

# Delay Performance of Multi-hop Wireless Sensor Networks With Mobile Sinks

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**Abstract** – A mobile Wireless Sensor Networks (WSN) owes its name to the presence of mobile sinks or sensor nodes within the network. The main aim of the project is to have transmission of packets from source to the destination sink by reducing delay and improving network lifetime constraints. End-to-End delay analysis can be used in Wireless Sensor Networks to design admission control policies that provide statistical quality of service guarantees. The scope of the work is to propose a packet transmission and to reduce the delay with Mobile sinks is used. Then analytically evaluate the probabilistic estimations of delay analysis of both the multi-hop delivery delay and the network lifetime in a wireless sensor network. Mobility Data Collection Model (MDC) approaches that includes many parameters such as number of mobile sinks and travelling path of mobile node. Route Delay Optimization Technique for Multipath - Generalized Topology Method for reducing the delay for AODV routing protocol. The analytical framework evaluate the performance of two different routing protocols like Ad hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) for monitoring of critical conditions with the help of important metrics like throughput and end-to-end delay in different scenarios.

**Index Terms** –Wireless Sensor Networks, multi-hop, AODV, Quality of Service ,Sink.

## I. INTRODUCTION

### A. Wireless sensor Network

Wireless sensor networks (WSN) are now used in many applications including military, environmental, health care applications, home automation and traffic control. WSNs are self created by the collection of a large number of sensor nodes, interconnected by multi-

hop networks. A wireless sensor network [1] typically consists of large number of small, low cost, robust, and low power sensor nodes and wireless communication capacities performing monitoring applications. Wireless sensor network generally composed of a large number of distributed sensor nodes that organize themselves into a multi-hop wireless network. Each network is connected with more than one sensor nodes, processing units, data processing and communication units.

Sensor nodes are capable of collecting information from neighbouring nodes and collaborating with one another via multi-hop networks and nodes measuring the condition of their surrounding environments. The collected data will be transferred to the sinks. Sensor nodes are expected to operate with battery nodes.

However the fact that the sensor nodes in WSN have short radio transmission range, co-ordinating nodes will be act as relay nodes to transmit data towards the sink node using multi-hop network.

This approach provides an analysis of cross-layer approaches in Wireless Sensor Networks and delay performance analysis in multi-hop Wireless Sensor Networks [5] with sinks. The scenario of this paper is reducing the end to end delay of multi-hop network with sinks.

Quality-of-Service(QoS) [5]routing protocols are needed to search for a path that can satisfy certain QoS requirements and constraints such as bandwidth ,reliability, fault tolerance, robustness. This approach provides an analysis of cross-layer approaches in wireless sensor networks and delay performance analysis in multi-hop wireless sensor networks with mobile sinks.. A sensor node usually sends its data to the sink by a multi-hop wireless sensor network route that composes many sensor nodes. The amount of power consumption is to determines the node`s network

lifetime. One way to maximize the network lifetime is to use a special Mobile-data collector (MDC) for data gathering, for multi-hop data transmission to the mobile-sink through co-ordinator. The MDC collects the data from the nodes and transfers it to the mobile-sink.

Finding a route from anywhere within the Network to a mobile node is accomplished by finding a route to a relay node in the network which is within a distance of the mobile-node. One way to maximize the network lifetime is to use a special Mobile data collector (MDC) for data gathering, for multi-hop data transmission to the sink.

Existing mobility data collector models can be classified according to the following criteria.

- Responsibility of the mobile sink.
- Mobility of the mobile node.
- Routing of data.
- Data collection rate

The responsibility of node comprises two types of mobile nodes are mobile sink and mobile relay. A mobile sink is the final destination in the part of a WSN of a set of data that were collected by sensors .mobile relay is temporarily stores data from and forwards data to the sink .in this thesis wireless sensor networks with multiple mobile-sinks have been investigated.

