PRIORITY BASED CACHE ALLOCATION AND CONGESTION CONTROL PROTOCOL IN WIRELESS SENSOR NETWORK

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Abstract: Reliable data transmission in wireless sensor network plays a critical part with the presence of increased data traffic and congestion. Successful data transmission can be ensured by providing cache resources to store the data before transmission. Reliable Transport protocol with a cache aware congestion control mechanism (RT-CaCC) is the existing approach used for secured communication. However, in this existing works, cache resource allocation is done evenly to all data flows on network which lead to data transmission failure due to insufficient resources. Cache resource allocation should be performed evenly in order to obtain consistent and successful data transmission. Priority based Cache Allocation and Congestion Control protocol (P-CACC) is used in this work for effective cache resource allocation. In the proposed research work, data transmission is performed reliably by giving more prioritization to the data flow with higher data rate. Here, initially uneven cache partitioning scheme is introduced for giving more prioritization to the flow with higher data rates. This is done by measuring the priority of the multiple data flows present in the network, and the weight assignment is done with the assistance of cuckoo search algorithm where the data flow with more priority will be assigned with more weight. The higher cache partition will be allocated to the data flow assigned with higher weight value. The simulation of the work is performed in NS2. It is confirmed that proposed research work tends to have improved outcomes than the existing techniques.

Keywords: Priority, Caching Resources, Weight Assignment, Cache Partition, Higher Data Rate, Cuckoo Search Algorithm.

I. INTRODUCTION

In modern days, developments in low-power wireless communications as well as in microelectronics have made possible to short-size and less-cost microsensors growth, that communicate along with each other through radios [1]. A huge quantity of wireless microsensors generate Wireless Sensor Network (WSN), in that sensor nodes cooperate for sensing actions or phenomena of significance, process sensed data and transmit them to customers of information (data sink) [2]. In the 21st century, WSNs are noticed as one of the very most valuable technology. Nevertheless, numerous technical confronts need to be concentrated before extensive business deployment of WSNs turned out to be realistic. Here, one of these confronts is, data transport over WSNs [3]. The transport layer protocols that are broadly-utilized in Internet, namely, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) possibly will not be appropriate for data transport in WSNs because of exact features of WSNs and novel necessities of applications over WSNs [4].

Wireless sensor nodes dispersed and energy-restricted are routinely processed with the cooperative monitoring or control of one or a few functions in a WSN[5]. The pre-processing or aggregation of event data in the intermediate sensor nodes is feasible and appropriate prior to additional transmissions in the direction of the data sinks for which the sensor data is assembled and the sensor nodes are managed[6].While, conventional transport layers have not been intended along with some consideration of these novel characteristics of WSNs, there is a requirement for improved transport protocols [7]. There are, two main tasks in transport layer, which are reliable data delivery and congestion control [8]. It needs that when packets are misplaced in a multihop WSN, a few or entire of misplaced packets is identified and misplaced information gathered through suitable mechanisms [9]. Reliability is needed during information is significant to a function in WSNs.

Congestion happens when numerous sensor nodes transmit data to sinks and data jamming quantity goes beyond network capability [10]. However, during congestion, nodes begin to drop packets or packets delay considerably goes beyond applications necessity. Repeated dropping of packets is a dissipation of energy and neutralize some attempt to attain consistency. Extreme delay of packets possibly will produce invalidity of data gathered by sensors [11]. Congestion controls intends to neglect congestion or simplify congestion intensity. Attempts have been carried out in recent times to manage consistent transport and congestion control issues in WSNs, such as, Event to Sink Reliable Transport (ESRT), Reliable Multisegment Transport (RMST), Congestion Detection and Avoidance (CODA), Pump Slowly Fetch Quickly (PSFQ), and GARUDA aiming consistent data transport or congestion control or both.

Here, reliable and congestion aware data transmission is guaranteed through allocating the cache resources to the various data flows in accordance with requirements. Here uneven resource allocation is guaranteed by measuring the priority of the data flows happening on the network. This is carried out by measuring the priority level of various data flows and higher cache resources are allocated to the data flow with increased priority level.

The organization of this research work is provided here. In this section 1, described introduction regarding the necessity of congestion and reliability consideration at the time of executing the data transmission in the WSN. In section 2, investigation of several relevant research methods that are commenced to realize the congestion avoided consistent data transmission. In section 3, proposed research method had been described thoroughly together with the appropriate figures and examples. In section 4, performance analysis of the proposed research method has been provided in accordance with numerical assessment. In the end section 5, on the whole, ending of the research work is provided in terms of getting experimental result.

