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QoS Achieving Sector Based Congestion Control Protocol in Wireless Sensor Networks

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Abstract: The current innovation pertains to an info acquiring mechanism for wireless sensor networks. The goal is to enhance Level of Performance in wireless sensor networks with applying bandwidth management sectoring techniques that decrease sensor node usage of energy. The nodes are distributed periodically throughout the system. There are several sectors constructed based on a comparable amount of sector heads. There is a single sink node that takes information from the sector leaders. Common nodes are distributed at randomly to transfer information to the corresponding level 1 node across a sector. Thus, channels for communication are managed, and network activity is controlled. The sector-based congestion reduction method fulfils different quality-of-service criteria for wireless sensor networks. Qualities of Service indicators include time (delay), energy utilization, delivery ratio, loss ratio, and throughput. This study describes the optimal methodology for accurate information distribution in wireless sensor networks. This is intended to achieve optimum QoS for wireless sensor networks. We have achieved QoS of WSN's like PDR, PLR, Throughput, Energy efficiency, Delay etc. This paper will be useful for new a researcher who wants to work on congestion control parameters of real time applications.

Keywords*: *Sector based congestion control algorithm (SBCCA), Sector head, Quality of Services (QoS), Wireless sensor networks (WSNs), Ad-hoc on demand distance vector routing protocol (AODV), Carrier sense multiple access (CSMA), Time division multiple access (TDMA).

I. Introduction

Wireless sensor networks, or WSNs, have transformed data collection and transmission. These systems are made up of tiny, low-power gadgets known as sensors that instantly link to one another to form systems. These sensors are able to transmit information in actual time to a centralized server from a range of situations, including commercial and natural environments. The versatility, cheap cost, and robustness of WSNs make them an increasingly attractive choice for surveillance and data collecting in harsh and distant situations. A wireless sensor network (WSN) is primarily made up of numerous tiny, battery-operated sensors, each of which has a wireless transmitter, sensing unit, and microcontroller. By using radio frequencies to connect with one another, the sensors form a mesh network that has a wide coverage area. This makes it possible for the sensors to talk to one another and send data to a gateway or sink, which is a central point. The capacity of wireless sensor networks to function independently without a specific infrastructure is one of their primary characteristics.

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This is as a result of the sensors' self-organizing, self-configuring, and self-healing design. This implies that they don't require human involvement to adapt automatically to modifications in the network, including the addition or removal of sensors. Because of this, WSNs are perfect for applications where regular modifications to the network topology are anticipated. The inexpensiveness of WSNs is another benefit. While wireless sensor networks are comparatively inexpensive and simple for setting up, typical cable sensor systems can be costly to build up as well as manage. Because these devices are usually compact and low power, they are inexpensive to make and run. As a result, a broad range of sectors and uses, including process control in factories and monitoring the environment, can benefit from WSNs. Additionally; WSNs can function in tough and isolated areas where standard Ethernet networks may not be practical. This is because they don't require physical facilities to cover large regions because they are wireless. Furthermore, a lot of sensors are now made with energy efficiency in mind, which allows them to function for longer periods of time with requiring new batteries. Tracking the environment represents one of the primary uses for wireless sensor networks.

The term "real- the environment, water purity, and air pollution monitoring is possible with WSNs. This information can be utilised for a number of things, such tracking the effects of human activity on the ecosystem or forecasting natural disasters. WSNs have applications in factories for process regulation and surveillance. On appliances and machinery, monitoring devices can be installed to track their operation and identify any possible problems. This makes scheduled repairs possible, which can lower downtime and boost productivity. WSNs are utilised in the medical field for monitoring patients remotely. Users might have the sensors connected to them in order to track their health indicators and send actual time data to healthcare providers. This can help patients get better results by enabling early identification of any potential medical problems.

