority. Compared to a baseline approach, the proposed congestion management method provides better scalability performance of WSN platforms. Simulation results demonstrate that throughput 36.76% enhanced dramatically whereas preserving 40.31% lesser latency performance.

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