II. RELATED WORK

A new bio-inspired routing protocol which is termed as CB-RACO is implemented by Rosset et al [12]. In this protocol, a distributed community finding as well as computationally inexpensive technique called Label Propagation (LP) is combined with Ant Colony Optimization (ACO) meta-heuristic algorithm. In WSNs, communities are generated using CB-RACO and through routing data inside-communities, it gathers energy utilization via swarm intelligence. It requires short memory, but need routing path safeguarding and enhances structure overhead.

For WSNs, a TDMA-based reliable multicast MAC (TRM-MAC) protocol is implemented by Bhatia et al [13]. This protocol is a parametric protocol which can be used to trade-off between delayed activities and reliability based on underlying function requirements. At different packet loss rate, reliability and delay performance of TRM-MAC protocol is assessed by authors and simulation investigation is used for assessing working of this protocol with other protocol.

Mohanty et al [14] recommended an energy efficient structure-free data aggregation and delivery (ESDAD) protocol, that aggregates unnecessary data in intermediary nodes. Here, waiting time for packets at every intermediary node is computed sensibly with intention that data is aggregated effectively in routing path. However, sensed data packets are transferred wisely to aggregation point for data aggregation. The ESDAD protocol calculates a cost function for structure-free, choosing the next-hop node and executes near source data aggregation.

For WSNs-dependent smart grid applications, Faheem et al [15] presented a new Energy Efficient and Reliable Data Gathering Routing Protocol (ODGRP). Here, this method uses a software-described centralized organizer and numerous mobile sinks for energy effective and reliable data collection from WSNs in SG. However, widespread experimental outcomes performed by EstiNet 9.0 demonstrate that modelled system outperforms current technique and attain its described aims for event-driven applications in SG.

For WSN, an interference and congestion aware energy efficient routing technique is proposed by Elappila et al [16] and it is termed as Survivable Path Routing. In networks with high traffic, this protocol can produce better results, where large amount of sources will try to transmit its packets to target, which is a common condition in IoT applications for remote healthcare monitoring. For selecting next hop node, scheme utilizes a criterion which is a task of three features: signal to interference and link’s noise ratio, survivability factor path from subsequent hop node to target, and congestion range at subsequent hop node.

A stable and congestion-reliant protocol was devised by Sharma et al[17], which provides congestion control based on both bidirectional reliability and rate adjustment. Nevertheless, in order to select the best direction for data transmission, it uses the Technique for Order Choice by Similarity to Ideal Solution (TOPSIS) scheme, as TOPSIS prefers an alternative to have the smallest distance from the perfect one and the highest distance from the perfect negative resolution. Congestion is defined as a degree of congestion by using a percentage of the average packet service time over the average packet inter-arrival time.

By changing C-SSA with Taylor series, Vinitha et al[18] resolved the energy complication and produced an energy-efficient multi-hop routing in WSN called Taylor dependent Cat Salp Swarm Algorithm (Taylor C-SSA). This approach passes through two stages to achieve multi-hop routing, including Cluster Head (CH) collection and data transmission. Using the Low Energy Adaptive Clustering Hierarchy (LEACH) protocol for the purpose of efficient data transmission, the energy-effective CHs are calculated using the sensor nodes to transmit data over the CH, which transfers the data to the Base Station (BS) from the best possible hop picked.

Devi et al[19] suggested the Latency and Packet Loss Reduction Cluster dependent Data Aggregation System. Two steps are used in the formulated method: Aggregation Tree Creation and Algorithm for Slot Scheduling. In this phase-1, each CH implements compressive aggregation from its associates for the inward details. The aggregation tree is then built through the sink using the Minimum Spanning Tree (MST). The packet loss rate and latency are considered during stage-2, when prioritising and handing over time slots along with aggregated data to the nodes. This technique avoids using redundant retransmissions and waiting, which aims to improve the efficiency of the network.

III. PRIORITY BASED CACHE ALLOCATION AND CONGESTION CONTROL PROTOCOL

In the proposed research work, data transmission is performed reliably by providing more prioritization to the data flow with higher data rate. Here initially uneven cache partitioning method is launched for giving more prioritization to the flow with higher data rates. This is carried out by measuring the priority of the multiple data flows present in the network, and the weight assignment will be done. Here, weight assignment is carried out through utilizing cuckoo search algorithm where the data flow together with more priority will be assigned with more weight. The higher cache partition will be assigned to the data flow allocated with higher weight value. The processing flow of the proposed research method is illustrated in the figure 1 given below.