II. Literature Survey

In this paper, the author aimed to optimise Low Energy Adaptive Clustering Hierarchy (OLEACH) to enhance the current LEACH and LEACH-C by dynamically picking clusters based on the remaining energy of nodes, hence reducing energy usage. This novel method uses sensors cluster-heads to determine how much energy is left over after each round. The new centralised routing protocol relies on energy value threshold, preventing the establishment of a group leader, to ensure consistent performance of the entire network, since the minimal amount of energy used for the choose is predetermined, reducing its capacity and constantly collaboration work. We implemented the WSN energy-efficient clustering method. Thorough models of wireless sensor networks show that our method is effective in prolonging the network's lifespan and can be used to extend its length of operation. We believe that O-LEACH will function in both dynamic and static networks. We examined O-LEACH exclusively on static networks in this article. It is also necessary to test this kind of protocol on networks that change.The outcomes of the experiment demonstrate that the suggested approach improves node lifespan and reliability and achieves longer durability when compared to the conventional LEACH and LEACH-C.[1]

Author Bharadwaj presents the dynamic traffic monitoring approach. WSN is used to achieve this strategy. In order to continuously regulate traffic, sensors are employed to identify areas of congested traffic. The drawbacks of static traffic control have been addressed by adaptive traffic management. The main drawback of static control of traffic is that, in certain cases, traffic congestion may obstruct rescue vehicles such as ambulances. This method effectively reduces traffic congestion by using a roadside unit, monitor unit, and traffic control unit. An emergency vehicle's specific RFID code is scanned by an RFID reader and sent to a monitor device. The monitor unit counts the regular and emergency cars using sensors, proximity switches, and RFID tags. The flow control unit receives the vehicle's count info. The dynamic signal modifications occur once the vehicle count data is received. The author has contrasted the outcomes of the dynamic and static traffic management techniques. The time it takes for cars to get from one place to another is measured, and time is computed based on both distance travelled and speed. The dynamic traffic management strategy is effective in all circumstances. The dynamic control of traffic method has the benefits of reducing traffic delays and saving time on travel efficiency..[2]

For the multi-hop wireless system, author Weiqi Chen has suggested a simultaneous QoS provisioning and congestion control solution. Two different strategies are combined to carry out this strategy. Semi-TCP is the second, and distinguished queued function is the first. These methods have the advantages of systematic hop-by-hop congestion control and per-packet granular QOS. Authors obtain two parameters by the Joint method. These adapt and change to fit the needs of the adaptive multi-hop network.. at the joint method, semi-TCP is utilised to address traffic management issues at the movement and MAC layer while DQS is utilised for quality of service in the logic level. The author has resolved the various problems with the current setup. These problems include cross-layer layout, latency estimates, delayed message processing, and the ACK process. The author has enhanced the overall throughput and decreased the overall latency in the (multi-hop), or multiple hops (levels), wireless network by using a combined technique. Data transfer ratio and average end-to-end latency parameter findings are obtained. By employing a combined approach, the writer has attained many benefits. Overdue packets, transfer ratios, and a lower total latency are managed for multi-hop wireless networks.[3]