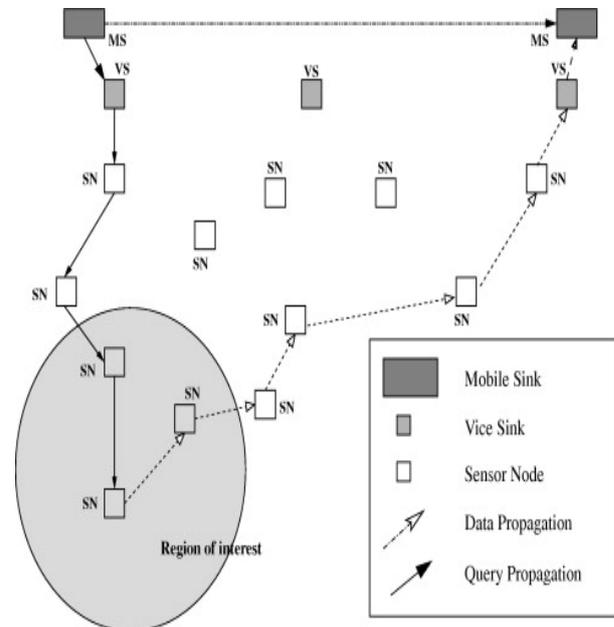
Mobility of mobile nodes focussed on determining the moving path of each mobile sink to maximize the lifetime. MDC models are based on controlled mobility in terms of mobile node travels in a predetermined path.

Routing of data deals with two styles, single-hop and multi-hop with single –hop routing, each sensor node forwards data to a mobile sink when it is in the communication range. Compared with single –hop routing, multi-hop routing a sensor usually forwards the data to the co-ordinator will send the data to the mobile sink.

Data collection rate ,most mobility assisted data collector assumed a fixed data collection rate two types of data are assumed, urgent messages with a fixed rate and regular messages travelling the path of node at a rate.

The multi-hop delay is one of the most critical and fundamental issues for Wireless Sensor Networks. More applications of sensor networks require an end-to-end delay guarantee for Time sensitive data. However, the end-to-end delay is difficult to bind for event-driven sensor networks, where nodes generate and transferring data only when an event of interest occurs, and thereby producing unpredictable traffic load. Meanwhile, the end-to-end delay[6] is tightly banded with many other

factors, e.g., energy and network capacity. cross-layer scheme provides good performance in terms of WSN-lifetime, Reducing the end –to-end delay of nodes, scalability and minimizing network-wide energy consumption cross-layer approach to investigate the impact of the physical-layer infrastructure on the data-link- performance in wireless sensor networks.



**Fig. 1** Wireless sensor Network

Packets are passed from source to destination through routing protocol where the bandwidth is used effectively. For increasing the network performance and maximizing the lifetime of packet. The simulator used in this project is Network Simulator and the packet or data transmission is based on AODV protocol specification. At the data-link layer, our focus is on how this physical layer infrastructure influences the real-time multimedia QoS provisioning performance such as delay-bound violation and buffer-overflow probabilities. To achieve this approach, we first model the physical-layer service process as a Route Delay Optimization Technique. Based on this multi-hop generalized topology, we then characterize the QoS performance at the data-link layer using the effective capacity methodology, which turns out to be critically important for the statistical QoS guarantees in Wireless sensor networks.

Accordingly a cross-layer design used in wireless sensor Networks to improve efficiency and reliable communication with other layers .cross –layer design developed with wireless sensor networks to minimize energy expenditure. It consists of the estimation of the multi-hop delay distribution function by using current

local state information of neighbour hops, which requires low memory and computational resources. We introduce a probabilistic approach based on the generalized notion, which approximates the multi-hop delay distribution of a routing path by performing statistical analysis of local information gathered at intermediate hops.. cross-layer design is developed to characterize the multi-hop delay distribution in wireless sensor networks deterministic and random deployment of nodes.