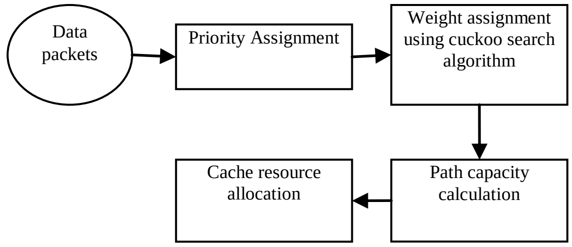

Figure1: Proposed Work Flow

3.1. Prioritization of Data Flow

Every packet is allocated with any one of two priorities namely dynamic or static priority in this proposed scheme.

- Static priority: It is allocated to sensor node in accordance with its data value. However, after saving the threshold limit, sensor node is about to sense particular application for which it is installed. The sensed value should be assessed with saved threshold limit to allot its priority. Here, packets that carry value higher or lower than threshold limit are noticed as high priority data packet though remaining packets are regarded as minimum priority/ordinary packets.
- Dynamic priority: It is allocated only for minimizing end-to-end delay. In a network, in general, there are two kinds of data, namely locally created and transit or route through. Here transit data, will have maximum priority while comparing with locally produce data in order to minimize end-to-end delay. For accomplishing this objective, placed route through data into priority 2 (pri2) queue at same time as locally produced data into priority 3 (pri3) queue.

Here, the proposed priority scheme is described thoroughly in order to enhance the system performance. While considering the first scheme, nodes with small energy construct smaller quantity transmissions than high energy nodes, efficiently enlarging system life span. In case of the second scheme, nodes with vital event packets have priority over nodes with data from less vital events.

Energy-Centered Priority Scheme: The important point of this method is for amplifying system lifetime. This is performed through minimizing transmissions count. Consequently, in this method, data resolution is considerably minimized, that also reduces energy utilization. While we demonstrate in results that data transmissions cannot be minimized arbitrarily, in view of the fact that this possibly will guide to reduced system performance. Alternately, it is suggested a fine tuning of scheme through picking proper values. On the other hand, it is obvious that this method is not aimed for applications where major goal is to collect as much information as feasible. Moderately, it is intended at conditions where patient possibly will be far away from hospital or medical staff for extended time period and only common details concerning his exact health is necessary, for example, for old people or patients suffering with chronic illness, or to assess a brain activities between different impulses all over the day, or even for sportsmen or women concerned in observing their physical condition. While considering the polysomnography, this method can be helpful mainly during medical staff needs the observation of a patient though he is residing at home and requires to examine elongated sleep phases.

We propose subsequent transmission probability for entire nodes in network. Specifically, event description nodes along with information required to be relayed, specifically, nodes that identified an event in the earlier frame (with probability ϵ), send with probability ρ explained as

$$\rho_i = \gamma e^{-E_o/E_r}$$

whereρ_i indicates transmission probability of node i, γ represents control parameter, E_o indicates initial battery energy, E_r represents residual battery energy. Here, utilizing this transmission probability, nodes with higher residual energy broadcast with higher probability, whereas nodes with short residual energy ranges broadcast at irregular intervals.

Data-Centered Priority Scheme. Different to the earlier method, where system life span is enlarged by minimizing low energy nodes transmission count, in this priority method, here aimed to accelerate highly significant packets over less significant packets, despite energy consumption. It is to be noted that, sensors have better importance than other nodes. Here, in order to distinguish low priority nodes from high priority nodes, we pre-assign priority range at system setup. Furthermore, transmission probabilities are shown below:

- Broadcasting probability of high priority nodes ρ_H.
- Broadcasting probability of low priority nodes ρ_L

3.2. Weight Assignment using Cuckoo Search Algorithm

By using above procedure, priority for the nodes in wireless sensor environment would be calculated. Priority value calculation based on, weight assignment for every node will be performed optimally by utilizing cuckoo search algorithm. It is a kind of optimization algorithm established by Xin-she Yang and Suash Deb in 2009 and it is motivated by few cuckoo types obligate brood parasitism by leaving their eggs in nests of other host birds. Few host birds can keep straight clash with interfering cuckoos. For instance, when a host bird finds out eggs are not laid by them, it will either throw away these strange eggs away or just discard its nest and construct a fresh nest somewhere else. Few cuckoo types, for example, New World brood-parasitic Tapera have developed in such a manner that female parasitic cuckoos are extremely expert in imitation in colors and model of eggs ofsome selected host species. Cuckoo search idealize these kind of breeding activities, and as a result can be useful for different optimization difficulties. Cuckoo Search (CS) employs following illustrations:

