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ENHANCING THE PERFORMANCE OF CONGESTED SENSOR NETWORKS BY USING DIFFERENTIATED ROUTING

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ABSTRACT

Network congestion occurs when offered traffic load exceeds available capacity at any point in a network. We refer to this zone, essentially an extended hotspot, as the congestion zone (conzone). In wireless sensor networks, congestion causes overall channel quality to degrade and loss rates to raise, leads to buffer drops and increased delays. We address a differentiated data in the presence of congestion, and this is implemented using differentiated routing. We propose algorithm called CAR (Congestion aware routing) to discover the congested zone of the network and queue-up the data based on data prioritization. Since CAR is not enough to handle mobility data sources, so we are moving to MCAR (Medium access control enhanced CAR) which includes MAC layer enhancements and provides high-priority paths for bulk of data. MCAR successfully handles the mobility of high-priority data sources, and at the expense of degrading the performance of low-priority traffic. MCAR enhances the performance of congested networks by using differentiated routing to provide load balancing and fault tolerance.

Keywords: Wireless sensor networks, congestion aware routing (CAR), Congestion control, Differentiated service, MAC-Enhanced CAR (MCAR)

1. INTRODUCTION

A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multihop communication. The sensor nodes are typically expected to operate with batteries and are often deployed in not easily accessible or hostile environments, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Although the lifetime of a WSN can be defined in many ways, we adopt the widely used definition, which is the time until the first node exhausts its energy. Much work has been done during recent years to increase the lifetime of a WSN. Among them, in spite of the difficulties in realization, taking advantage of mobility in the WSN has attracted much interest from researchers. We can take the mobile sink as an example of mobility in a WSN. Communication in a WSN often has the many-to-one property in that data from a large number of sensor nodes needs to be concentrated to one or a few sinks.

Wireless Sensor Networks are on the brink of bringing true ubiquitous computing as we have never known it. A vast host of daily possessions will autonomously collect various types of sensor data and process and distribute this information to anywhere we wish to access it. Wireless Sensor Networks are going to change the way we live and work much like the internet has already changed the way we learn and communicate. Of course, it is impossible to conceive of all the possible applications of wireless sensor networks, but we can be sure that it will bring a new revolution in products and services.

Sensor networks are composed of small sensing devices that have the capability to take various measurements of their environment such as temperature, sound, light etc. These devices are equipped with a processor and wireless communication antenna and are powered with a battery. Upon deployment in a field, they form an ad hoc network and communicate with each other and with data processing centres. The routing protocol in such networks has an important effect on congestion, especially with increasing sizes of the deployments. Congestion becomes worse when a particular area is generating most of the data. This may occur in some deployments when sensors in one area of interest are requested to gather and transmit data at a higher rate than others. Energy consumption is most important factor for routing protocols in wireless sensor networks .Based on deployment sizes and data rates grow, **Congestion** arises as a major problem. Congestion may leads to indiscriminate dropping of data.

The proposed method is aware of the traffic congestion problem in specific sensor nodes and collects information about the child sensor nodes. Based on this information, the lightweight genetic algorithm is performed to select sensor nodes available for forwarding the congested data. Since the heavy traffic loads congested in specific sensor nodes are distributed to the forwarding sensor nodes, the problems due to traffic congestion can be alleviated. In experiments, the proposed method shows efficient data transmission due to much less queue overflow and supports fair data transmission for all sensor nodes. From the experimental data, it is evident that the proposed method not only enhances the reliability of data transmission but also balances the energy consumption distribution across wireless sensor networks. This result contributes directly to the extension of the total lifetime of wireless sensor networks.

2. RELATED THEORY

Since wireless sensor networks work on limited network bandwidth, traffic congestion frequently occurs during the relay process of sensing data. In wireless sensor networks, when a sensor node detects events in the surrounding environment, the sensing period for learning detailed information is likely to be short. However, the short sensing cycle increases the data traffic of the sensor nodes in a routing path. Since the high traffic load causes a data queue overflow in the sensor nodes, important information about urgent events could be lost. In addition, since the battery energy of the sensor nodes is quickly exhausted, the entire lifetime of wireless sensor networks would be shortened.