In wireless sensor networks multi-hop delay is a critical parameter for quality of service guarantees. We analyze the end-to-end delay distribute on in wireless sensor networks for AODV protocol[4]. The multi-hop delay distribution problem in wireless sensor networks is defined and an overview of the proposed Multipath-Generalized Topology Method is used.

In single –hop delay distribution approach calculate with inter-arrival time and service time of packets. In inter-arrival time is determined with multi-hop wireless sensor networks at each nodes consists of generated packets and relay packets. In generated packets consists of general information from the sensor nodes and relay packets consists of information received from neighbours of the node. The inter-arrival time of each node determined with many applications are periodic and event based .In periodic the generated data is monitored and nodes repeatedly sense their nodes and while in event based applications nodes send data only particularly in a certain physical interests eg pressure exceeds a certain threshold. Considering such physical events does not occur periodically, the probability determined that the event occurs at any time is calculated with poison process. inter-arrival time of packets in a multi-hop wireless sensor networks for both types of applications ie, generated and event based for low and high traffic rates.

## II. SYSTEMS DESIGN

The main objective of the system is to provide a continuous communication between the Sensor nodes by reducing the mean packet delay considerably within the multi-hop network with Mobile sinks. The Figure 2 shows the system architecture of the project. The above figure explains the packet transmission. Wireless Sensor Network is a Wireless Sensor Network, which works with AODV protocol a where different nodes are sending packets from one end to other end. It concentrates in decreasing the delay in transferring packets and to increase throughput. It focuses on reducing packet loss rate. This work is mainly deals with three important layers of ISO-OSI model.. The Network Layer performs network routing functions, using AODV and Dynamic Source Routing protocols

and report delivery errors in the network. Routers operate at this routing layer—sending data throughout the extended network and making the Internet possible. The cross-layer analysis is done with different layers of OSI reference model. Mobility Data Collector (MDC)[3] is used in the Wireless Sensor Networks to determine the lifetime of the packet in the multi-hop network.MDC also finds the responsibility of node, mobility of node, routing of node. The Application Layer is the OSI layer closest to the end user. Application layer functions typically include identifying communication nodes and availability of nodes and synchronizing communication. QoS guarantees deals with in the Application Layer .It mainly contributes with two factors reliability and timing. Here the packets are sending to the neighbour node or client or receiver. Initially allocate the sink i.e. the no of nodes available to the multi-hop Network. Then transfer the packet in to sensor nodes, based on no of nodes available in the multi-hop network. Measure the delay also for each node and update it.

There functional modules in the system may include Multi-hop delay distribution, Mobility of node, Path selection ,Advertise neighbour and path, Route Delay Optimization, Route Discovery. These six modules deal with how packets are transmitting from sensor nodes to a Sink to increasing throughput, reducing delay and bandwidth constraints and maximize the network lifetime.. Packets are passed from source to destination through routing protocol where the bandwidth is used effectively. For increasing the network performance and maximizing the lifetime of packet mobility of node is used. The simulator used in this project is Network Simulator and the packet or data transmission is based on Dynamic Source Routing protocol specification.

A sensor node usually send its data to the sink by a multi-hop wireless sensor network route that composes many sensor nodes. The amount of power consumption by the nodes determines the node and network lifetime. One way to maximize the network lifetime is to use a special Mobility data collector(MDC) for data gathering, for multi-hop data transmission to the sink. The MDC collects the data from the sensor nodes and transfers it to the mobile sink.

Mobile node is modelled according to a real time queuing model which is determined by its inter-arrival time and service time. In a multi-hop wireless sensor network, the input traffic path at each node consists of two packets, generated packets and relay packets. Relay packets depends upon network parameters and information received from the neighbours of node. A generated packet depends upon the physical phenomena of interest and real time applications and consists of

local information detected by the sensors. in Wireless Sensor Networks overall network performance actually improves as an increasing number of sensor nodes are added to the network..