Every egg in nest symbolizes a solution, and cuckoo egg symbolizes novel solution. At this point, intention is for utilizing novel and possibly better solutions (cuckoos) for changing a not-so-fine solution in nests. Consequently, in uncomplicated way, every nest has one egg. The scheme is stretched to make difficult cases in which every nest has several eggs demonstrating a set of solutions. CS is dependent on three idealized rules:

1. Every cuckoo lays one egg at a particular time, and leaves its egg in an arbitrarily selected nest;
2. Finest nests having eggs great eminencewill move to next generation;
3. Existing hosts nests count is predetermined, and egg laid by a cuckoo is found out by host bird with a probability $p_a \in (0,1)$. Determining control on few set of worse nests, and determined solutions dumped from farther calculations.

The pseudo-code can be briefly given as:

Objective function: f(x), $x=(x_1,x_2,...,x_d)$

Create a primary population of n host nests;

While (t<MaxGeneration) or (stop criterion)

Obtain a cuckoo arbitrarily (say, i) and change its solution by means of carrying out Lévy flights;

Assess its quality/fitness
[For maximization, $F_i \propto f(x_i)$];
Select a nest in the midst of n (say, j) arbitrarily;
if ($F_i > F_j$),
Substitute j by novel solution;
end if
A fraction (p_a) of inferior nests are neglected and novel ones are constructed;
Maintain most excellent solutions/nests;
Nests/solutions are ranked and recent best is computed;
Recent best solutions are passed to subsequent generation;
end while

3.3. Cache Partition Allocation

Following the distribution of data packets into their respective queues, the sensor node would like to identify the overall path capacity. Here, end-to-end path capacity can be computed. Moreover, the connecting two nodes, x and y point out that y indicates the parent of x in the communication arrangement and the dotted line only demonstrates the link. To begin with the path capacity among parent and child node can be computed. The computed path capacities are subsequently directed to Base Station (BS). In order to compute the path capacity every node verify radio link concerning it to its parent node. Each node transmits bulk of data packets in a specific time to its parent node. Each data packet in the burst will be transmitted subsequent to accepting acknowledgement of preceding data packet or time out of the preceding submitted data packets. The path capacity Cu,v is subsequently computed through dividing the overall amount of acknowledge packets with time taken. Subsequent to this step, every node transmits the computed path capacity and parent node ID to BS. Then, BS carries a table that includes entries for the entire paths form source nodes to BS. Moreover, the table include node id, id of parent node and path capacity of the nodes in the path form source node to BS.

Subsequent to path capacities compilation at BS, further step is to compute slot period. For the entire sensor nodes, in order to neglect congestion and to make sure the synchronization, slot duration have to be the same during sending and receiving process for achieving synchronization. In order to get slot duration BS select least possible path capacity of a node for effectively transmit one data packet (Lpc). In order to transmit one data packet effectively, the transmitting node requires 1/Lpc seconds. The achieved value will be slot period. Data loss and congestion is subsequently neglected by means of computing an appropriate sending data rate through BS for each sensor node u. This transmission rate possibly will not further than every node's sending capacity in path in direction of BS.

IV. RESULTS AND DISCUSSION

The performance assessment of proposed system P-CACC is done with RT-CacC. The assessment was carried out in terms of parameters are known as Total Energy Consumption, Throughput and Network Lifetime. The WSN is designed through a multiagent scheme and each sensor is characterized by a software agent. Our multiagent scheme was generated with the NS2 simulator.The simulation of this research directs to give the optimal result than the existing research techniques.

Total Energy Consumption: A node utilizes its energy for the purpose of sensing, transmission and computing that energy utilization of the proposed work is low when evaluated with RT-CacC.

Overall Network Lifetime: It can be considerably increased through sensor node's efficient exploitation, hat P-CACC provides much network lifetime. Here, it is high when the energy consumption is less.

Throughput: Network throughput is described as how efficiently data is sent to sink node or BS. It is to be pointed out that, number of data being transmitted in bits per second (bps).