To address these problem issues, a new routing protocol is proposed based on a lightweight genetic algorithm. In the proposed method, the sensor nodes are aware of the data traffic rate to monitor the network congestion. The fitness function is designed from both the average and the standard deviation of the traffic rates of sensor nodes. Based on dominant gene sets in a genetic algorithm, the proposed method selects suitable data forwarding sensor nodes to avoid heavy traffic congestion. In experiments, the proposed method demonstrates efficient data transmission due to much less queue overflow and supports fair data transmission for all sensor nodes. From the results, it is evident that the proposed method not only enhances the reliability of data transmission but also distributes the energy consumption across wireless sensor networks.

Data congestion in WSN into two groups:

- Congestion avoidance
- Congestion control

In [1] the authors have propose an energy aware QoS routing protocol which can support the delivery of real-time data in the presence of non real-time data by using multiple queues in each node in a cluster based network. The division of data into non-real-time and real-time data is similar to concept of low and high priority data but it does not consider the impact of congestion due to excessive data rates in a localized part of the network. CAR (Congestion aware routing) is the protocol is to dynamically discover the conzone. The CAR is to enforce differentiated routing; high priority packets are routed in the conzone. The simulations show that CAR leads to a significant increase in the successful packet delivery ratio of high priority data to the sink, and a clear decrease in the average delay compared to AODV (Ad-Hoc on demand Distance vector routing). CAR also provides low jitter which makes it able to support real-time multimedia applications. It also reduces the energy consumed in the nodes that lie on the conzone which leads to an increase in connectivity lifetime.

In [2] the authors detailed about Flooding the network can cause collusions between the packets. Also there is always a small time delay at the beginning of a new connection because the initiator must first find the route to the target. Data delivery issues, in the presence of congestion in wireless sensor networks are analyzed. CAR (Congestion aware routing) protocol, the differentiated routing protocol uses data prioritization. MCAR(Medium access control congestion aware routing) protocol, which deals with mobility and dynamics in the sources of HP data. Both CAR and MCAR support effective HP data delivery in the presence of congestion. CAR is better suited for static networks with long-duration HP floods. For bursty HP traffic and/or mobile HP sources, MCAR is a better fit.

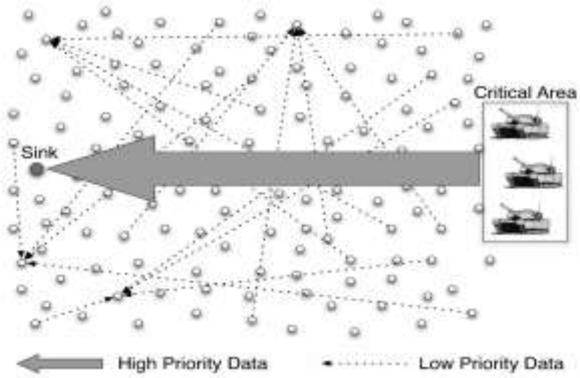

Fig 2.1: A typical mobile conzone (Congested zone) network

In [3] the authors have presented an energy efficient congestion control scheme for sensor networks called CODA (Congestion Detection and Avoidance). The framework is targeted to CSMA-based sensors and comprises three key mechanisms: (i) receiver-based congestion detection, (ii) open-loop hop-by-hop backpressure, and (iii) closed-loop multi-source regulation. Simulation results indicated that CODA can improve the performance of directed diffusion by significantly reducing the average energy tax with minimal fidelity penalty to the sensing application. Future congestion control mechanisms for sensor networks must be capable of balancing the offered load, while attempting to maintain acceptable fidelity (i.e., rate of events) of the delivered signal at the sink during periods of transient and more persistent congestion.

In [4] a hierarchical routing protocol which considers both energy and congestion as two main parameters in routing process is proposed. Authors have proposed protocol extends the routing approach in. Simulation results show that Hierarchical Tree based Energy efficient and Congestion aware Routing Protocol (HTECRP) catch its goals. HTECRP consider two different traffics:

- High priority
- Low priority.

Proposed protocol, uses best routes for high priority traffic and manages congestion, therefore they have suggest HTECRP for transmitting real time traffic. The proposed protocol is an energy efficient routing one which tries to manage congestion and perform fairness in network. Reactive Energy Decision Routing Protocol (REDRP) is another routing algorithm for WSNs whose main goal is optimal energy consumption. This algorithm attempts to distribute traffic in the entire network fairly. Using this mechanism, it decreases total network energy consumption.