III. Proposed System

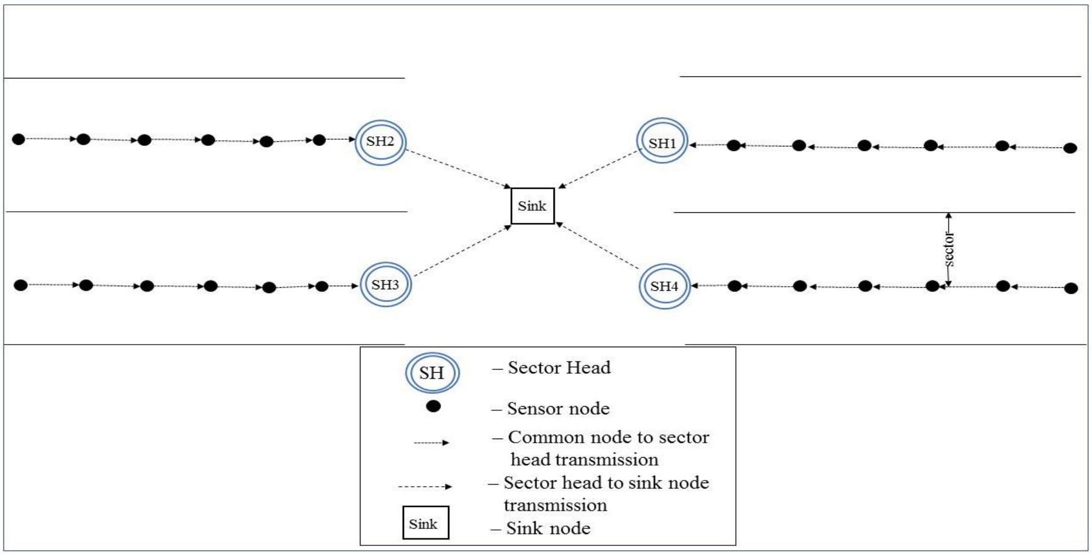

Fig 1:- Architecture of Sector Based Congestion Control System

We can observe that nodes are placed arbitrarily throughout the network as shown in the above picture. Sectors are organized based on the same amount of sector heads. Traffic on a network grows as a result of reduced channel communication capability and less bandwidth accessible for the transmission of packets. This has an immediate impact on QoS metrics including delay, throughput, energy efficiency, packet delivery ratio, and dependability. Sectoring will lessen problems with bandwidth and congestion in the suggested architecture. That is a single sink node which collects data from the sector's heads. Common nodes are distributed at random and provide streams of data to the associated first-level nodes throughout a specific area.. Sector heads are not anything other than level 1 node. This approach will manage bandwidth while minimizing congestion in networks.

SBCCA Algorithm:

Step 1 - START

Step 2 - Initialization of scenario.

Step 3 - Initialization of sink node equal to zero. Step 4 - Set hop count (level) to all nodes.

Step 5 - Determine the nodes which are one hop away from sink node i.e Find out level

one nodes.

Step 6 - Assign level one nodes as sector head.

Step 7 - Formation of sectors depending on the total number of sector heads.

Step 8 - Common nodes within a sector transmit the data packets to their sector head.

Step 9 - Sector heads transmit the collected information to sink node.

Step 10 - STOP

First, the scenario will be initialized, and the sink node will be set to zero. Set the hop count for all nodes to find out their levels in the entire network. The next stage is to identify nodes that are one hop away from the sink node. Determine which nodes are level 1 nodes. Level 1 nodes are close to sink nodes, so the next step is to identify them as sector heads (SH). Congestion on the network increases when the communication channel's capacity and bandwidth for the transfer of packets decrease. In this situation, the development of sectors will determine bandwidth. Create sectors equivalent to the entire number of level 1 nodes (sector head). Following the establishment of sectors, transmission of information will occur. Data is transmitted inside the sector. Common nodes within a sector send information packets to the sector head. The sink node receives information packets from level 1 node, also known as the sector head. This approach will regulate bandwidth while decreasing network traffic.

IV. Result Analysis:-

In our scenario, we compared our proposed SBCCA technique with the existing TDMA, CSMA, and 802.15.4 techniques. We used the AODV routing protocol to decide the fastest path among sources and destinations. Using 30 sensors set up for information transmission in a 1000 m × 1000 m region, we sent 50-byte information packets. The rate at which information is transmitted has been increased from 10 to 50 packets per second that is the main change inside the simulation.