Cross-layer approach is used in the end –to end delay is defined as here the packets are sending to the neighbour node or client or receiver. Initially allocate the parents, i.e. the no of parents available to the multi-hop. Then divide the messages in to data, based on no of sensor nodes available to the network. Allocate channels to the sink and send the messages. Measure the delay also for each arrival of packet and update it. Sending nodes or the servers sends the packet to the client through the Sensor nodes in the multi-hop network. For sending the packets to the client, the server uses balance routing algorithm in order to arrangement of nodes in the multi-hop network and also analyse the performance of the network. The performance analysis is based on delay analysis, packet loss ratio, packet delivery rate, bandwidth analysis.

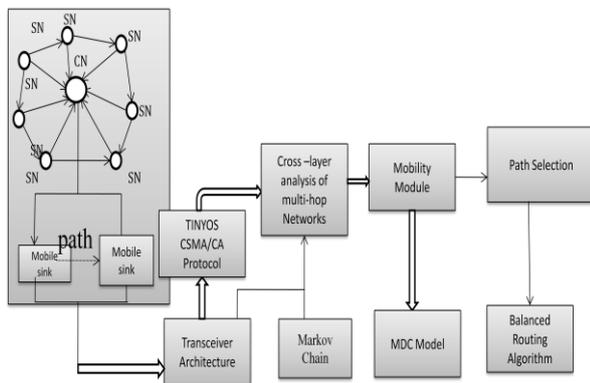


Fig 2. Overall System Design

With multi-hop delay distribution is modelled as a proposed Route Delay Optimization Technique[2] uses dynamic source routing algorithm, which provides soft QoS guarantees with respect to end-to-end reliability by discovering a set of multiple disjoint paths and transmitting data along these paths. , the entire network is considered as a queuing network. Multiple nodes are connected from source station to destination (mobile sink) through co-ordinator. Nodes are inter-related according to the traffic constraints. More specifically, the successfully transmitted traffic rate from one starting node to destination node is should be equal to the sum of the incoming relay traffic rate at each of the next-hop neighbours of the node. The topology of the Queuing network depends on the routing protocol used. In this scheme, focussed on the reducing the delay of multi-hop Wireless Sensor Networks with mobile sink in which each node maintains a probabilistic routing table

for its neighbours, e.g., geographic routing protocols .Nodes transmits their packets to each of their neighbours according to a probability in their routing tables.

Multiple nodes are connected from source station to destination (mobile sink) through co-ordinator. Nodes are inter-related according to the traffic constraints. More specifically, the successfully transmitted traffic rate from one starting node to destination node is should be equal to the sum of the incoming relay traffic rate at each of the next-hop neighbours of the node. The topology of the Queuing network depends on the routing protocol used Network build routing trees for each cluster from sensors to cache nodes. To create the nodes, and proposed a Balanced Routing Algorithm, let  $B_j$  be the number of sensors on the tree rooted at cache node  $j$ . The input of balanced routing algorithm is location of sensor nodes in the Network. Beginning with connecting every sensor nodes with one of its neighbour's nodes in the multi-hop network. Mobile sinks are determined the sender and destination nodes. For each sensor  $s$  and  $g_i$  is the minimal number of hops in the network. The beginning of algorithm determines connect every sensor node with its neighbour node.

### III. IMPLEMENTATION

#### A. Route Delay Optimization

Route Delay Optimization Technique uses dynamic source routing algorithm, which provides soft QoS guarantees with respect to end-to-end reliability by discovering a set of multiple disjoint paths and transmitting data along these paths. First, the source node selects multi-hops network and that need to send data to Mobile Sink. Multi-hop -Generalized Topology) model adaptively utilizes the network qualities including packet loss rates and delay histories in the route selection. It consists of two phases: route discovery phase and route maintenance phase.