In [5] the authors discusses about a new routing protocol is proposed to distribute the data traffic congested in a specific sensor node to available neighbour sensor nodes. The proposed method uses traffic awareness and a genetic algorithm. TARP (Traffic aware routing protocol) was proposed to alleviate the traffic congestion problem in wireless sensor networks. It used the lightweight genetic algorithm to select the data forwarding sensor nodes. These sensor nodes took over the data traffic of the sensor nodes suffering from heavy network traffic. Due to the limited resources in wireless sensor nodes, the proposed method devises a lightweight genetic algorithm by restricting the number of iteration loops for computation.

3. SYSTEM DESIGN AND PROPOSED SYSTEM

To secure routing protocol to improve the security of end-to-end data transmission based on multiple-path deliveries. The set of multiple paths between each source and its destination is determined in an online fashion, and extra control message exchanging is needed proposed a secure stochastic routing mechanism to improve routing security. Congestion may lead to indiscriminate dropping of data (i.e., high-priority (HP) packets may be dropped while low-priority (LP) packets are delivered). It also results in an increase in energy consumption to route packets that will be dropped downstream as links become saturated. As nodes along optimal routes are depleted of energy, only non optimal routes remain, further compounding the problem. To ensure that data with higher priority is received in the presence of congestion due to LP packets, differentiated service must be provided.

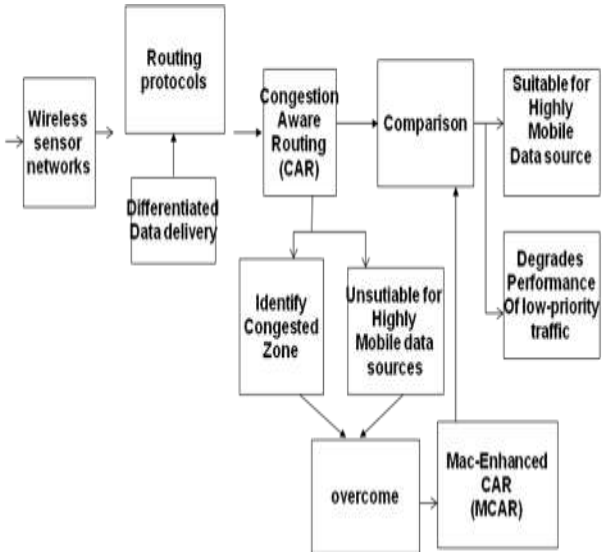

Fig3.1: Architecture diagram

The proposed system implements a class of algorithms that enforce differentiated routing based on the congested areas of a network and data priority. It employs the use of data prioritization and a differentiated routing protocol and/or a prioritized medium access scheme to mitigate its effects on HP traffic. The basic protocol, called Congestion Aware routing (CAR), discovers the congested zone of the network that exists between high-priority data sources and the data sink and, using simple forwarding rules, dedicates this portion of the network to forwarding primarily high-priority traffic. Since CAR requires some overhead for establishing the high-priority routing zone, it is unsuitable for highly mobile data sources.

To hold these, defining MAC (Medium access control)-Enhanced CAR (MCAR), which includes MAC-layer enhancements and a protocol for forming high-priority paths for each burst of data. MCAR enhances the performance of congested networks by using differentiated routing to provide load balancing and fault tolerance.

4. ROUTING PROTOCOLS

Routing protocols which only consider energy as their parameter are not efficient. In addition to energy efficiency, using other parameters makes routing protocol more efficient. For different applications, different parameters should be considered. One of the most important parameter is congestion management. Congestion occurrence leads to increasing packet loss and network energy consumption. Congestion occurs for different reasons in networks. One of the main reasons is storage space constraint in relay network nodes. When a node receives packets more than its capacity, congestion is occurred, and then many packets will be dropped. Congestion occurred for almost similar reasons in wireless sensor networks.