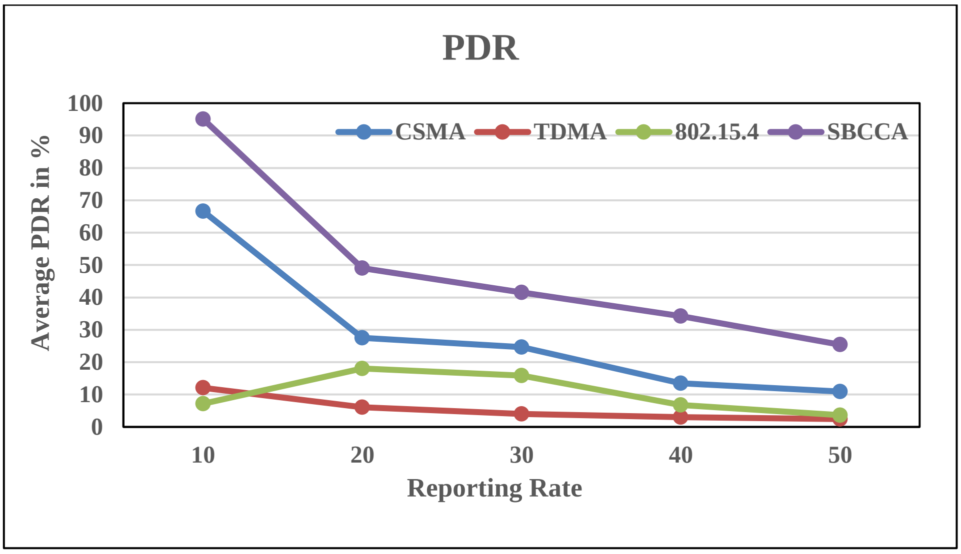

Fig 2. Average PDR for Reporting Rate

The figure represents an average PDR for reporting rates. QoS metric is the packet's delivery ratio. Average PDR rises when information is delivered from one node to another. Techniques for controlling congestion as well as traffic are helps to enhance the efficiency of networks. The SBCCA method performs considerably better in the above graph compared with the various techniques that are currently in use. The SBCCA sectoring technique improves the reliability of data delivery. The SBCCA performs admirably at a reporting rate of 10 packets per second; however, when that rate rises to 50 packets per second, efficiency starts to degrade. and SBCCA protocols.

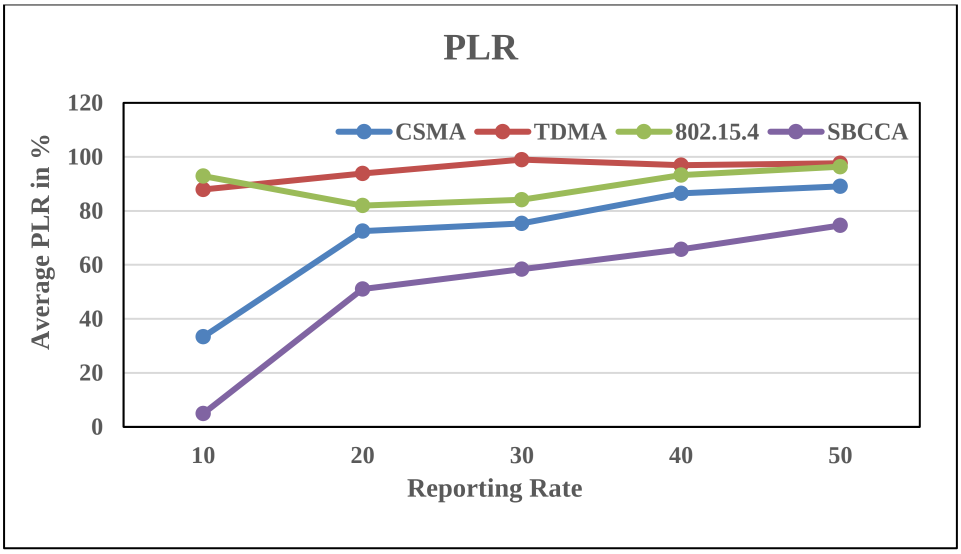

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Fig 3. Average PLR for Reporting Rate

The above figure indicates the average PLR for the reporting rate. The packet loss ratio rises as a result of congestion and traffic in the network. However, the SBCCA's sector-based congestion control mechanism aids in lowering the network's average PLR. The SBCCA protocol has a significantly lower average PLR as compared to other current protocols. If the reporting rate is changed from 10 packets per second to 50 packets per second, it results in a 20–40% reduction in the packet loss ratio. When compared to SBCCA and CSMA protocols, the efficiency of the TDMA protocol is significantly worse due to its time slot assigning technique, which raises the packet loss ratio throughout the entire network. The CSMA protocol provides excellent outcomes for PLR because it uses a congestion detection and minimization approach.