#### B. Route Discovery

To initialize the route discovery process, route discovery algorithm. Algorithm performs some steps to construct various routes from source to mobile sink. From these routes multiple paths and alternate paths are chosen to flow the data over those multi-hop network. After discovering all the possible paths, multi-hop identification is performed. In the proposed AODV routing protocol the communication is spread over the nodes lying on different possible paths between the source and the sink to provide a reliable transmission.

#### C. Path Selection

The Balanced Routing algorithm is composed of two major steps. The first step is path-sorting algorithm,

which is simply a sorting procedure that sorts all feasible paths (gathered from the REQ messages) in a descending order according to their accumulated path reliabilities. The second step is a path selection algorithm that selects a group of separate paths from the candidate set, such that this group of separate paths may collectively satisfy delay.

#### D. Advertise Neighbour And Path

Advertise neighbour and path discovery is performed when the sensor node has no idea about the structure of its immediate surroundings. Every time a node wakes up, it broadcasts HELLO message. Only nodes that are also awake and within the communication range can hear this message and establish connections. The node out of communication range doesn't establish the connection with that node. After discovering the neighbours, routes are discovered using tree based search algorithm that calculates the path from one node to some pre-specified goal node.

#### E. Mobility of Node

Mobility of mobile nodes focussed on determining the moving path of each mobile sink to maximize the lifetime. MDC models are based on controlled mobility in terms of mobile node travels in a predetermined path.

### IV. PERFORMANCE EVALUATION AND SIMULATION METRICS

#### A. Performance Metrics

The performance of Route Delay Optimization Technique and standard DSR are compared by using the following metrics:

#### B. Packet Delivery Ratio:

It is the ratio of the number .of packets received successfully and the total number of packets transmitted.

#### C. Average end-to-end delay:

The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

#### D. Throughput:

It is the ratio of successfully received data packets by the base station to the total packets being sent from the source nodes.

### V. RESULT ANALYSIS

The availability of continuous communication by reducing the end to end delay is the main objective of the work implemented The end to end delay performance of multi-hop network with mobile sinks is analyzed. The performance of Route Delay

Optimization Technique and standard DSR protocol is used to analyze the delay of packet Many algorithms is used to find the path selection and route discovery of multi-hop network. Mobile sinks is used to increase the lifetime of the network. Based on this information graphs are plotted with nodes against the average end to end delay. The end to end delay of these nodes are also shown with these obtained values. From the graph, it is able to know number of sensor nodes which are connected in the network and their connectivity between each other.

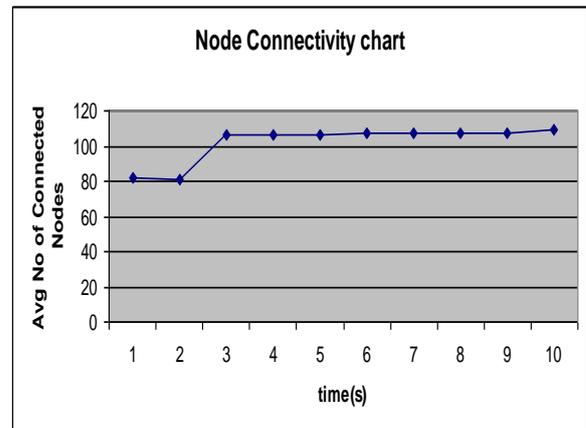


Fig 3.average end to end delay

### VI. CONCLUSION

In Wireless Sensor Network (WSN) network Providing QoS guarantees in Wireless Sensor Networks (WSNs) necessitates a probabilistic approach, where the queuing delay and the effects of wireless channel errors are captured. In this approach, an End-to-End Delay analysis of multi-hop Wireless Sensor Networks with mobile sinks is determined and communication delay is provided. . A Route Delay optimization Technique process based on multi-hop generalized topology is used to model the communication process in a multi-hop network. The developed model is validated by extensive test-bed experiments through several network configurations and parameters. The results show that the developed framework accurately models the distribution of the multi-hop delay and captures the heterogeneous effects of multi-hop Wireless Sensor Networks.

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