Table 1: Total Energy Consumption Comparison values

Time in ms	Total Energy consumption	
	RT-CacC	P-CACC
1	20	10
2	27	21
3	50	30
4	56	45
5	60	30
6	73	48
7	90	50
8	101	88
9	130	100

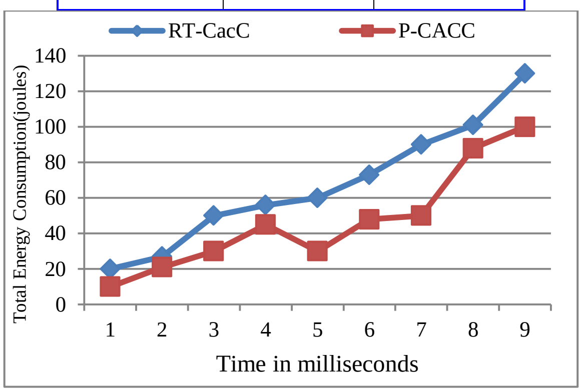

Figure 2: Total Energy Consumption at Different Time Slots

Individual node generation happens in the existing clustering methods which reasons for more energy utilization. Total energy consumption at various time slots displayed in the above Figure 2. Based on the assessment, it is verified that the proposed scheme P-CACC shows 30.47% lower energy consumption than RT-CACC.

Table 2: Network Lifetime Comparison Values

Time in ms	Network Lifetime	
	RT-CacC	P-CACC
1	6000	7000
2	4500	5000
3	4000	5000
4	2000	3000
5	1800	3000
6	2000	2200

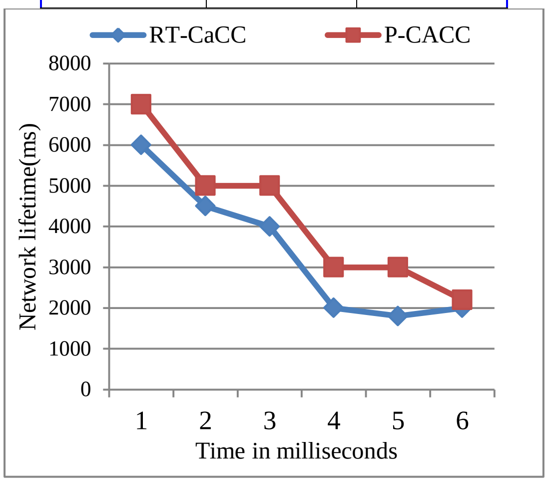

Figure 3: Overall Network Lifetime at Different Time Slots

The Network Lifetime also reduced considerably owing to much energy consumption. By means of toggling the nodes either to active or sleep mode, energy utilization can be reduced. Figure 3 gives the whole network lifetime at various time slots, these proposed scheme provides more network lifetime. From this assessment, it is verified that the proposed scheme P-CaCC shows 24.13% higher network lifetime than RT-CACC.

Table 3: Throughput Comparison Values

Time in ms	Throughput	
	RT-CacC	P-CACC
1	50000	55000
3	50000	56000
5	50000	55000
7	51000	56000
9	52000	54000

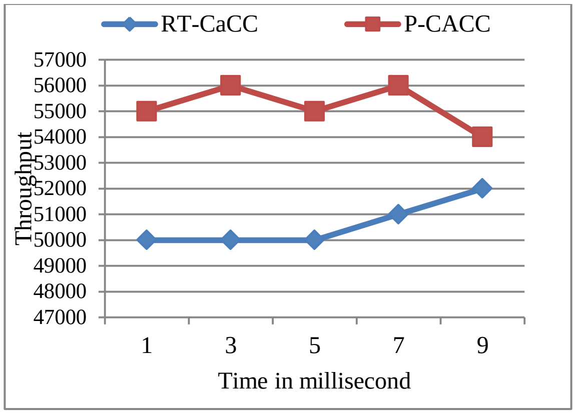

Figure 4: Throughput at Different Time Slots

Figure 4 demonstrates throughput at various time slots. Throughput is higher for an efficient scheme and provides best lifetime. From this assessment, it is verified that the proposed scheme P-CaCC shows 9.09% higher throughput than RT-CACC.

V. CONCLUSION

In the proposed research work, data transmission is executed consistently by means of providing more prioritization to the data flow along with higher data rate. Here, initially uneven cache partitioning method is introduced for providing more prioritization to the flow with higher data rates. This is carried out through measuring the priority of the several data flows included in the network, and the weight assignment will be performed. Here weight assignment is carried out through utilizing cuckoo search algorithm where the data flow together with more priority will be allocated with more weight. The higher cache partition will be assigned to the data flow allocated with higher weight value. The overall evaluation of this research work is performed in NS2 simulation, from which it is verified that proposed research work tends to have best result than the existing schemes.

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