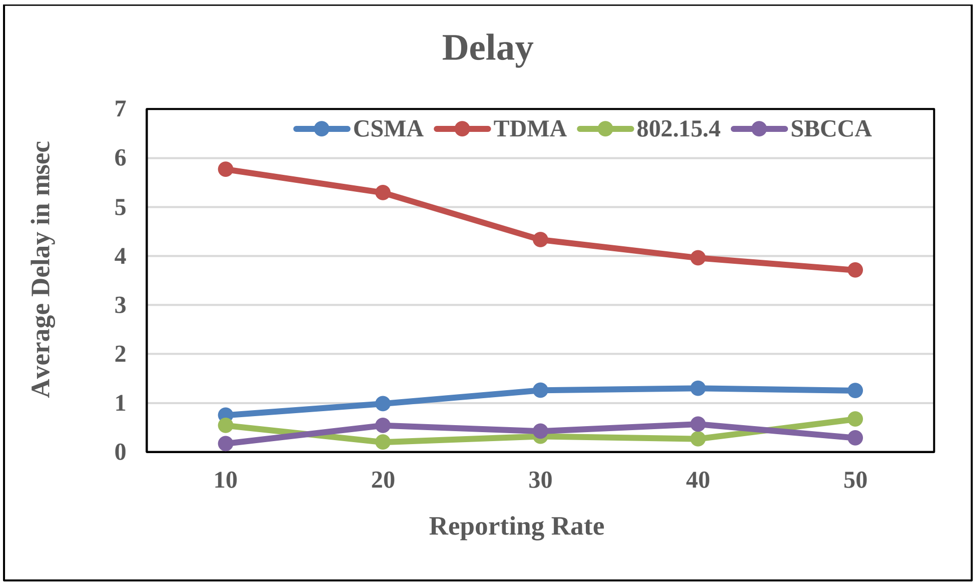

Fig 4. Average Delay for Reporting Rate

The average delay for reporting rates is shown in the graph. Latency is an average amount of time needed to send information from one end to another. For varying reporting rates, the SBCCA and 802.15.4 standards performed excellently. The 802.15.4 protocol has no limitations for SBCCA, however it performs more effectively at densities of 30 nodes because it is intended for local transmission. The SBCCA protocol also provides the optimal outcome or latency for varying node densities and reporting rates. When there are delays, the TDMA performs terribly.

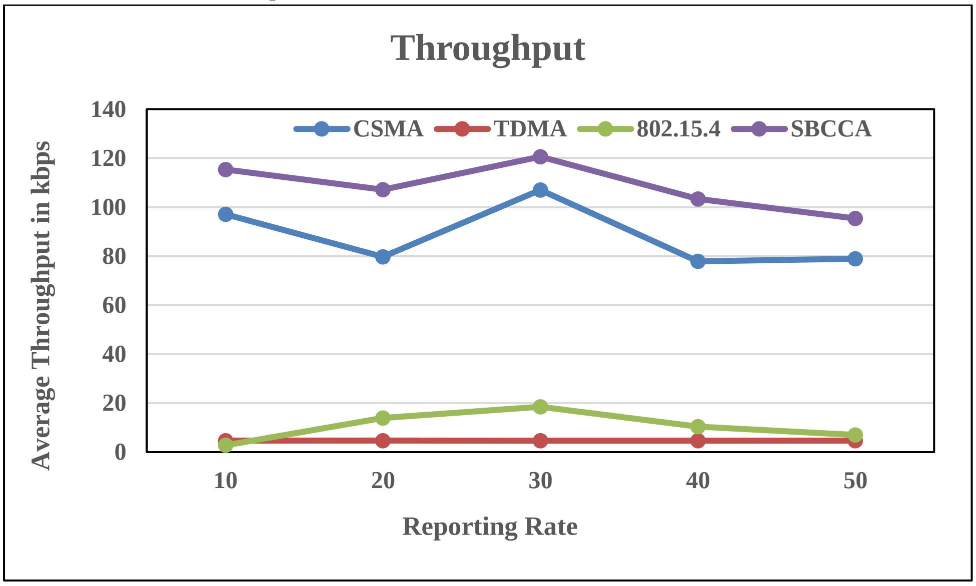

Fig 5. Average Throughput for Reporting Rate

The average throughput efficiency for various MAC protocols along with reporting rates is shown in Figure. For varying reporting rates, the SBCCA protocol performs 40–60% greater in terms of average throughput. The use of a transmission link determines the average throughput. Sharing information across sectors improves network throughput. When compared to 802.15.4 and the TDMA protocol, the CSMA protocol performs 20–30% better but is still 10–20% worse. The TDMA protocol performs far worse than other current protocols and the proposed SBCCA protocol because time slot-based data transfer minimizes the channel of communication utilization.

V. Conclusion

A SBCCA – sector based congestion control protocol is a novel protocol designed for congestion control and achieving QoS parameters of wireless networks. This protocol gives drastically better result as compare to existing MAC protocols like CSMA, TDMA and 802.15.4. SBCCA protocol gives almost 17-20% better result for PDR, 15-20% better result for PLR, 5 to 10% better result for delay and 20 to22% better result for network throughput as compare to second best protocol CSMA. SBCCA is almost 40 to 50% better as compare to TDMA and 802.15.4 for all QoS parameters. Sectoring technique in SBCCA helps to reduce heavy traffic, congestion and improve performance of the network. In future work we will implement hybrid MAC protocol which will be combination of CSMA and SBCCA Protocol for better network performance.

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