4.1 CONGESTION-AWARE ROUTING PROTOCOL (CAR)

Congestion aware routing (CAR) protocol for sensor networks are to provide high priority data with better service quality compared to other routing schemes. These include higher delivery ratios, lower delays and lower jitter to support real-time data. The aim is to decreasing energy consumption which will lengthen the lifetime of the network. While high priority data is routed through the conzone, low priority data is routed using the other nodes. Low priority data that originates outside the conzone is routed exclusively on off-conzone nodes using regular routing protocols such as AODV.

CAR increases the fraction of high priority data delivery, decreases delay and jitter for such delivery while using energy uniformly in the deployment. Since CAR reduces the energy consumed in the nodes, it leads to an increase in connectivity lifetime.

4.2 MEDIUM ACCESS CONTROL- ENHANCED CAR PROTOCOL (MCAR)

MCAR is primarily a MAC-layer mechanism used in routing to provide mobile and lightweight conzones to address sensor networks with mobile HP data sources and bursty HP traffic. As a result, by using a lightweight dynamic differentiated routing mechanism to accommodate mobile data sources. MCAR is based on MAC-layer enhancements that enable the formation of a conzone on the fly with each burst of data. The enhanced MAC-layer of MCAR uses an RTS/CTS (Request to send/ Clear to send) protocol that is augmented to carry information about the priority level of the data being transferred. Each RTS and CTS packet is tagged with a priority level. MCAR in that they both prioritize access to the medium, the prioritized RTS/CTS messages in highly congested networks may be dropped. MCAR uses a mechanism that does not require pre-empting all LP data transmissions in the neighbourhood for each HP data to be sent. MCAR silences the conzone and its neighbourhood during route discovery and/or maintenance. MCAR is not prohibitive, since it uses these RTS/CTS packets only during the route discovery.

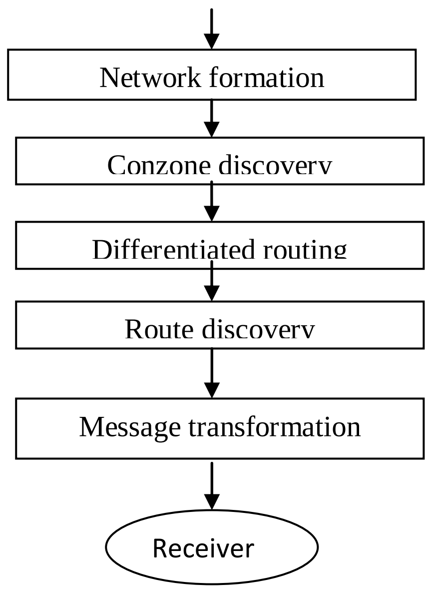

Fig4.1: MCAR Data Flow diagram

4.2.1 DIFFERENTIATED ROUTING

Once the conzone is discovered, next task is to route high priority data on the conzone and route the low priority data off the conzone. Since the critical area is a part of the conzone, all high priority data will be generated inside the conzone. Congestion occurrence leads to increasing packet loss and network energy consumption. One of the main reasons is storage space constraint in relay network nodes. When a node receives packets more than its capacity, congestion is occurred, and then many packets will be dropped. Here CAR is developed to monitor the differentiated delivery services, and each data will be delivered by different node.

4.2.2 ALGORITHM DEFINITION

Conzone discovery from critical area to sink:

If a node x receives destination from child then
If onConzone is equal to FALSE then
If ToSink_received is greater thenToSink threshold then
OnConzone is equal to TRUE
If the x is not sink then
Broadcast ToSink with node depth
Else
Increase the destination received
Else if node x receives destination from parent then
Decreasing of off-Conzone parents is equal to parent
Increasing of off-Conzone parents is equal to patent
Else if node x receives todestination from sibiling then
Decreasing of off-Conzone sibiling is equal to sibiling
Increasing of on-Conzone sibiling is equal to sibiling

5. CONCLUSION

This paper address data delivery issues in the presence of congestion in wireless sensor networks. CAR and its variants increase the fraction of HP data delivery and decrease delay for such delivery while using energy more uniformly in the deployment. CAR also routes an appreciable amount of LP data in the presence of congestion. MCAR maintains HP data delivery rates in the presence of mobility and show that the route setup and increases the performance by decreasing data loss rates. Also, while the effectiveness of MCAR merges multiple conzones, and are exploring the interactions of differentiated routing and multiple conzones. MCAR is better when compared to CAR, because it improves the overall performance of congested sensor networks.

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